DEPARTAMENT D'ECONOMIA APLICADA

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PH.D THESIS

VALUE EQUIVALENCY ANALYSIS: QUANTITY COMPENSATION, DISTANCE DECAY, AND TIME TREATMENT

BY: DULCE ARMONIA BORREGO

ADVISOR: PROF. PERE RIERA

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Contents

Introduction

In 2004 the European Parliament and Council passed the Environmental Liability Directive (ELD) requiring Member States (MS) to codify environmental liability into national law. The ELD was adopted on 21 April 2004 and the deadline for its transposition in the MS was 30 April 2007, although the transposition of the ELD is still ongoing in some MS throughout the European Union (EU) after the deadline.

Environmental liability can be defined as the mechanism by which the cost of damaging the environment is transferred back to operators who cause the damage. Hence, the ELD provides the legal framework for introducing environmental liability motivated by the Polluters Pay Principle (PPP). That is, the responsible operators must provide environmental compensation for these losses through *restoring, rehabilitating, replacing, or acquiring the equivalent* of the injured resources (15CFR 990.30) rather than cash payment which is typically associated with civic liability.

In this context, the ELD requires operators to cover themselves for damaging the environment. The most popular instrument to cover environmental liability is insurance followed by bank guarantees and other market based instruments (MBI) such as permits, assets deposits, etc. The law requires the competent authorities to establish a system to control de validity of insurers and operators to provide the competent authority with the information that it might request in this regard.

The responsible parties of the damage are required to restore the subsequent environmental damage to its baseline condition. The restoration can consist of active actions or of natural recovery. Both of which with respect to losses of environmental resources and services. The concept, highlighted in Annex ll of the ELD, is not significantly different from civic liability: *a responsible party found to be environmentally liable is required to pay compensation (a restoration project) to the affected party (the public who loses a functioning environmental resource) and the compensation should be commensurate with the damage caused (i.e. the restoration project should be equivalent in scale to the contamination)*.

When determining the scale of restoration, the ELD recommends the use of the Equivalency Analysis (EA) approach. EA approaches can be used in the assessment of environmental damage and selection of appropriate remediation projects and have been broadly used in the United States to measure environmental liability with the purpose of protecting natural resources.

EA is a tool to determine the necessary amount of remediation required to return the environment to its baseline situation, as if it had not suffered the damage. This is possible by providing services that are equivalent to the interim losses of natural resource services following the damage and consists of actions that provide natural resources of same type, quality and quantity. The equivalence between damage and remediation can be estimated in terms of services (e.g. hectares of wetlands), also called service-to service approach, or resources (trees, fishes, birds, etc), called resource-to-resource approach, but under some circumstances the law also provides for welfare equivalency (generally expressed in monetary units), in the latter case, the analysis is called value-to-value approach.

According to section 1.2.2 of Annex ll of the ELD: "*When determining the scale of complementary and compensatory remedial measures, the use of resource-to-resource or service-to-service equivalence approaches shall be considered first. Under these approaches, actions that provide natural resources and/or services of the same type, quality and quantity as those damaged shall be considered first. Where this is not possible, then alternative natural resources and/or services shall be provided. For example, a reduction in quality could be offset by an increase in the quantity of remedial measures*".

This Doctoral Dissertation is composed of three independent papers based on a case study that uses value equivalency analysis (VEA) approach. The common feature in all of them is that they all deal with the concept of remediation to off-set the environmental damage following a forest wildfire in Spain. The study discusses some related issues to value-to-value equivalency methods, like the role that location of the restoration actions plays in determining the overall benefits and the time treatment.

Following this introduction, an overview of equivalency under the ELD and the key concepts associated with environmental compensation are briefly presented. Chapter one "**Forest Fire Compensation. A Contingent Valuation Exercise with a Fix Bid and Varying Environmental Quality Levels"** presents the mentioned application of equivalency analysis to estimate the compensatory remediation required to off-set the environmental damage following a wild forest fire in Catalonia, Spain. Value Equivalency Analysis is undertaken by a Contingent Valuation (CV) exercise to determine the welfare loss from the initial damage and interim loss and then a remediation project that can be established based on that information. A further issue associated with the compensation for the burned forest is the fact that the study elicits the minimum amount of compensation required to make individuals as well off as they would be in the baseline situation.

This analysis relies on a value equivalency approach and constitutes a first application for forest fires as those are not covered under natural resource damage liability in the US (regulations for liability only covers oil spills -OPA- and chemical releases -CERCLA-). Thus, from a restoration perspective, the application poses some interesting challenges.

The second chapter **"Distance Decay Functions from Damage to Restoration Site. A Value Equivalency Exercise"** explores an interesting issue in scaling regarding the role of the remedial actions using VEA approach. Specifically, the distance of an off-site remediation from the damaged site influences the amount of remediation to be supplied. Intuitively, the idea that location of an off-site restoration project taking place further away from the damaged site may require more credit than if the restoration was to take place more proximate to the damage site. An additional exercise was designed to estimate the trade-off rate for compensating in a farther away site (the equivalent to the discount rate in time).

Finally, the third chapter **"The Perception of Inflation in Stated Periodical Payments. Some empirical Evidence"**, focuses on the information provided to respondents regarding payments in the survey instrument. This includes telling respondents how they would pay for it and if the payments correspond to nominal or real values. While most practitioners believe that the design of the information component is a crucial component of any contingent valuation study, the implicit assumption of many studies is that respondents understand the information and that it does not affect the outcome of statistical tests. This implicit assumption may be invalid, and careful consideration must be given to all the information provided to respondents in a contingent valuation survey. In order to explore this issue the value elicitation question in this survey took the form of a single bounded dichotomous choice where the payments were to be made every year, for ten years, and they would go up every year according to inflation.

Overview of Equivalency Analysis

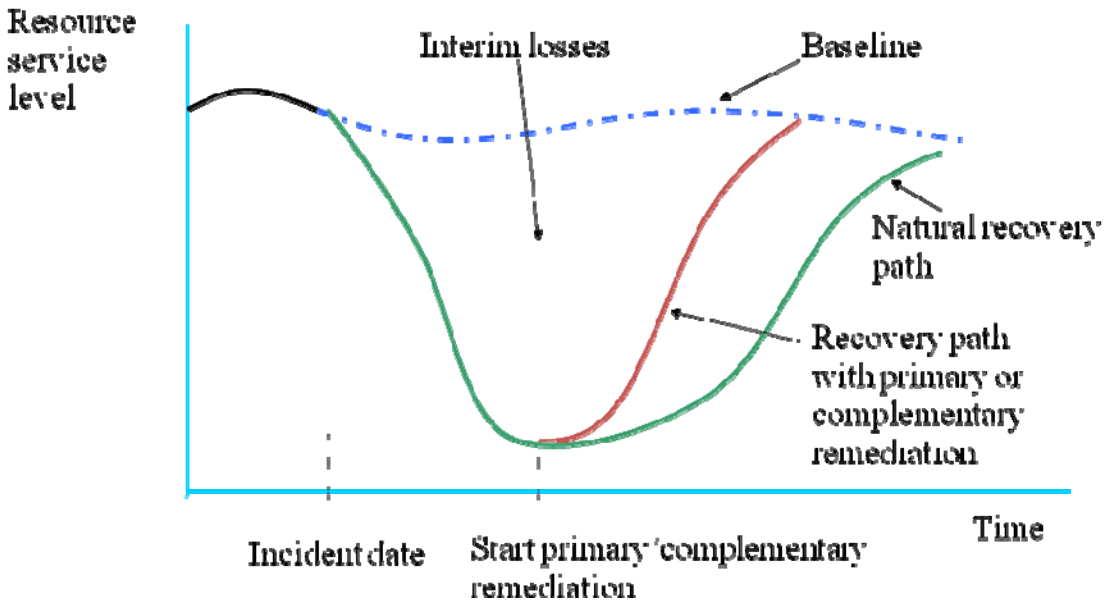
In the event of an incident (or an imminent threat of an incident) that causes environmental damage ELD requires the damage to be remediated so that the affected environment returns to its baseline. The Directive also requires that the public is compensated for the initial damage and the losses during the time the environment takes to recover back to baseline.

The concept of compensating the public for environmental contamination could be confused with a “cash payment” to off-set the damage. Instead, the ELD requires that compensation occur vis-à-vis the public –and not an individual, as in civic liability- and repair environmental damage through remedial actions. Rather than a cash payment, responsible polluters bear the cost of remedial actions required by the ELD.

Equivalency Analysis methods are only one input to the process of deciding how remediation should proceed. There may be other considerations that Competent Authorities, operators or other stakeholders may wish to take into account for a given damage site. These site-specific considerations may also be taken into account in any negotiation toward a final remediation agreement to offset environmental damage.

Figure 1 shows a stylized picture of what an incident and its effects on the environment may look like over time.

Figure 1. The Anatomy of Damages in Equivalency Analysis



The y-axis of the graph in the figure measures the quality and/or quantity of the natural resource affected. It can be measured in any unit, or **metric**, so long as both damages from the incident and benefits from remediation are estimated using the same metric. Selection of the metric determines the type of EA: If the metric is expressed in terms of resource units (such as number of fish or birds), the analysis that follows is called **Resource Equivalency Analysis (REA).** Here, damage is measured in terms of the reduction in the chosen resource units. The benefit of remediation is measured in terms of the increase in the chosen resource units. If the metric is expressed in terms of habitats (e.g. provisioning, nutrient and carbon cycling, regulating etc.), the analysis that follows is called **Habitat Equivalency Analysis (HEA)**. Here damage is measured in a combination of the area of habitat(s) damaged and the degree of damage (in terms of the percentage reduction in the ecosystem services typically provided in the baseline). The benefit of remediation is measured in terms of area of habitat improved or recreated and/or provision of services improved.

If the metric is expressed in terms of money, the analysis that follows is called **Value Equivalency Analysis (VEA)**. There are two variations to VEA. In the **value – to – value** variation, both damage and benefit of remediation are measured in terms of their economic value, i.e. in money units. In the **value – to – cost** variation, damage is measured in terms of the economic value lost. The remediation actions are then

designed to cost at most as much as the monetary estimate of this value lost. 'Value' measured here refers to Total Economic Value of the environment based on individuals' preferences for the use they make of the environment and for other non-use reasons[1]. VEA is likely to be most appropriate when the nature, scale, or location of remediation projects differs from the specific resources and services damaged or if the damage results in a welfare loss to a significant user population (i.e., fishing, swimming, recreation, etc).

The x-axis of the graph in the figure shows the change in the quality and quantity of the natural resource/service affected over **time**. The environment varies over time due to natural and human-made factors and so does its recovery after an incident.

The first solid then dashed line at the top of the figure shows the **baseline**. Baseline reflects the condition of the resource and its associated services (including the physical, biological, or ecological functions of a resource, as well as any use or nonuse human services provided by the resource) had the damage not occurred. In the figure, a more or less flat baseline is shown, implying that the conditions would not have varied substantially had the damage not occurred. The figure also shows an 'incident date'. This point represents the onset of environmental damage and typically represents the **base year** for any analysis.

As soon as the ELD is deemed to apply, it requires the implementation of **primary remediation**. Primary remediation includes any remedial measures which return the damaged natural resources and/or impaired ecosystem services to (or towards) baseline conditions. The selection of primary remediation measures are typically conducted in conjunction with clean-up on-site restoration activities and are motivated by immediate ecological impacts rather than considerations of compensation for loss.

Where primary remediation measures do not result in fully remediating the damage natural resources and/or ecosystem services back to baseline conditions, further **complementary remediation** measures are required. These are most likely to involve remediation of similar resources offsite, or remediation of resources that differ somewhat from the damaged resources. Thus, an equivalency between the damage and the benefits provided by the complementary remediation needs to be

[1] Total Economic Value is measured by individuals' willingness to pay (WTP) for an improvement or to avoid degradation in the quality and/or quantity of a resource or their willingness to accept compensation (WTA) to forgo an improvement or to tolerate degradation. There are several motivations for why individuals may have WTP and WTA for the environment: direct use value (consumption of resources or non-consumptive uses like recreation), indirect use value (ecosystem services that regulate the functioning of the environment), option value (for future uses of the environment) and non-use values (protecting the environment for others who make use of it now – altruistic value; for future generations – bequest value; and for the sake of the environment itself – existence value).

established. The EA approaches can be used to help select the type and define the scale of complementary remediation measures.

Primary and complementary remediation measures need not require human intervention. **Natural recovery** can and should be considered as a remediation option. Green and red lines in the figure show these possible remediation options.

The figure shows that recovery of the resource back to baseline takes time during which there will be loss of resources and services. This is referred to as **interim loss**. In the figure, this is the area under the baseline curve and above the primary / complementary recovery curve. In cases where it is not technically feasible for the resource to recover back to baseline, the interim loss continues into perpetuity.

The ELD requires that interim losses are compensated. Remedial measures designed to address interim losses are referred to as **compensatory remediation**. Compensatory remediation measures are most likely carried out on a different resource than the damaged resource and usually at a different site. Thus, an equivalency between the damage and the benefits from compensatory remediation needs to be established. Thus, in addition to the selection of complementary remediation measures, EA can also be used to select the type and scale of compensatory remediation measures.

In the language of EA, **the debit** refers to an expression of the loss suffered due to environmental damage. The debit is often multi-dimensional, since an environmental damage can have adverse impacts on many species, habitats, ecosystem functions, and human use and non-use values. In addition, the spatial and temporal extent of the damage and degree of the damage can vary depending on how damage is measured.

The credit in an equivalency analysis is the amount of resource or service benefit that will be gained through complementary and compensatory remediation. An off-site project (or suite of projects) is designed and implemented to enhance the resources and services that were damaged. The number, type and size of projects are scaled so that the expected amount of benefit generated approximately equals the debit, quantified in terms of the same metric used to quantify the debit.

Ensuring equivalency between the debit and credit is conceptually quite simple:

- Add up all the losses (debits) caused by the damage;
- Determine the amount of benefit expected per unit of remediation (credits); and

- Divide the debit by the per-unit credit to get the total amount of remediation needed.

However, in practice, ecosystems are complex, and understanding and quantifying the impact of an environmental damage can be difficult. In addition, quantifying the benefit that will be provided over time by a remediation project can be difficult. Therefore, quantifying the debit and credit typically requires expertise and professional judgment on the part of the equivalency analysis team. Such a team might include biologists, ecologists, toxicologists, chemists, hydrologists, economists, recreation managers, and other environmental specialists whose knowledge is relevant to the type of resources and services damaged or remediated.

CHAPTER 1

Forest Fire Compensation. A Contingent Valuation Exercise with a Fix Bid and Varying Environmental Quality Levels

ABSTRACT

In dichotomous choice contingent valuation, the environmental change is fixed throughout the sample whereas the monetary bid changes. This paper applies this procedure to estimate the “debit” or value of a natural resource damage. In a value to value framework, the equivalent “credit” in environmental improvement has to be calculated. For that, a variant of the dichotomous choice contingent valuation method is proposed, where the monetary bid is fixed to the estimated debit value and the amount of environmental compensation varies. In that way, the minimum amount of physical compensation for the damage is calculated. A case study application is preformed based on a forest fire occurred in the northeast of Spain. It is estimated that for each hectare of forest burned, a primary remediation of one hectare, and a compensatory remediation of approximately one third of hectare for the interim losses are needed.

1.1 Introduction

Resource equivalency approaches have been broadly used in the United States to measure environmental liability with the purpose of protecting natural resources. Recent European Union environmental laws have been enacted to ensure that environments are rehabilitated and restored by providing compensation for damage of man-kind to natural resources (European Commission, 2006). In this context, environmental liability may be defined as the responsibility of polluters to restore the environmental damage to a baseline condition.

In general, two approaches can be used to calculate the amount of required compensation: the physical natural resource needed to compensate for the harm (resource-to-resource or habitat-to-habitat) and the social value of the harm (value-to-value). The European Directive on Environmental Liability gives priority to the former, but also contemplates the latter.

In a resource equivalency analysis the “debit” or damage is computed in terms of lost of damaged resources. The planned compensation or “credit” is equivalent in resource terms to the debit. Similarly, in a habitat equivalency analysis, the debit and credit in terms of habitat are equated. Also, in the value equivalency analysis (VEA), the value to society of the credit offsets the social value of the debit. Depending on the approach adopted, the results would be expressed in different metrics, for example the area of required remediation (e.g. hectares of forest), the number of organisms or species to be replaced (e.g. trees, birds, or other wildlife), the time units of recreational use, the monetary units, etc.

This paper applies a stated preference approach –the contingent valuation method (CVM)– as a tool for estimating the appropriate remediation for a burned forest in Catalonia, Spain, in a value to value framework. The contingent valuation method is probably the most widely used method for the valuation of environmental resources (Carson, 2004). A questionnaire describes the change to be valued, explaining how it will be implemented, and the method of payment (Mitchell and Carson, 1989). In its open ended format, the elicitation question asks a sample of the population to report their maximum willingness to pay (WTP) to obtain an improvement or avoid a worse situation, or their minimum willingness to accept to forego an improvement or accept a worse situation. These types of questions have often been criticized in the CVM literature (Arrow et al., 1993, Hanemann, 1994). Instead, referendum type questions are often recommended, since such questions are often considered to be more similar to everyday consumption decisions, i.e. where you either buy or do not buy the good at a certain price. However, the open-ended format also has

advantages such as a much more efficient use of the data and absence of starting-point and yea-saying bias. Also open-ended provides a conservative design since responses generally tend to give lower mean WTP compared to questions of referendum type (Hausman, 1993). More often, however, a dichotomous choice approach is used. The respondent is faced with and environmental change and a payment (or a compensation), and is asked to state whether she would agree with the new situation at the given cost. The amount asked to be paid, usually called bid, varies across the sample, while the environmental change remains constant.

Most VEA approaches have employed attributed-based stated choice methods in order to identify the preferred alternatives that will provide compensation from interim losses (Bishop et al., 2000; Swait et al., 1998). The main contribution in this paper is to propose and apply a variant of the contingent valuation method in a value to value or VEA framework. While the debit is estimated with a standard CVM application, the credit uses a dichotomous choice type of question where the environmental change varies and the bid is fixed and equal to the debit. In this way, the minimum amount of environmental change that offsets the value of the environmental damage to be compensated is estimated.

Thus, the application to a forest fire and the subsequent afforestation uses two sequential CVM questionnaires. The first questionnaire estimates the economic value to citizens of the Barcelona province for a forest fire prevention program using the typical dichotomous choice format. The size of the forest area prevented from burning is defined in accordance to past events caused by power lines in the central part of Catalonia. The second questionnaire, measures the public preferences for the amount of the restoration project to provide services of equivalent value due to the incident, using the explained variant of the dichotomous choice format.

Next section presents a brief overview of the theoretical framework of CVM. Section 3 provides information about the construction of the survey design. Section 4 addresses details of the experimental design and about the application in the pilot study. Section 5 reports the results, and section 6 the conclusions. Appendices A and B reproduce the questionnaires used in the case study.

1.2 Foundation

Welfare economics provides the framework for assessing natural resource damages. Specifically, compensating variation (CV) is a measure of welfare change that provides a basis for the pursuit of damage valuation. It is assumed that individuals will maximize their utility based on their budget, prices of market goods (x), non-market good levels (z), and other characteristics (s). The level of non-market goods is assumed exogenous.

$$Max \quad u(x, z, s)$$

By solving this problem one can obtain the optimal consumption combination (in particular, the optimal quantity of x^*). The utility function can also be expressed in an indirect form:

$$u(x^*, z, s) = v(p_x, y, z, s)$$

The indirect function depends on the prices of market goods (p_x), the income of the individual (y), the initial and final level of the public good change, and other characteristics of the individual (s). The utility function can include a random variable, represented by the stochastic component, ε, reflecting the limited or imperfect information that a researcher faces. Thus, the indirect utility function is represented by $v(p_x, y, z^0, z^1, s, \varepsilon)$, where the change from the original to the final level of the public good $(z^o$ and $z^1)$ is what typically the researcher intends to value.

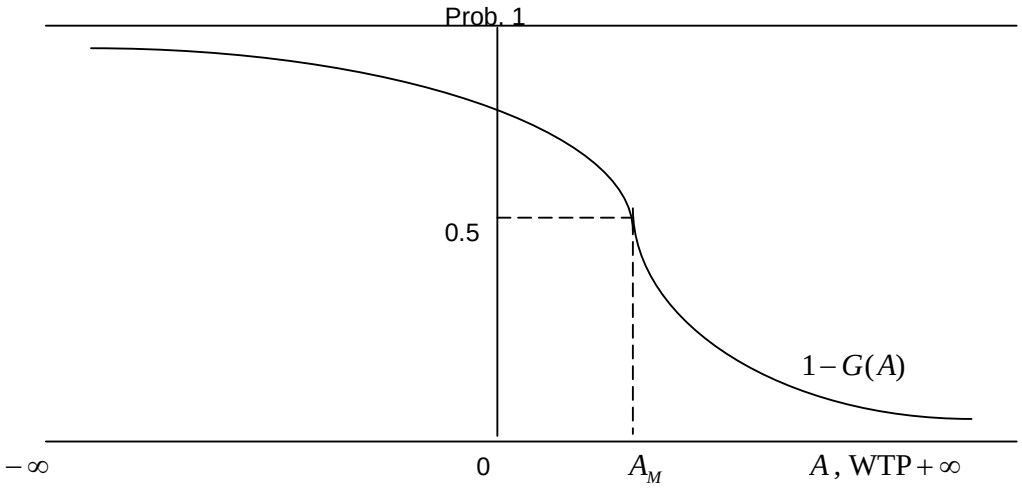
Using a dichotomous choice contingent valuation format, the probability of a respondent saying yes to a propose payment of a bid amount of *A* monetary units is equal to the probability of CV or maximum willingness to pay being greater or equal than *A*. Or, what is the same,

$$\Pr\{yes\} = \Pr\{v(p_x, y, z^0, s, \varepsilon) \leq v(p_x, y - A, z^1, s, \varepsilon)\} \qquad (1)$$

An assumption on the distribution of the stochastic term, together with varying the bid amounts asked to respondents, is the basis for the econometric estimations undertaken in actual applications to elicit the mean or median CV. Graphically

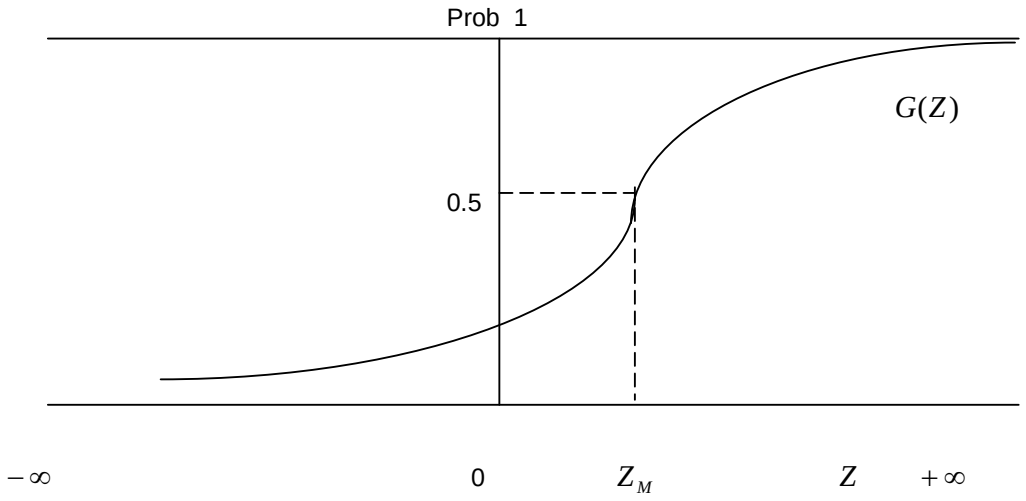
(figure 2), the probability of saying yes to the bid amount *A* is modeled through 1-G(*A*), where G(*A*) is the cumulative distribution function (cdf) of the compensatory variation or maximum willingness to pay.

Figure 2. Probability of saying yes to a given bid amount



Similarly, the level in the provision of the public good (z^1) can vary, keeping the bid amount constant. The probability of saying yes to the proposed change at a cost of *A* depends on whether the change is large enough, provided as an improvement. Therefore expression (1) applies. The difference is that now an assumption on the distribution of the stochastic term, together with a varying (z^1), elicits the mean or median minimum or public good compensation required (z^1) for the fixed payment of *A*. In graphical terms, the probability of saying yes to the public good compensation can be represented by the cdf of the minimum amount of public good required, G(*Z*), as shown in figure 3.

Figure 3. Probability of saying yes to a given public good increase



1.3 Construction of the Contingent Valuation Market

For this study two different valuation exercises are needed. Both exercises correspond to a contingent valuation survey conducted in Catalonia. The first exercise obtains values of a fire prevention program for one third of the *pinus nigra* forest area in Catalonia. A second survey presents a *pinus nigra* afforestation program in other parts of Catalonia as compensatory restoration plan and identifies the amount of size compensation required to return individuals to the pre-fire utility level.

The first stage of this study aims to assess social values for losses due to a large forest fire occurred in Catalonia in 1994 that affected approximately one third of the *pinus nigra* forest area. Even though this particular incident happened some years ago, it was presented as a future scenario in the questionnaire. The baseline and post-fire information about this event was available from the Forest Ecological Inventory of Catalonia (IEFC) and the Spanish Second National Forest Inventory (IFN2) carried out in the burned area just one year before the occurrence of the large forest fire.

The affected species is included in the EU Habitats Directive with a high priority of conservation. This species is the third most extensive pine type growing in

Catalonia. The lack of regeneration of the *pinus nigra* results in changes in the landscape. In mixed forests, oaks have resprouted, as well as grasslands and open shrublands. *Pinus nigra* forests are mainly used for recreational alternatives such as mushroom picking or rural tourism.

The information presented to respondents in a survey was provided by *pinus nigra* and forest fire specialists in Catalonia in order to ensure accurate information in the questionnaire. In particular, the expected effects for the next years until full recovery as well as consequences on the habitat for wildlife species and recreation were estimated by ecology specialists.

Two focus groups were conducted with a total of nineteen participants selected from the general public. In addition, several one-on-one interviews, and a pilot were undertaken before the final survey to ensure clarity in the information provided to respondents with respect to the consequences of a *pinus nigra* wildfire for the next 50 years, a clear understanding of the fact that this case results in interim losses, and the acceptance of the market institution simulated in the questionnaire (vehicle payment, time period of payments, etc.).

Finally, two open-ended surveys were conducted in the pre-test stage. Results were useful to define the range of bid amounts and the forest compensation levels to use in the final version of the questionnaires.

1.3.1 Prevention of large forest fires

Following current practice in natural resource damage assessment (see for instance Carson et al., 2003), a future large forest fire prevention program was considered. Thus, the fire prevention program proposed in the questionnaire aims at protecting and preserving one third of the *pinus nigra* forest area distributed in the central surface of Catalonia that would otherwise burn in the next 10 years. The constructed scenario of the CV questionnaire on the first stage emphasizes the duration and extent of damage of the expected fire from the time of the incident until the forest recovers to baseline conditions. Thus, the information provided to respondents indicates that after the occurrence of the expected large forest fire it would take about 50 years to return the environmental levels to baseline conditions.

1.3.2 Compensatory program

The second step in a value equivalency approach requires the identification a compensation program that offsets the value for interim losses. The approach selected was the plantation of *pinus nigra* trees as it would provide similar habitat lost, and conceptually, the loss can be off-set through the provision of similar resources but off-site. The practical reason for choosing an off-site regeneration program is to test for WTP distance decay from the damage site. Details of the study on distance decay can be found in Chapter 2 of this thesis work.

As already mentioned, for purposes of this study, a modified form of the CVM was used to estimate the adequate quantity of compensatory program, by keeping the bid amount constant to the value estimated from the previous questionnaire, and varying the amount of compensation.

1.4 Application

1.4.1 Questionnaire design

The CV survey was conducted in the winter of 2007/2008 in municipalities belonging to the province of Barcelona using in-person interviews. The sample size for the prevention program was 298, and 293 for the compensation program. The survey was designed to be conducted using face-to-face interviews with residents of at least 18 years of age. The average interview lasted 12 minutes including debriefing questions. Individuals were randomly selected in parks and were asked to participate in a survey. Those surveyed were represented in terms of gender and age but not in terms of income. The demographics of the sample, upon concluding the surveys were also compared to the demographic data for the census tracts in the surveyed areas.

Almost all respondents stated to be familiar with the main effects and consequences of the large forest fires in Catalonia. After the elicitation question, respondents were asked about their reasons for accepting or rejecting the WTP question, which were then used to identify protest answers in the survey.

1.4.2 Prevention questionnaire

After the introductory presentation, the questionnaire asked respondents to indicate the level of concern for some general problems such as: immigration, household expenses, environmental protection, and unemployment (see appendix A). This question had the intention to start the respondent's process of thinking in a general context.

Next, the questionnaire informed about the surface covered by forests in Catalonia. Pictures were used to introduce the four main forest types, which included the *pinus nigra* specie. From these pictures respondents were asked to indicate which of those four types, if any, they had visited in the past. The information also included a map showing the distribution of the *pinus nigra* forests.

After this, the valuation stage of the questionnaire described the current situation of the *pinus nigra* forest and the likelihood of the occurrence and consequences of a large fire due to the density of the forest. The program that could avoid the mentioned forest wildfire was to be promoted by a non profit organization. Respondents were informed that in order to implement the prevention program it would have to be supported by all Catalonia residents through annual compulsory contributions to a special fund over the next 10 years. The WTP question took a single bounded dichotomous choice form with bid intervals varied between 10 and 150 euros that were randomly assigned to respondents.
Finally, the third part of the questionnaire included some debriefing questions and collected socioeconomic characteristics of the respondent and their household.

1.4.3 Compensation questionnaire

The compensation questionnaire was structured similarly to the prevention one (appendix B). Before asking respondents whether they would be willing to pay for the remediation program, the scenario described the post-fire scenario and the expected years until full recovery. Then they were informed that a non profit foundation was promoting a program with the aim of compensating the interim losses. The proposed remediation consisted of an afforestation program in suitable areas of Catalonia other than the burned area. They were told that the afforestation plan would have a cost and it would have to be covered by Catalonia residents in compulsory annual contributions over a 10 year period.

As already explained, the elicitation question stated a fixed bid for different amounts of compensation program (i.e. hectares of afforestation) due to the losses caused by

the environmental damage. The afforestation surface was expressed in percentage terms of the originally burned area. Five levels were randomly assigned to respondents ranging from 10% to 100%.

1.5 Results

1.5.1 Prevention program

The estimations for the valuation of the prevention program include 185 of 298 responses as 40% of the questionnaires resulted in protest answers. The main protest reason for not willing to pay was "the program should be paid by the government", hence, protest answers were discarded for the WTP estimation. Table 1 presents some statistics from the respondents and Table 2 shows the number and percent of "yes" responses at each bid amount. As can be seen it is a fairly, although not perfectly, well behaved distribution.

Table 1. Mean of some demographic characteristics

Percent Male	45.00
Education level (years)	13
Age	35,4
Monthly Income (€)	1.120

Table 2. Responses at each bid amount

BID (€)	Yes	No	%Yes
10	12	6	66
20	15	7	68
40	8	11	42
50	6	13	31
60	7	5	58
70	9	8	52
80	11	10	52
100	7	13	35
120	7	10	41
150	8	12	40

A logit model relating the yes/no answer to the cost of the prevention program presented to the respondents was estimated to elicit the mean WTP (Hanemann, 1984). A full statistical model including all survey demographic and attitude variables was initially estimated, however, demographic variables such as income, education or age were consistently insignificant and were not included in the final model.

Table 3 reports the regression results. The bid is statistically significant at a 5% level and the negative sign denotes that the higher the amount of money the respondent was asked to pay, the lower the probability that the respondent would accept the prevention program.

Table 3. Logit regression results for prevention

Variable	Coefficient	T-statistic
Constant	0.4490	1.56
Bid	- 0.0072	- 2.04
Log likelihood	- 126.03	
Chi-square	4.25	
N	185	

Table 4 presents the estimated mean WTP and confidence interval based on 1000 random draws using the Krinsky and Robb (1986) procedure. The resulting mean annual willingness to pay per individual was 62.25 euros in values of 2007 during 10 years with a confidence interval of(18.4, 101.92).

Table 4. Confidence Intervals for prevention program

	Prevention program
Mean	62.25 (18.04,101.92)*

* Significant at 5% level

1.5.2 Compensation program

The compensation questionnaire was based on results obtained in the previous exercise, thus the mean WTP was rounded to 60 euros. The protest response rate was 27%, leaving 216 elicitation answers for the analysis. Again, the main reason for protesting was that "the government should take care of the program implementation without extra payments from the citizens", followed by the opinion "forest owners should pay". Table 5 shows some statistics from the surveyed population and Table 6 shows the number and percent of "yes" responses at each size of the restoration program.

Table 5. Mean of some demographic charateristics

Percent Male	47.00
Education level (years)	13
Age	33,77
Montlhy Income (€)	1.000

Table 6. Responses at each restoration level

Restoration Level (%)	Yes	No	%Yes
10	18	28	39
30	20	22	47
50	17	16	51
70	18	16	53
100	23	8	71

A logit model relating the yes/no responses to the size of restoration was estimated, as shown in Table 7. The coefficient for Surface is significant at the 5% level suggesting that larger levels of the restoration program increases the likelihood of accepting to pay for the program.

Table 7. Logit regression results for restoration

Variable	Coefficient	T-statistic
Constant	-0.3235	-1.33
Surface	0.0110**	2.38
Log likelihood	145.35	
Chi-square	5.87	
N	215	

The mean of the minimum compensation for the interim losses, expressed in percentage (over the originally burned area) of reforestation of *pinus nigra* resulted in 29.30%, or 7,325 hectares to be planted. This implies that to compensate for the interim losses of burned *pinus nigra* an off-site afforestation of approximately one third of the burned area is needed, based on social preferences. The results of the mean and the confidence intervals at 95% are presented in Table 8. Confidence intervals were calculated from 1000 repetitions following the Krinsky and Robb (1986) procedure.

Table 8. Confidence Intervals for restoration program

	Percentage of restoration
Mean	29.3 (1.68, 53.80)*

* Significant at 5% level

1.6 Discussion

The procedure followed above of estimating first the interim damage social value and then the equivalent compensation, requires some certainty on the amount and type of damage and the compensation scheme. In practice, equivalency analysis lacks such a certainty. In that regard a choice modelling approach yielding marginal values would bring flexibility into the equivalency exercise. On the other hand, the end estimation is of a discrete change, and this is believed to be better approximated by contingent valuation than by choice modelling marginal estimations extrapolated to account for a discrete change (Hanley *et al*., 1998; Hanley *et al*., 2001; Bateman *et al*., 2002; Alpizar *et al*., 2003.)

The procedure described above can, however, be adapted to marginal value estimation by varying both the bid level and the environmental change level, keeping the same elicitation question format as far as the respondent is concerned. The results could simultaneously be expressed in terms of environmental change per monetary unit, or in terms of monetary change per environmental unit.

Another possibility is to combine the discrete and marginal values. By split sampling, both a discrete and a marginal value estimation could be used. Then, the discrete value could be used as a basis and variations be adjusted via marginal values. This would combine the expected better accuracy of contingent valuation in discrete estimations with the flexibility sometimes required in equivalency analysis applications. This issue could constitute a future research topic.

1.7 Conclusions

Sometimes, like in equivalency analyses, researchers might be interested in estimating both the value of a damaged environmental resource, or debit, and the minimum amount of environmental improvement (credit) that offsets the loss value. This paper proposes a sequential approach, where a standard CVM application is used to calculate the value of the damage first, and a modified CVM variant estimates the mean or median of the minimum compensation required. The variant consists of fixing the bid amount and varying across the sample the environmental quality level. Both CVM applications are based on a random utility maximization model.

The application to some forest management in the northeast of Spain suggests that the sequential approach is feasible. The fact that in a single bounded format, the

elicitation question in both CVM variants looks the same to the respondents, i.e. whether a given amount of euros would be paid for an environmental change, facilitates the implementation of the minimum compensation approach.

The use of CVM was capable of assessing the interim losses of utility due to environmental damage as well as the compensating program to offset the loss. Results showed that people distinguished the differences between permanent and temporary consequences of losses.

The debit pre-test application to a forest prevention program that would save one third of the *pinus nigra* area in central Catalonia that otherwise was expected to be burned in the next 10 years, showed a mean value of practically 60 euros (in 2007 values) to be paid annually for 10 years. The 60 euros value of the interim losses constituted then the bid amount for the credit calculation. The mean minimum compensation consisted in planting *pinus nigra*, off-site, for an extension equivalent to 29% of the stated burned area (one third of the *pinus nigra* forest in central Catalonia).

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CHAPTER 2

Distance Decay Functions from Damage to Restoration Site. A Value Equivalency Exercise

ABSTRACT

A number of papers have been looking at distance decay functions from residence to the valuation site. This paper looks at a similar function from the damage site to the restoration site in a value equivalency framework. In the context of restoration, sometimes projects must be done off-site. In such cases the calculation of the benefits requires to incorporate the distance in order to address the scale of the restoration of equal value to the losses. This study uses the Multinomial Logit to determine if distance affects WTP for a restoration program needed to offset losses resulting from a forest fire occurred in Spain. Consistent with expectations, data analysis identifies decay functions supporting the hypothesis that restoration programs located closer to the damaged site increase the likelihood of WTP for any combination of attributes.

2.1 Introduction

In a valuation framework, *distance decay effects* suggest the lessening on social values due to spatial increases, like for example, the limit from people's residence to the location of the environmental good under valuation (Hanley, Schlapfer et al. 2003). In this context, households living near the environmental good under study may reflect a different perception than those living further away. Therefore, geographical issues may be influencing social welfare.

Some studies found that omission of distance can underestimate welfare analysis and bias the overall benefits estimates (Georgiou et al. 2000; Concu, 2007). Still other valuation studies have emphasized the role of people's preferences over space (Fotheringham and Pitts, 1995; Moran, 1999; Perrings and Hannon, 2001)

The literature reports two different results regarding social preferences and distance: those finding a negative relationship for distance and values and those reporting no distance effects. While there is widespread acceptance that response rates decline with distance (Bateman and Langford 1997; Concu 2007) and similar behavior pattern is expected for visit rates (Sutherland and Walsh, 1985; Moran, 1999; Bateman et al., 2000), the relationship between values and distance differs for certain goods or type of users; thus, the existing analysis on willingness to pay (WTP) regarding distance is still open to debate.

This study was designed to investigate the relationship between willingness to pay (WTP) and distance effects in an Equivalency Analysis (EA) framework. According to recent environmental laws enacted in Europe regarding restoration of damaged natural resources, compensation equivalent to injured natural resources can be provided through rehabilitation. The process of damage assessment calculates the appropriate compensation with the aim to recover the state of the injured natural resources as they would be if no damage had occurred and taking into account the temporary losses. Flores and Thacher (2002) suggest that distance from the restored resource to individuals' site is likely to matter in the expected level of restoration.

Through Value Equivalency Analysis (VEA) the social value of services gained through the remediation project can be scaled to equal the value of the injured resources using valuation techniques. The metrics used under VEA, also known as value-to-value approach, are typically expressed in monetary units.

Sometimes remediation projects have to be done off-site since on-site remediation is not feasible. When this occurs, the assessment incorporates changes in natural resource location for calculating the adequate level of improvement or compensation. Thus, the potentially expected changes on social benefits of an off-site restoration could be captured incorporating the existing distance in the estimation of the compensatory restoration.

Typically valuation studies observe the distance decay by changing the distance from the environmental good location to a respondent's home. However, the decay may be estimated with respect to other locations, like the distance from the injured site to the rehabilitation location, in an equivalency analysis framework.

Since the priority of the equivalency analysis is to compensate for natural services lost, increasing distance from restoration to damaged natural resources may demand more compensation than if it would be provided on site, assuming there is a distance decay effect.

This study attempts to estimate a distance decay function of social preferences by applying a stated preference valuation approach that proposes different locations for the restoration program.

The remainder of this study is organized as follows: Hereafter some background about distance decay is provided as well as the background on this case study. The next section specifies the theoretical model used to obtain WTP estimates of the attributes. Section 2 describes the case study, the design of the experiment and selection of the attributes. The subsequent section outlines the model specification and estimation strategy. The fifth section reports the econometric results. Empirical results are discussed in section 6 and the final section summarizes the main conclusions and provides some concluding remarks.

2.1.1 Distance Decay Functions

Several studies have proposed that values could tend to fall into decay functions with distance (Sutherland and Walsh, 1985; Loomis, 1996; Bateman et al., 2000; Hanley et al., 2003). Loomis (1997) states that it would seem valid to expect that the further away individuals reside from an area, and therefore less possibilities to visit or to have knowledge about a place, the less likely they would be willing to pay for improvements to the area. Hence, the expected connection between geographic distance and people's valuation, if any, could be negative.

Stated preference methods such as the contingent valuation (CV) and choice modeling (CM) techniques have been used to estimate decay effects. In particular, several CV exercises have been undertaken to test distance effects: the Sutherland and Walsh (1985) study considered geographic distance effects for non-use values on the preservation of water quality in Montana. Results identified a negative relationship between non-use values and distance; Loomis (1996) evaluated distance effects for restoration of fish populations and the Elwha river located in Washington, coefficients showed negative effects between values and distance. Pate and Loomis (1997) measured willingness to pay values for alternative programs to protect wetlands and reduce wildlife contamination in the San Joaquin Valley in California. Their report found willingness to pay decreases with distance increases for wetlands and contamination control. A similar finding was reported by Bateman and Langford (1997) in a CV survey for estimating mean willingness to pay for preservation of Norfolk Broads' park. Georgiou et al (2000) carried out a survey for water quality improvements for the River Tames in Birmingham and found WTP estimates to be inversely related to the distance from the river to respondent's home place. Hanley, et al (2001) explored WTP for protecting two types of landscape in Scotland (i.e. heather moorland and rough grazing) that could be affected by countermeasures. Each study reflected WTP decreases with distance. Hanley, Schläpfer and Spurgeon (2003) examined distance decay effects through CV study for improvements on the river Mimram in England due to problems caused by low flow and reported decreases on the estimated values as distance increased. Finally, the only CM application sought was provided by Concu (2007) who conducted a study to estimate benefits for conservation of a 400 hectares urban park in Australia and reported a negative relationship between distance and utility. Contrary to much of the literature, Pate and Loomis (1997) measured the willingness to pay for salmon improvement program and identified no distance effects.

Although no clear consensus has been found on the theoretical basis for the inversely association related to distance and benefits, the literature suggest that care must be taken when aggregating WTP values for the relevant population since benefits may be over or under estimated (Georgiou et al 2000).

2.1.2 Background on the case

A statute on Environmental Liability was held in Europe in 2004 with regard to the prevention and restoration of environmental damage. New regulations apply to damages resulting from injuries to natural resources, so that injuries can be offset by applying remediation actions for returning the environment to the conditions that

would have existed if harm had not occurred (i.e. baseline condition). Through restoration actions natural resources can be returned to their initial condition (primary restoration) and compensated for losses of resources during the time the environment takes to recover back to baseline (compensatory restoration).

This study applies the mentioned environmental regulations in a particular case of a natural resource injured. The case study is regarding a forest wildfire which occurred in the Spanish Autonomous Community of Catalonia (north-east region of Spain, Figure 4) caused by a malfunctioning power line. The fire affected more than one third of land covered with *pinus nigra* forests, a species included in the EU endangered habitats directive (Habitat 9530 *Sub-Mediterranean montane forests with endemic black pines*).

The dimension of the wildfire resulted in ecological and socio-economic consequences. For instance, landscape changes due to the lack of natural regeneration of *pinus nigra* after fire (Espelta, Retana et al. 2003), indirect ecological impacts on the flora and fauna (Pemán and Navarro, 1998), and changes in forest species caused by understory oaks root sprouting from beneath *pinus nigra* trees (Retana, Espelta et al. 2002). The wildfire also affected popular recreational activities such as mushroom-picking, hunting, and rural tourism. Impacts are expected to continue over fifty years into the future (the interim losses, that is), that encompass the time required to reforest the whole burned area and new trees to mature.

The application of this article belongs to a larger case study that illustrates Resource Equivalency Analysis (REA) and VEA. Also, the study is part of a natural resource damage assessment report for estimating damage and compensatory remediation following the considered wildfire caused by a power line in Catalonia in the mentioned habitat protected under the EU Habitats Directive.

The amount of restoration to be provided depends on the damages through time captured by the interim losses, that includes losses suffered due to environmental damage (i.e. the debits) and the amount of resource benefit that will be gained with compensatory remediation until baseline (i.e. the credits). Thus, two separate exercises were undertaken for estimating interim losses in this study; first, application that calculates the debits, and second, a survey to estimate the credits.

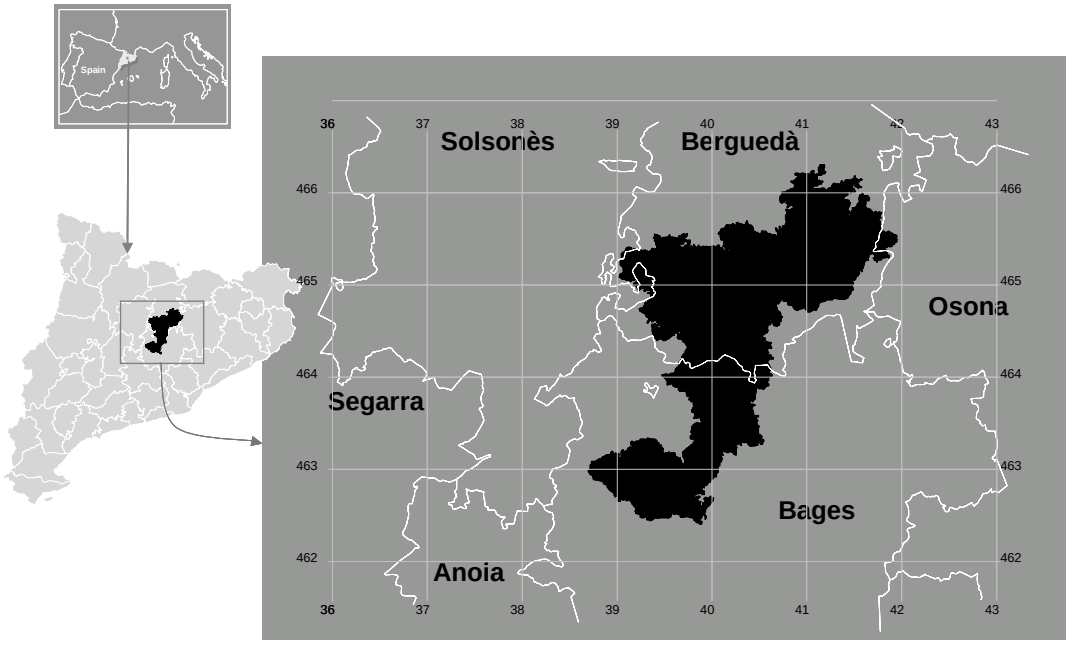
The estimation of the debits used the CV method to obtain WTP responses for determining the social value of the damage with emphasize on the interim losses (i.e. fifty years to return the environment to baseline conditions). More details of the debit estimation can be found in chapter one of this study.

The remediation program proposed focuses on actions that can offset the interim losses due to the injury of one third of the surface covered with of *pinus nigra* trees burned in a large wildfire in central Catalonia, Spain. *Pinus nigra* forests are a protected species under the EU Habitats Directive and assigned a high priority of conservation. The resources are expected to return to baseline within 50 years.

Data for analysis was collected from a survey that elicits willingness to pay (WTP) to compensate the interim losses of *pinus nigra* trees through afforestation programs in several areas. The Multinomial Logit model typically requests a questionnaire describing the natural resource being valued through series of alternatives. Every alternative within a choice set is described by characteristics or attributes presented in levels and ranges. The exercise requires that only one alternative be chosen within the choice set and responses allow for estimation of consumers' surplus estimates for each attribute level that can be based on the coefficient on the cost attribute. The value reported is assumed to correspond to the level of compensation required to mitigate interim losses until resources are returned to baseline.

The credits were estimated using a choice experiment exercise that measures public preferences for a compensation project consisting of *pinus nigra* trees plantation. Value to value is used in this study since post-fire regeneration has produced forest changes, thus restoration provides similar services, but not the same, as those lost because a different species has grown after wildfire.

Figure 4. Bages and Berguedà forest fire



2.2 The Model

The estimation of preferences for variations in restoration programs can be modeled in a way that shows how individuals trade off among different program levels in monetary terms. Most microeconomic models of consumer behavior (e.g. Random Utility Model –RUM-) are based on the assumption that individuals maximize their utility subject to constraints such as income, time, etc. The microeconomic theory (e.g. the Lancasterian approach) also provides basis for the study of values in which the utility derived from a good is measured from the value of its characteristics or attributes (Lancaster 1966).

In this context, environmental goods, such an afforestation program, can be measured through existing techniques, such as Choice Modelling, using a survey to elicit respondent's preferences for the mentioned restoration program.

Under RUM, an individual i faces a choice among J alternatives and obtains the utility U_{ij} from alternative j with $j = 1...J$ is and chooses the alternative that

maximizes her utility. The decision maker knows her utility but not the researcher. Thus, the utility can be partitioned into two parts: V_{ij} representing the systemic and representative of observable part of the chosen attributes by the consumer and ε_{ij} that captures unobservable factors affecting the utility and introduced as an error component. Then the utility function is decomposed as:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad (1)$$

The probability of individual i choosing alternative j over other alternatives from a choice set will be equal to the probability that the random disturbance ε_{ij} is equal of option j for agent i been greater than the random component of option k for consumer i in the choice set:

$$\begin{aligned} \Pr\{choose\_j\} &= \Pr\{V_{ij} + \varepsilon_{ij} \rangle V_{ik} + \varepsilon_{ik}\} \forall j \neq k \\ \Pr\{choose\_j\} &= \Pr\{\varepsilon_{ik} - \varepsilon_{ij} \langle V_{ij} - V_{ik}\} \forall j \neq k \end{aligned} \qquad (2)$$

Since the unobserved component is unknown, individual's choices can be estimated in terms of probabilities under some assumptions on the random term ε . Thus, the estimated parameters in the utility function will depend on the distributional assumption of the stochastic elements ε that enter in the conditional indirect function, and also on the specification of the econometric model.

The specification of the utility function the MNL model assumes that the stochastic components are independently and identically distributed (IID) with an extreme value type I distribution (i.e. a Gumbel distribution) implying that the unobserved factors are uncorrelated over alternatives as well as constant variance for all alternatives, resulting in the independence of irrelevant alternatives property (IIA).

Under these assumptions the choice probability of choosing j over k alternatives (Hensher et al 2005) shown in (2) can be written as:

$$\Pr(U_{ij} \rangle U_{ik}) = \frac{\exp^{\beta' x_{ij}}}{\sum_j \exp^{\beta' x_{ik}}} \qquad (3)$$

with x_{ij} representing a vector of variables and β' a vector of parameters. The logit choice probability function (3) scales the coefficients to reflect the variance of the unobserved portion of utility.

Maximizing the likelihood function (i.e. the function of the probabilities of the preferred alternatives) can be written as:

$$L(\beta,\sigma)=\prod_i \prod_j \left(P_{ij}\right) \qquad (4)$$

The likelihood function that is maximized for a single individual is the product of the probabilities of the chosen alternatives and maximizing the likelihood function is equivalent to maximizing the joint probability of observing the collective choices. For instance, maximizing with respect to β gives the estimate of the β vector providing consistent parameter estimates asymptotically efficient under the additional assumption that ε_{ij} are uncorrelated across j.

2.2.1 Welfare effects

The unconditional indirect utility function is

$$V_{ij} = \beta_0 + \beta_1 A_1 + ... + \beta_n A_n + \beta_a S_1 ... + \beta_z S_m \qquad (5)$$

With β_0 containing the alternative specific constant (ASC), the attributes of the afforestation program is n and the socioeconomic characteristics of respondents to explain the choice of the afforestation program in m. The vectors of coefficients β_1 to β_n t and β_a to β_z are attached to the vector of attributes (A) and to vector (S) that influence utility, respectively.

Once the parameter estimates are obtained, the expected compensating variation (CV) for a change in attributes can be obtained by solving the equality (Hanemann, 1999):

$$V(A_0, p_0, y) = V(A_1, p_1, y - CV) \qquad (6)$$

Where A describes the good, p is the price, and y is income. If errors are extreme value distributed, the expected CV in the attributes is:

$$E(CV) = \frac{1}{\bar{\gamma}}\left\{\ln \sum_{j \in C} \exp(V_1) - \ln \sum_{j \in C} \exp(V_0)\right\} \qquad (7)$$

With V_0 and V_1 indicating the indirect utility before and after the improvement, $\bar{\gamma}$ is the marginal utility of the price attribute, and C the choice set. Because utility function is linear in the vector of marginal utilities, if one attribute changes the marginal rate of substitution between two attributes is as follows:

$$CV = \frac{1}{\gamma}(V_1 - V_0) = -\frac{\beta_j}{\gamma} \qquad (8)$$

2.3 Case Study

2.3.1 Questionnaire design

The purpose of the survey was to estimate the amount of compensation required for interim losses due to a wildfire in 25.000 hectares of *pinus nigra* forest in the central part of Catalonia and to determine whether the location of the remediation action influences the amount of restoration to be provided. The Value Equivalency Analysis also needed to address the relevant alternatives according to the Resource Equivalency approach and also the identification of credible, realistic and capable characteristics being understood by the sample population.

The description provided in the questionnaire related to past events was discussed with technical expertise of ecologists and the Fire Department (i.e. forest fire dimension and expected consequences), so that, the information provided to respondents was truthful and reliable. In addition, the earliest versions of the survey were tested in a focus group and two one in-depth interviews to ensure that the information was clear and understandable. The survey was pretested on a small sample of Barcelona residents in order to detect potential biases of the questionnaire. Completed surveys from the pilot were used to establish the appropriate levels for bid amounts and size of compensation programs whereas the locations for restoration programs were consulted with ecological experts. Finally, interviewers received a booklet containing the questionnaire survey and cards with figures and maps.

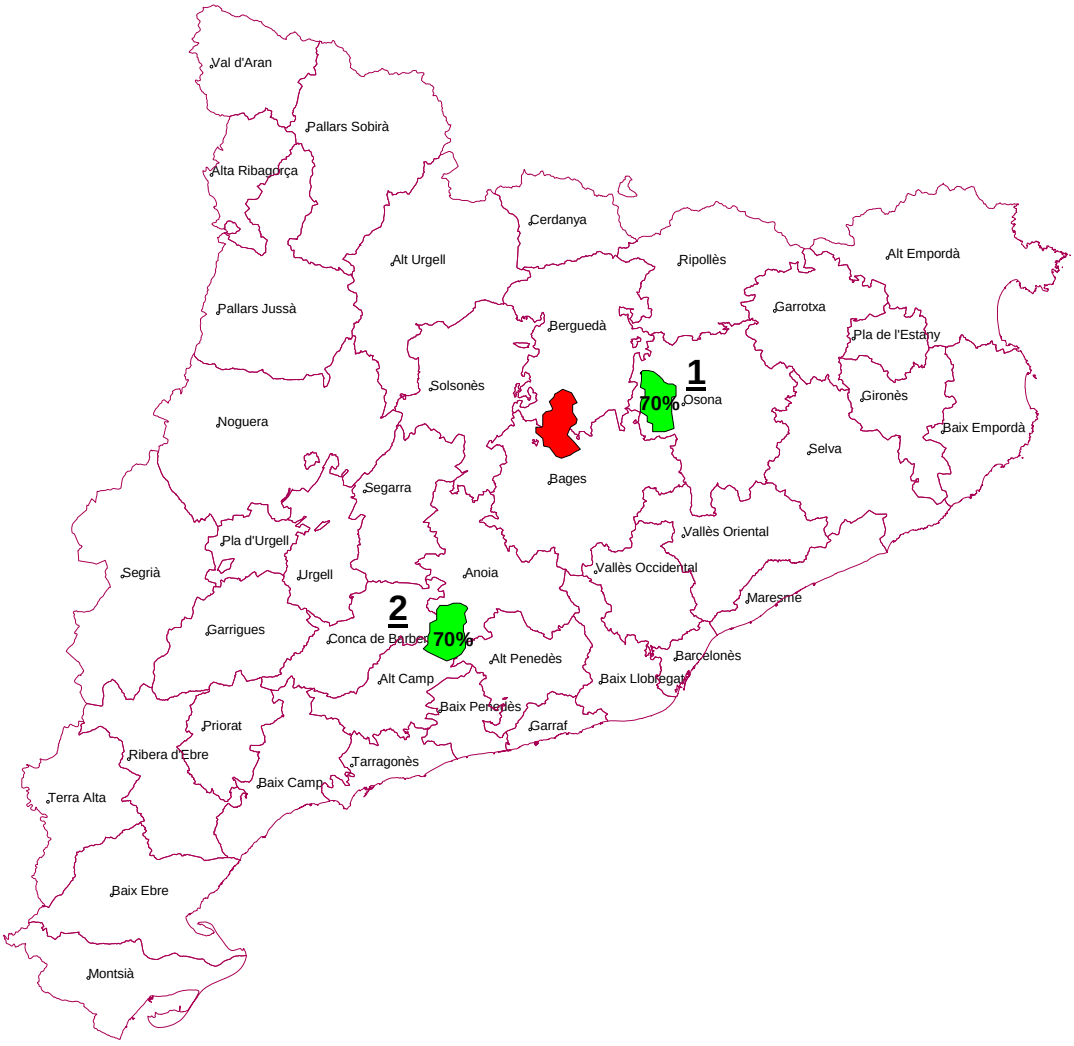
The constructed scenario of the questionnaire was organized in three parts: the first section of the survey asked introductory questions about the personal level of concern regarding general problems existing in Spain such as immigration, environmental protection, housing cost, and unemployment. Next, respondents were introduced pictures corresponding to the fourth most abundant type of forest, among which *pinus nigra* accounted for the fourth most abundant, and asked if they were acquainted with each species. Respondent's answer allowed the analysis to identify the level of familiarity respondents were regarding the natural resource under valuation. After this, respondents were asked about their personal level of concern about forest fires in Catalonia.

The second section considered the central part of the questionnaire. Since the study was designed under the Equivalency Analysis (EA) framework the information emphasized 1) the duration of the damage expected to be over the next 50 years, also called *interim losses* in the language of EA; 2) the extent of the injury (i.e. reduction of 35% of *pinus nigra* forest in Catalonia); 3) the size of the off-site restoration programs, or *scaling,* in EA terms; and 4) the location of the *pinus nigra* plantations available in a map for respondents that stressed the existing geographical space from the restoration to the damage site.

Before informing about the cost attribute two combinations of restoration programs were presented to respondents and asked their most preferred option and the reasons behind their answer. After this, individuals were informed that those programs would imply a cost for all citizens from Catalonia and were introduced with the elicitation questions that contained the restoration programs previously presented but this time including the cost attribute. The stated preference question was supported by a map describing respondents the levels of the attributes following a close-ended (yes/no) format for each scenario.

Figure 5 provides an illustration of the choice questions presented and the text of the script read to respondents. Then, individuals were allowed to support (i.e., pay) the proposal of the restoration program assigned or to oppose the project. Rejection of the alternative indicated preference for status the quo condition, that is to say, no additional forest enhancement and no additional cost. Alternatives in each valuation question included a specific combination of the remediation program.

Figure 5. Example of Choice Question.



If the plantation of [q] hectares of black pine in site 1 were the only alternative available, Would you pay [x] euros every year for the next 10 years for this program?

In order to capture distance effects on the benefit values for restoration programs sixteen zones were selected from optimal areas for *pinus nigra* plantation. The afforestation sites were placed mainly in Catalonia and a few outside of Catalonia considering their distance from the damage area.

The payment mechanism used in this survey consisted on compulsory payments to a fund over a 10 year-period. The way of collecting payments and temporal payment schedules were acceptable and realistic and no protest against the payment vehicle was found in the pretest or the final survey.

After the elicitation question two additional questions regarding the previous answer were included: the first question asked respondents the level of confidence they had for the latter answer; and the second considered the reasons for accepting/rejecting the restoration program that allowed analysis to identify valid values and protest answers of the hypothetical scenario.

Finally, some diebriefing questions were included before continuing with the third part of the survey, that is, the socio-demographic characteristics such as education and income level, household members, and age of participants. The entire questionnaire is contained in Annex A.

2.3.2 Selection of attributes and levels

Consultation with ecologist specialists allowed the study to select feasible attributes whereas levels considered for the chosen attributes in the survey reflected technical options available jointly with responses obtained in focus groups and completed surveys from the pilot. The monetary attribute was included for the estimation of WTP.

Respondents were randomly assigned the extent or amount of restoration program and payment schedule. Three attributes and four levels for each attribute were selected as follows: a) *The size of the afforestation*, considered the extent or amount of surface planted from a list of four possible levels that respondents were randomly assigned; b) *Distance from the damage to the restoration site* consisting in sixteen afforestation sites from optimal areas for *pinus nigra* plantation deeming their distance from the damage area placed mainly in Catalonia and a few outside of Catalonia; and c) The *payment* schedule that varied the price of the restoration program across sample from four possible amounts. The final set of attributes and their levels are shown in Table 1.

Once identified the relevant attributes and levels the experimental design permitted the creation of sets alternatives using a full factorial design that produced $2^4 16^1$ = 256 possible combinations of restoration programs. Rather to use the 256 combinations this study arranged the number of programs according to a fractional factorial design (Louviere, 1988) resulting in 27 combinations.

Table 1. Attributes and levels in the survey

Attributes	**Levels**	**Levels**	
Surface area (in %)	0		Status quo condition. No repairing program.
	20		The damage will be compensated with 20% of the burned surface i.e. 5,000 hectares in total
	50		The damage will be compensated with 50% of the burned surface i.e. 12,500 hectares in total
	70		The damage will be compensated with 70% of the burned surface i.e. 17,500 hectares in total
	100		The damage will be compensated with 100% of the burned surface i.e. 25,000 hectares in total
Location	8		
	17	96	
	28	106	
	37	112	Distance in km from the afforestation to the damage site
	44	155	
	62	197	
	64	204	
	65	253	
Cost (in €)	0		Status quo condition. No additional cost.
	30		Annual cost per person
	50		Annual cost per person
	70		Annual cost per person
	100		Annual cost per person

2.4 Model Specification

To analyze the survey responses it is necessary to assume that the utility for the choice alternatives takes an specific mathematical form. This study followed the common practice of assuming that utility is a linear function of the utility parameters that describe the restoration programs.

The utility for the restoration program alternatives are given by:

$$U_{ij} = \beta_i^{'} x_{ij} + \varepsilon_{ij} \qquad (9)$$

As explained in the model section U_{ij} represents the utility of the alternative j to individual i. $\beta_i^{'}$ is a vector of parameter of the variables for agent i, x_{ij} is a vector or explanatory variables that relate to alternative j and to individual i, and ε_{ij} the random component. The term $\beta_i^{'} x_{jk}$ corresponds to the nonstochastic part of utility, while ε_{ij} represents the stochastic component.

From (9) the model obtains 9 parameters related to the attributes: the SURFACE attribute represents the share of hectares with respect to the size of the forest fire (i.e. 25.000 hectares accounts for 100% of afforested area); the COST attribute is expressed in Euros used as the monetary values of trade-offs; INCOME is a log transformed variable of the income perceived by individual per month; ENV_PROT variable was categorical variable taking values from 1 to 5, the latter indicating high level of concern on environmental protection and the former no concern at all; AGE is a continuous variable reflecting the age in years of the respondents; and the CATALONIA, SPAIN, FRANCE are dummy coded representing whether the restoration area is placed in Catalonia, Spain, or France.

There exists little guidance on the functional form to calculate distance decay effects and several functional forms were tested. In some valuation studies distance has been assumed linear (Sutherland and Walsh, 1985; Loomis 1996; Bateman et al, 2006) or log-linear transformation has been used (Silberman et at, 1992; Bateman et al., 2000; Pate and Loomis, 1997; Hanley et al., 2003) whereas in the transportation field several functional forms have been undertaken (Beckmann, 1999). Empirical results argue that distance changes in the proximity of the place or reference may present larger impact on WTP than distance changes located further away suggesting a log-linear form (Silberman, Gerlowski et al. 1992; Pate and

Loomis 1997). For the present study, using the natural log in the distance variable was found to give a superior fit to the data for distances ranged from 8 to 253 km from damage to restoration site.

2.5 Results

2.5.1 Descriptive Statistics

The survey was carried out in the spring of 2008 through in-person interviews of local residents from 18 municipalities belonging to the Barcelona province, where the wildfire took place. Barcelona's population was 1.6 million as of the 2008 Census estimates, and the total population over 18 years of age reached 1.3 million. A random sample of 204 individuals was interviewed following a random selection of Municipalities over 10.000 inhabitants and picked out according to their weight on the population size, as with age and gender, which were similarly selected following their representativeness by location. The average length for an interview was 14 minutes and from the total sample 21% corresponded to protest answers, resulting in a 79% response rate. Protest answers were excluded for calculations in the analysis, but included genuine zeros, and 145 out of 210 questionnaires were used for estimations (i.e. 290 observations).

Table 2 provides a summary of the descriptive statistics of the sample and the adult population of Barcelona (Institut d'Estadistica de Catalunya, 2008). Census statistics may not be strictly comparable to our population of all adults. The average age of respondents in the sample was lower than the population age and the sample over-represented females. The average personal income in the sample ranged between 10,000 and 12,000 euro per year, although 10% of the sample refused to state their income and Barcelona. Twenty one percent of individuals had children under the age of 18 in the sample. The percentage of respondents that had obtained a university or higher degree was 28%, approximately half the sample completed some post-secondary education and 21% had secondary or basic education, the remaining 4% declined to answer.

Table 2. Comparison of sample and population characteristics

	Population	Average or percentage of sample
Age (years)	37	34.3
Male	47.4	43.6
Female	52.6	56.3
Education (years)		13

The queries elicited in the survey regarding respondents' awareness showed that 60% of the sample agreed to be extremely or very concerned about the protection of the environment and almost same proportion declared to be extremely or very concerned about forest fires in Catalonia. Turning to consider respondents' familiarity with the *pinus nigra* species, 42% of the sample admitted to be cognizant of the *pinus nigra* forests whereas 7% did not recall. Moreover, 55% already knew that after a wildfire some type of forests, such as *pinus nigra* forests, are replaced with a different species by Nature and 93% clearly perceived the consequences of the *interim losses*.

Almost 40% of the sample reported positive willingness to pay (WTP) falling in the following categories: "for improving the environment" (70%) followed by "to contribute to a good cause" (40%), next motivation was "for the future generations" (28%) and "because the forests provide recreational options and rural tourism" (21%). Only 4% of the respondents declared "the program worth at least this cost to me".

The majority of reasons for declining to pay were: "I cannot afford the program" followed by "very expensive program if supported by all citizens from Catalonia" and "uncertainty since payments are over a long period of time". On the other hand, refusals falling under the following categories: "should be paid from existing taxes" (20%) and "I don't think the program will be successful" (1%) were classified as protest responses.

Table 3 provides information of some attitudinal variables and Table 4 presents distribution of the sixteen restoration programs in the survey and the response rate. The table lists the restoration zone number, the existing distance to the damage site, the sample size and the valid survey responses. Even with the small sample sizes,

the results provide insight into whether respondents are responsive to restoration programs with proximity to the restoration site.

Table 3. Other characteristics and awareness of respondents

Variable	Type	Meaning
Concern Fire	Categorical	Concern Fire= 1 if respondents are less concern about forest fires in Catalonia, 5 if were very concern
Knowledge	Categorical	Knowledge= 1 if respondents are familiar with pinus nigra trees
Environment	Categorical	Environment Protection= 1 if Environment protection less important issue, 5 if most important
Catalonia	Categorical	Catalonia= 1 if the afforestation program was placed in Catalonia

Table 4. Response rate according to the location of the restoration program

Restoration Zone	Distance from Damage Site (km)	Questionnaires	Valid responses	Response rate
1	8	12	12	100
2	17	6	6	100
3	28	30	28	93.3
4	37	24	16	66.7
5	44	42	30	71.4
6	62	24	18	75.0
7	64	24	16	66.7
8	65	42	34	81.0
9	96	48	39	81.3
10	106	6	5	83.3
11	112	24	20	83.3
12	62	42	31	73.8
13	155	24	16	66.7
14	197	6	3	50.0
15	204	24	22	91.7
16	253	30	25	83.3
Total		408	321	78.6

2.5.2 Econometric Analysis

The estimates reported in Table 5 were performed using in NLOGIT 4.0 statistical package (Green, 2010). The constant parameter is statistically significant and positive indicating that the utility associated with an afforestation program is positive. As expected, the DISTANCE coefficient is negative and significant at 1% level, that is, the coefficient does fall as the restoration site becomes more distant from the damage site suggesting the presence of a distance decay effect. The COST coefficient is negative and statistically significant at 1% level indicating negative effect on utility since higher costs of remediation programs decline the probability of preferring a restoration program over the status quo condition. The positive sign of the SURFACE variable, which is positive and statistically significant at 10% level, indicates that larger afforested areas are positively valued by individuals increasing the likelihood to choose the restoration program with larger afforestation programs.

Table 5. Multinomial Model estimation

Variable	*Model 1*
ASC	2.3104 * (1.93)
LnDistance	-0.9435 *** (3.64)
Surface	0.0085 * (1.87)
Cost	-0.0163 *** (-2.95)
LnIncome	0.1427 ** (2.20)
Env_Prot	0.3434 ** (2.99)
SPAIN	-3.7731 *** (-3.40)
FRANCE	-4.5686 *** (-3.91)
Pseudo-R2	0.10
Log-likelihood	-179.93
Observations	290

***,**,* 1%, 5%. 10%, respectively
t-statistics in parenthesis

With respect to the respondents' awareness, the variable EVIRONMENTAL CONCERN is consistently significant with positive effect, suggesting that respondents with higher levels of concern towards the environment are more likely to report a positive WTP than those who were less aware. Similarly the INCOME variable is significant at 5% level and positive, suggesting an increase in the likelihood of WTP for those individuals with higher income levels. The dummy variables SPAIN and FRANCE take the value of one whether the afforestation program is located in Spain (i.e. Valencia or Aragon) and France, being CATALONIA the reference category. Consistent with expectations, the SPAIN and FRANCE dummy variables have negative sign suggesting that the probability of choosing an alternative located in SPAIN or FRANCE decreases when the afforestation program is located outside of Catalonia.

The log-likelihood function at convergence was -179.93. The model was found to be statistically significant based on a X2 statistic of 39.82 against a X2 critical value of 20.09 (with 8 degrees of freedom at 1% level) and a Pseudo-R^2 of 10 percent, a typical value for cross-sectional data.

Table 6 presents the implicit prices calculated for the SURFACE attribute and Table 7 reports the confidence interval at 95% level obtained with the Krinsky and Robb method (Krinsky and Robb, 1986). The confidence interval was calculated using 1000 replications and values of mean WTP correspond to euros at 2008 values.

Table 6. Implicit Prices (2008 values)

	Marginal change per individual	Aggregate
Distance	- 0,57 €	
Surface	0,52€	676.000 €

Table 7. Confidence interval (2008 values)

	Confidence Interval
Surface	0,54 € (-0.096, 1.66)
Total WTP	0,84 €

95% Confidence Interval

Results indicate that citizens would be willing to pay on average 0.52 € per year to get an additional increase of one percent in the afforestation program (i.e. 250 hectares of afforestation). However, an increase of 1% in the DISTANCE between the afforestation and damage site the difference in the expected mean WTP will be, on average, - 0.57 €. Interestingly, an increase by 1% in the distance variable will decrease the extent of the afforestation program in about 1.1%, that is, 268 hectares.

Hence, the maximum distance that individuals in the sample would be willing to support for the last one percent of the afforestation program would be up to 100 km away from the damage site, which is consistent with respondent's preferences as 70% of the respondents getting an afforestation program located 100 km away, or farther, preferred the status quo condition (i.e. no payment).

The aggregate welfare effects for compensation are calculated using equation (8) and taking into account the adult population over 18 years of age in Barcelona. The mean WTP per individual is 0.52 €, thus, by aggregating the population the mean WTP would represent 676.000€ for an increase of 1% of *pinus nigra* (i.e. 250 hectares).

2.6 Discussion

This VEA study identifies the distance effects of an off-site restoration program designed to offset the losses resulting from a *pinus nigra* forest burned in Catalonia. The estimated value was scaled to the equivalent value consistin in 29% of the burned area. This assessment uses the multinomial logit model to determine the distance decay values of restoration and results highlight the possibility of a program

that provides sufficient benefits with value equal to the *pinus nigra* losses if the program is sufficiently extensive and comprehensive.

It can be seen from the results that, on average, respondents prefer shorter distance between damage and restoration site, lower cost of restoration programs, larger surface for forest plantations, and, afforestation programs located in Catalonia. In addition, respondents in this survey expressed clear preference for those locations in Catalonia in comparison with those located in Spain or France. The general answer for alternatives located in France was “should be paid by the citizens of France”.

The finding related to distance is consistent with others results reported in the literature review. Here, one increase in the DISTANCE variable decreases the probability of WTP by 0.57 euros; and on average, each individual would be willing to pay 0,52 € per year over a ten-year period for a plantation of 250 hectares with *pinus nigra* forest in Catalonia, thus, the aggregate WTP would be equal to 676,000 €. According to the attitudinal questions 70% of the reasons why people reported positive WTP corresponded to the category corresponded to the category “to improve the environment” followed by “to contribute to a good cause”, and the least voted was “because the new forests represent recreational option and rural tourism”.

Several alternative choice models were estimated that included socioeconomic and attitudinal variables (e.g. random parameter logit model) but those did not improve the fit of the model. The distance attribute was transformed in its logarithmic form as this specification was the one that better supported the data in this study. This is consistent with other studies (Pate and Loomis, 1997) supporting the idea that distance changes might be reflecting higher impact on WTP for shorter distances in comparison to distance changes located far away.

Interactions of distance attribute with share and the price attribute were tested but none of these parameters were significant in the model. Among the socioeconomic variables, gender, age, income, education, concern of fire in Catalonia, and the knowing the *pinus nigra* species were not statistically significant, only age was found to contribute in explaining WTP in the model. However, the education and income variables were found to be highly correlated and income became significant when education was excluded.

2.7 Conclusions

This study contributes to the Equivalency Analysis literature as it illustrates the impact of distance decay for an off-site compensation program and provides some insight into the relationship for distance and restoration. The evidence in this study shows a WTP decrease for compensation programs with increases in distance from the damage site.

In this study a survey is used to obtain information about people's preferences and values for alternative off-site restoration projects. The survey data allows estimation for different afforestation programs associated with restoration under the Value Equivalency approach. The use of Choice experiment is appropriate to scrutinize the preferences from different combinations or programs and as is consistent with welfare economic theory.

Results support the hypothesis that willingness to pay may decrease as distance increases when assessing natural resources damaged, especially when a restoration program takes place further away from the damaged site. However, off-site compensation is feasible whether the program is large enough according to social preferences.

The mean value obtained for 1% increase in the afforestation program (or 250 hectares) reported 0.52 € per year and person, hence, the aggregate benefit estimates for compensation for residents from Barcelona correspond to 676.000 € (in 2008 values).

From a restoration perspective, off-site compensation could pose some interesting challenges. Would there be enough land to establish the same type of Mediterranean-forest habitat as was destroyed by the fire? An interesting option to consider would be to look for opportunities to preserve similar Mediterranean forest habitats in France or Italy, for example, it would be suitable compensation for habitat loss occurring in Spain. From an ecological viewpoint it may be a valid alternative, however, this analysis supports the hypothesis that residents of the area affected would probably disagree with such remediation initiative.

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CHAPTER 3

The Perception of Inflation in Stated Periodical Payments. Some Empirical Evidence

ABSTRACT

Stated preference valuation methods often ask respondents for onetime payment, periodical payments, and sometimes for the remaining life of the person. Usually, it is not specified whether those payments will vary according to inflation. For cost-benefit analysis, policy implications, and other purposes the interpretation could have a considerable impact. A contingent valuation survey was applied involving several levels of an afforestation program in Spain. The study elicited the minimum amount of physical compensation for the damage in a value equivalency framework. Using a split sample contingent valuation survey finds that respondents interpret payments in nominal terms when no information is provided in the questionnaire. In addition, results indicate that information regarding payments positively influenced respondents' WTP values. Likewise, participants in focus groups considered the importance of providing information regarding payments in the hypothetical scenario since the inclusion of inflation on payments could modify their answer to the WTP question.

3.1 Introduction

The social perception of periodic payments in contingent valuation has received limited attention in the valuation literature. Typical time periods used within the environmental literature are one-off payments, payments over a specific period, or multiple payments over time however few studies have specified whether the series of payments are expressed in nominal or real terms.

When the survey does not make clear the payment scenario it is unclear whether people answer in nominal or real terms. Do respondents *think* about real or nominal payments? Do some individuals *interpret* payments as nominal and others as real?

Several valuation studies have analyzed the temporal dimension (i.e. payments) and have reported sensitivity in respondent's WTP for changes in payment designs ((Kahneman, 1992 #22)Kahneman and Knetsch, 1992; Stevens et al., 1997; Johnson et al., 2006; Kovacs and Larson, 2007).

A number of valuation studies involve periodical payments for several years (Kahneman and Knetsch, 1992; Stevens et al., 1997; Carson et al., 1997; Shabman and Stephenson, 1996; Krupnick, et al 2002 –RFF-) or for life (Whittington et al. 1990; Hanemann et al., 1991; Nabro and Sjostrom, 2000). In many cases the payments involved in order to maintain the quantity of quality of the environmental good is not defined in precise terms. If the payments were in nominal terms, respondents may be more prompt to commit to the cost than if payments would increase with inflation, thus the estimated WTP result being higher.

When periodical payments are used in stated preference methods and there is no indication on whether values are nominal or real, the respondent is left with the interpretation. For instance, a respondent with the experience of a mortgage may believe the payments will not increase with inflation. On the other hand, many payments, like for utilities and many consumer goods experience price inflation. Studies like DEFRA (2004) or NEEDS (2007) interpret the payments for the increase of life quality (QUALYs) as real ones, while Hanemann, et al (1991)., interpret the payments for protecting wildlife and wetlands habitat in California's San Joaquin Valley nominally as well as Shabmand and Stephenson (1996) to estimate the value of flood risk reduction from the construction of a flood control project.

The incorrect interpretation of information by respondents could result in a bias. For instance, over a period of 10 years, the undiscounted sum of a nominal payment of 100 euro per year is 1000 euro. The sum for real payment values with an annual

inflation rate of 3% goes up 146 euro, with a near 15% increase. This bias could become significant when the results of the valuation study are to be used in policy design instruments, like cost-benefit analysis, equivalency analysis or optimal taxation since the value obtained from the study is critical to the social welfare estimates.

Values obtained from CV surveys are determined by the characteristics of the respondents and the characteristics of the hypothetical market specified to individuals. Therefore, the specification of the payments involved is fundamental to the veracity of the WTP values. Fischhhoff and Furvy (1988) have pointed out the importance of explaining the context of payments, however, in contingent valuation studies is not common to specify whether payments are being asked in nominal or real terms.

Equivalency Analysis borrows the time discount treatment from economics. Thus, a hectare restored next year is less than a hectare seen from the present. More tree credit is needed if forest restoration is delayed. The same applies to VEA. However, VEA has to deal with an additional time treatment issue: inflation. Values can be expressed in nominal (inflation is included) or real (inflation effects are removed) terms. If left to respondents in a stated preference valuation exercise, some individuals consider inflation while others don't. Mortgage payments are not revised according to inflation, while gas prices during the life of a car are.

This study contributes to the valuation literature that focuses on the analysis of the effect of changes in payments on social preferences. A valuation exercise was applied to explore this issue in an equivalency analysis framework. The experiment uses the value-to-value approach to elicit the minimum amount of compensation after a forest wildfire occurred in Spain. Using split samples, this study examines whether leaving respondents undetermined in the wording of the questionnaire would differ from specifying information. Also, it estimates the impact on the WTP estimates when the questionnaires make it clear that payments are considered nominal or real.

The next section reviews some of the literature on this issue and provides background on the topic. It is followed by a description of the model used for estimation and tests to be undertaken. The case study is presented next. The final sections are devoted to the results, discussion and conclusions.

3.1.1 Background on the case

In valuation studies individuals are often asked whether to support public goods that will provide benefits in the future. The public project, which is supposed to provide these benefits, can be implemented during a specific period or in perpetuity. Hence, values of public goods can be elicited in different time schedules (e.g. one-time payment, annual payments over a specified period, payments in perpetuity, etc.) and the survey instrument tells individuals the time frame of payments they will be required to make and the frequency of the payments required for the provision of the public good.

Although there is a widespread acceptance that the length of time horizon is an important factor in determining whether the benefits are enough to take the project (Mitchell and Carson, 1989), little discussion has been found within the CV literature related to the detection of distinctions by respondents when payments are asked to be over long term periods, and more explicitly, when the corresponding payments are assumed to be in nominal or real terms.

As stated by Strotz (1956) individuals are often expected to plan future consumption based on current experience to maximize their utility. At the same time, consumption depends on a budget constrain. As long as the central valuation question in CV approaches can be asked in different time schedules, the time of payments might have consequences on the respondent's budget as they are conscious that stating a positive WTP implies reduction in the consumption of other goods or services (Smith, 2003). Similarly, when valuation studies involve projects that are spread over time, the expected series of payments can be expressed in nominal or real terms. Thus, a clear defined scenario to respondents, such as the distinction of nominal and real values, is fundamental to the veracity of the WTP results.

The specification on payments is important as it provides the foundation for the individual's budget constraint. The NOAA expert panel on contingent valuation recommends that the respondent should be made explicitly aware of their specific budget constraint (Arrow et al. 1993). Hence, it is relevant to indicate in the survey that the provision of the commodity described and respondent's WTP might have actual financial consequences for their income. In this context, it would be appropriate to make the time period explicit in the contingent market and to describe whether the bids are expressed in nominal or real values.

The present study prepared carefully the questions in the survey for analyzing distinctions perceived by respondents when they are asked WTP values to support

a restoration program over a ten-year period when they are informed that the proposed payments will be, or not, adjusted for the effect of inflation every year.

The study uses the Equivalency Analysis approach to calculate the minimum amount of restoration required to offset the losses due to an environmental damage (i.e. a forest wildfire caused by a power line in Catalonia) in a habitat of protected species under the EU Habitats Directive (i.e. *pinus nigra* forest). More information related to Equivalency Analysis is provided in the general introduction.

3.2 The Model

Individual's utility function can be denoted as $u(x,z)$ where x represents a vector of the amounts of good consumed at a fixed price p_x and z represents the quality of the environmental goods in question. According to Hanemann (1984) individuals derive utility from environmental assets and money income y. The initial level of utility is $u = u(x, z^0, y)$ and the new utility level is $u^1 = u(x, z^1, y)$. The random utility model assumes that, even though the individual knows his preferences with certainty, the utility function contains some components that are unknown to the researcher. These components can be treated as stochastic and the random utility model can be written as $u = u(x, z^j, y) = v(p_x, z^j, y) + \varepsilon_j,\ j = 0,1)$. For simplicity the price vector from the indirect utility function is suppressed. If the change in the environmental good is regarded as an improvement it can be expressed with

$$v(z^1, y, \varepsilon) \geq v(z^0, y, \varepsilon)$$

In the CV scenario a certain bid or cost is proposed, however, for purposes of the study here, the size of an afforestation program will be proposed. The probability that the respondent will respond with a *Yes* to the suggested (and fixed) payment given the size of the afforestation program s_k can be denoted with

$$P(yes) = P\left[v\left(z^1, y + s_k, \varepsilon_1 \geq v\left(z^0, y, \varepsilon_0\right)\right)\right]$$

A common assumption is that the individual understands the proposed change in the environmental good and is capable of evaluation the effect of this change on her

utility and considers the proposed size of afforestation program. Thus, her response depends only on this evaluation.

A commons assumption is that the stochastic part of the utility is additively separable $u(z_i, y) + \varepsilon$ .The probability of a *yes* can be as follows:

$$\Pr(yes)) = P\left[v\left(z^1, y + s_k\right) - v\left(z^0, y\right) + \varepsilon_1 - \varepsilon_0 \geq 0\right]$$

The probability indicates that the individual will respond with a *Yes* response if the sum of the deterministic change in utility $\Delta u = v(z^1, y + s_k) - v\left(z^0, y\right)$ and the difference in the errors terms, $\eta = \varepsilon_1 - \varepsilon_0$,is greater than zero. The probability can thus be written as

$$\Pr(yes) = P\left[\eta \geq -\Delta u\right]$$

From probability theory it can also be written as

$$\Pr(yes) = P\left[\eta \geq -\Delta u\right] = 1 - F_\eta\left(-\Delta u\right)$$

with F_η denoting the cumulative density function (cdf) of η. In this formulation the size of the afforestation program s_k is fixed and known. The randomness arises from the component unobservable to the researcher.

For a symmetric distribution the expression is $F(x) = 1 - F(-x)$. Therefore assuming that η is symmetrically distributed the probability will be

$$P(yes) = F_\eta(\Delta u)$$

and the probability of a *No* response

$$P(No) = 1 - F_\eta(\Delta u)$$

3.3 Case Study

3.3.1 Questionnaire design

The construction of the survey followed the scientific standard requirements recommended by the NOAA panel (Arrow et al., 1993). The information provided in the survey was obtained from research literature and discussion with a team of experts. The information presented in the questionnaire was calibrated with two focus groups that included from 6 to 10 people in semi-structured discussions. Focus groups were executed with participants from the general public and the ideas provided were useful to communicate the information of the survey in a clear and simple manner. Participants in focus groups responded previous versions of the questionnaire and discussed their perceptions and attitudes towards the questionnaire. In addition, three in-depth interviews were held to refine the treatment for each of the experiments and a research team member debriefed the respondent on the survey and their answers. Finally a pilot was implemented before the final survey and no major problems were detected in the interviewing process.

The survey instrument began by mentioning a number of social problems and asked the level of respondent's personal concern on a scale of 1= *Not concerned at all* to 5= *Extremely concerned* with the purpose to make the individual comfortable with participating in the survey and answering questions. The second question caused respondents to think about forests in Catalonia, their knowledge of the *pinus nigra* species, whether they were worried about forest fires in Catalonia, attitudinal data, etc., then additional information was presented in order to describe the problem – a protected species that was burned in a forest fire- and then the potential solution was described –an afforestation program to offset the losses-. Next, the central part of the survey presented the scenario of the hypothetical market including the elicitation question that used a modified form of the dichotomous choice type question to find the minimum amount of compensation to offset losses due to a forest fire. The survey collected responses by varying the physical attribute into five different levels ranging from 10% to 100% which were distributed randomly to respondents in the survey consisting of different amounts of hectares to be planted in an afforestation program. Independent of the amount of hectares to be planted, every program would have a fixed cost of 60 € for a 10 year period administered by a fund (this was the payment vehicle used since it was identified as the most appropriate by participants in focus groups).

In order to assess the impact of perception of payments on WTP, the sample was split into three sub-groups; each subgroup received the same information of the

general questionnaire but differed in the information related to the payments. The definition of variables used for treatment of subsamples is shown in Table 1.

Table 1. Definition of variables

Variable Description	Definition
Surface	The size of the afforestation program in percentage terms
Perception	Dummy variable indicating respondent's interpretation of payments. 1= Respondents interpreted payments as fixed over time, 0= If they interpreted payments rising to match with inflation every year.
Fixed Payments	Dummy variable telling whether respondents take into account that payment would be fixed over time when responding the WTP question. 1= Did take into account that payments are fixed over the 10 years, 0= Did not take into account the information about payments.
Varying payments	Dummy variable telling whether respondents take into account that payment would increase each year to adjust for inflation when responding the WTP question. 1= Did take into account that payments would rise to match with inflation, 0= Did not take into account the information about payments.

For one sub-group, the questionnaire did not mention at all whether the cost of the program was expressed in real or nominal terms as follows:

Now I would like to ask you whether you would be willing to pay [x] € for this ***RESTORATION PROGRAM*** *for the next 10 years.*

Following the elicitation question subjects were asked about their interpretation of payments, that is, if they thought that the proposed cost of 60 € would remain fixed over the 10 years or would vary according to inflation rate as follows:

When you decided if you would be willing to pay for the program, did you think that the payment would be fixed over the 10 year period? Or that the payment would rise to match with inflation rate every year?

The second and third groups were given additional information previous to the WTP question: one sub-sample was informed that the annual payments would remain fixed over the whole period as follows:
*Now I will ask you whether you would be willing to pay [x] € for this **RESTORATION PROGRAM** for the next 10 years. This [x] € would not increase even if general prices increase each year and will remain fixed for the 10 year period;* whereas the other was told that the given cost of the program would be increasing according to the annual inflation rate every year as follows:

*Now I would like to ask you whether you would be willing to pay [x] € for this **RESTORATION PROGRAM** for the next 10 years. This [x] € would increase each year to adjust for inflation. Thus, if the next year inflation rises by 3%, the next year you would pay [x] € and each year it would rise with general prices.*

A follow-up question was asked after the elicitation question to those groups belonging to the second and third subsample coded in a five-point rating scale indicating whether the information provided regarding the variation of payments, or no variation, had an effect on their decision of the WTP question, where 1 indicated not at all and 5 that the information provided influenced a lot.

After the core of the interview some debriefing questions were included and a question asking how confident respondents were in their answer to the WTP question as well as reasons for accepting/refusing to pay in order to determine valid criteria for values stated (Mitchell and Carson, 1989). Finally, the last part of the survey collected some standard socio-demographic characteristics. The final questionnaire is contained in appendix B.

3.4 Model Specification

Responses from the dichotomous-choice survey can be specified in a simple linear WTP function for individual i

$$WTP_i = \beta x_i + \varepsilon_i$$

Where x_i is a vector of variables such as socio-economic and household's characteristics, β is the corresponding parameter vector and ε_i is an error term. The probability that a respondent will answer yes to a size of restoration s is given by

$$\Pr(yes) = P\left[\alpha_i + \beta s + \varepsilon_i > \alpha_j + \varepsilon_j\right]$$
$$\Pr(yes) = P\left[\varepsilon_i - \varepsilon_j > -\alpha - \beta s\right]$$
$$\Pr(yes) = P\left[\eta > -\alpha - \beta s\right]$$
$$\Pr(yes) = 1 - F_\eta\left(-\alpha - \beta s\right)$$
$$\Pr(yes) = F_\eta\left[\alpha + \beta s\right]$$

Where F is the cumulative density function of ε.

Therefore, the practical situation of this study the respondents responded with a "yes" or "no" response to a single size of an afforestation program and the cumulative distribution function corresponds to the outcome from the questionnaires corresponding to the probabilities

3.5 Results

3.5.1 Descriptive Statistics

The analysis of perception of inflation in periodical payments was obtained from a contingent valuation questionnaire administered to residents of Barcelona, ranging from 18 to 64 years of age, in the spring of 2008. The case study was based on data taken from face-to-face contingent valuation survey of WTP for the extent of

restoration required to offset losses due to environmental damage (i.e. a forest wildfire in Catalonia) using the value-to-value approach. (Details of this study are provided in chapter one)

Residents from Barcelona with more than 18 years of age were randomly selected in parks located in the city and asked if they would be willing to participate in the study. Individuals interviewed in the sample reflected the population and demographic characteristics. The socio demographic characteristics of the sample are provided in Table 2.

Table 2. Socio demographic characteristics by subsample

Demographic characteristics	Subsample without information	Fixed Payments	Varying Payments
Percent Male	54.00	49.00	44.00
Age	35.15	32.8	33.61
Income (€)	1.150	1.255	1.200
Education (years)	13	13	13

Out of the 293 questionnaires completed, a total of 79 were classified as protest answers. The overall response rate of the survey was 73% and each interview lasted about 13-15 minutes. Based on the demographics of the sample, 47% of the total respondents were male and the average age of respondent was 35 years old.

From the valid survey responses, 54% reported positive WTP. Respondents who stated a positive WTP as well as respondents who rejected to pay for the program were asked their reasons for doing so in order to understand the response that was given. The motivations indicated by individuals for accepting to pay for the program were related more to environmental and psychological indicators than to economic pointers. The following motivations were indicated: “for improving the environment” (37%), “to contribute to a good cause” (21%), followed by “for the wild animals living in the forest” (18%). Respondents who indicated that they would not pay for the program considered reasons most closely related with an economic basis “I cannot afford the program at this time” (55%), “there are issues more important than the environment” (25%), and “very expensive program if paid by all citizens (22%).

3.5.2 Econometric Analysis

As explained earlier the survey consisted of a split questionnaire sample design. The samples sizes for each subgroup at each of the restoration level (10%, 30%, 50%, 70% and 100%) are shown in Table 3.

Table 3. Sub-sample sizes

Subgroup	Restoration level					Total
	10%	30%	50%	70%	100%	
Fixed payments	20	15	9	10	9	63
Varying payments	19	16	12	9	9	65

The models were estimated by the logit model and the results of the subsamples are presented in Table 4. In each of the models, the SURFACE coefficient has the expected positive sign and is statistically significant at a 5% level in the three subsamples indicating sensitivity to the size of the afforestation, that is, the larger the extent of the restoration program, at a fixed cost, the more likely individuals would accept to pay for the program. This demonstrates that respondents in the sample are responsive to the amount of the restoration program being offered. Other socio-economic variables (e.g. gender, income, age) were found insignificant, hence were not included in the model.

The first column corresponds to the results of the subsample that was asked their WTP for a restoration program without information indicating whether the payments would be nominal, real, or fixed over the 10 year period. The PERCEPTION dummy variable in Model 1 was found positive and significant at a 5% level, indicating that respondents in the sample did consider the cost of the program as fixed payments over time.

The second and third subsamples were told that payment would be in nominal and in real terms, respectively. To test the impact on WTP values the debriefing questions asked the respondents to rate the level at which they felt they were influenced by this information when deciding if they would be willing to pay for the

program using a Likert type scale ranging from 1=*Did not influence their answer at all* to 5= *Greatly influenced their answer*.

Both subsamples reflected similar commitment for accepting to pay for the program as 54% of the subsample informed that payments would remain fixed over the whole period supported the payment versus 56% for the subsample warned about the increments every year. However, the estimates of the size of the restoration program were different across the two versions (41% versus 33%).

In Model 2 the coefficient of FIXED PAYMENTS is positive and significant at a 10% level suggesting that respondents are sensitive to the information provided in the questionnaire with a positive influence on the WTP response; specifically in this case respondents were informed that payments would remain fixed over the 10 year period. The coefficient of VARYING PAYMENTS in Model 3 is highly significant and positive indicating that respondents take the information about payments seriously, therefore the likelihood of responding to the WTP question positively is influenced when individuals are informed that the bid will rise with inflation every year.

The relative magnitude of the parameters of FIX and VARYING PAYMENTS reveals the relative importance of the variables in terms of the effects on respondents' probability of WTP. The comparison reveals that informing individuals that payments will increase with inflation has a larger impact on the size of restoration than informing respondents that payments will remain fixed over time.

Table 4. Logit regression model of probability

Variable	Model 1	Model 2	Model 3
Constant	- 0.6136 (.3529)	- 0.4154 (.3734)	- 0.0280 (.4013)
Surface	0.0277** (.0111)	0.0159** (.0061)	0.1329** (.0064)
Perception	0.0020** (.0008)		
Fixed Payments		0.00081* (.0004)	
Varying Payments			0.0012*** (.0004)
Mean Size of Afforestation Program	30.07* (16.58)	40.14*** (12.34)	33.37** (14.44)

***,**,* 1%, 5%, 10%, respectively

t-statistics in parenthesis

Table 4 also presents the results of the mean size of the afforestation program by subsample. The means for the subsample without providing information regarding payments, the subsample stating that payments would be nominal, and the subsample stating that payments would be real are 30%, 40% and 33%, respectively. Since the SURFACE is a percentage based on the size of the original forest fire, the number of hectares equivalent to each percentage is 7.500, 10.000, and 8.250. Finally, Table 5 shows the confidence interval using the Krinsky and Robb (1986) procedure for the split questionnaire samples. The intervals of confidence are calculated from 1,000 repetitions.

Table 5. Krinsky-Robb

	Model 1	Model 2	Model 3
Mean Surface	30.07	40.14	33.67
Confidence Interval	(-4.76, 61.70)	(16.07, 62.64)	(5.82, 62.41)

95% Interval

Since the estimates of the mean size of the restoration programs are similar across the three subsamples the statistical significance of differences in dichotomous choice responses can be compared by using the statistical likelihood ratio test (LLR). In this case, the comparison is performed for two subsamples (i.e. fixed payments versus varying payments subsample) in order to test differences in the slope and intercept for two subsamples. Differences in response behavior should be reflected in differences between the values of the log likelihood values for the pooled data and the separately log likelihoods of the two subsamples.

The individual and pooled log likelihoods are shown in Table 6. As can be seen, the pooled and individual likelihoods are -122.05, -78.52, and -79.43 respectively. The result of the LLR test calculates a chi-square of 58.84. Since the critical value at the 0.001 level of significance is 10.83, a strongly significant difference is detected in the responses to the WTP question when different information is provided in the questionnaire (i.e. nominal payments or real payments).

Table 6. Logit regression model of probability

Variable	Fixed Payments	Varying Payments	Pooled data
Constant (t-statistic)	- 0.6399* (.3529)	- 0.4898 (.3548)	0.5620** (.2751)
Surface (t-statistic)	0.0159*** (.0061)	0.0145** (.0061)	0.0143*** (.0049)
Log-likelihood	-78.52	-79.43	-122.05
Chi-square	7.23	5.85	8.91
Mean WTP	40.14	33.37	39.05
	n=119	n=120	

***,**,* 1%, 5%. 10%, respectively
t-statistics in parenthesis

3.6 Discussion

The findings from this study suggest that in contingent valuation studies, explicit information relating to payments involving relatively long time horizon periods could avoid miscalculation of parameters. Since results obtained from valuation approaches are typically incorporated into cost-benefit analysis to estimate the aggregate benefits, bearing in mind that respondents may be reflecting sensitivity to whether nominal or real payment are being elicited could be useful when assessing relatively large scale projects.

This is also valid in the context of Equivalency Analysis. The present study used the value-to-value approach and asked respondents to support a restoration program with increments in payments. Results provide evidence that changes in the extent of the restoration program can be found in the context of natural resource damage assessment.

The reasons for accepting to support the program in the present study were found to be more related to psychological than economic motivations. The legitimacy of motives behind stated values have been discussed in the valuation literature linked to the validity of CVM (McConnell, 1997).

The present split-sample study involved annual payments for an afforestation program over 10 years. The fact that the SURFACE variable has a positive coefficient indicates that individuals are more likely to pay the higher amount of the afforestation program. The results also show that the subgroup that missed the specific information regarding payments (i.e. the control group) interpreted payments as nominal. In addition, in the focus groups and survey pretests, participants also construed the payments as fixed. From eighteen participants in two focus group sessions only one subject interpreted increasing payments over time. However, after disclosing his point of view to the group, the rest of the participants agreed that his perception was correct, since "*X euros today will be worth almost nothing in 10 years*". They vociferously supported the idea that the payments for sure would be increasing every year. The individual introducing the idea of varying payments was an insurance agent, thus, it is possible that the subject occupation may be influencing WTP values, however, this factor was not taken into account in the experimental design.

The estimates of the mean size of the restoration program from the FIXED PAYMENTS subsample and the pooled data were found to be similar (41% versus 39%). One possible interpretation for this similarity is that respondents already have in mind the idea of fixed payments; thus, there may be no need to remind respondents that payments will be fixed over time when nominal payments are being valued. On the other hand, the mean obtained from the VARYING PAYMENTS subsample calculates a size of 33% or 8.250 hectares. The unexpected drop in the mean size of the restoration program with respect to the other subsamples may indicate that respondents could be facing uncertainty over the future (e.g. higher restoration costs as result of increment in prices, hence lower level of afforestation program).

The positive sign and statistical significance of the FIXED and VARYING dummy variables provides evidence that information on payments positively influenced respondents' WTP values. One possible explanation is that individuals are limited in their opportunity to absorb new information in valuation surveys and they value the specific information that may affect their income. Likewise, participants in focus groups considered how important was to provide accurate information for the scenario they were presented since the inclusion of inflation on payments could modify their answer to the WTP question.

The results show the importance of providing information to respondents regarding payments may enable a precise aggregation of benefits over time.

Although many studies of contingent valuation have asked payments at intervals of projects the WTP values drawn from CV survey may result in an unclear interpretation for respondents. Therefore, it is important that the framing of contingent valuation questions makes clear whether the valuation question refers to nominal or real payments toward obtaining more accurate values.

3.7 Conclusions

The survey used in this study elicited WTP values to estimate the amount of remediation that increases the social welfare by the same amount that was decreased due to a forest fire in Catalonia. The sample was split into three subgroups to analyze whether the inclusion of information, related to changes in payments over which WTP values were assessed, affected respondents' values.

Each subsample was asked the same time period of payments (i.e. 10 year period) but different information regarding payments: the control group was asked payments for an afforestation program and asked whether they thought that payments would be fixed over the ten years or would vary according to inflation rate. The second subsample was informed that payments would remain fixed over time, whereas the last group was warned about the increments of payments to match with inflation every year.

The results show that the value estimates were affected by specific information about payments. The mean size of the afforestation program for the control group was 30% or 7.500 hectares; the FIXED PAYMENTS mean was 40% or 10.000 hectares, and the VARYING PAYMENTS subsample 33% or 8.250 hectares. This outcome suggests that specific information on payments may be important in applications where respondents are confronted to long periods of time. In addition to the information about the time period of WTP values, and the frequency of payments required to maintain the quantity or quality change, respondents should be aware whether nominal and real values are being elicited in order to provide more accurate values.

The expected difference found in the mean size of restoration between the FIXED and VARYING subsamples indicates that subjects were affected by the increments in payments. To determine any consistent influence of respondents' occupation on the WTP values further research is required. The drop in the mean size of the restoration program found in the VARYNG subsample was unexpected, and is

interesting in its own right. This may be due to the uncertainty of expected increments in prices in the next ten years. This finding deserves further research.

Environmental policies or projects involve benefits and cost that accrue over a number of years. A well designed contingent valuation study can provide important insights to guide public policy. The findings from this study suggest that the provision of information should be clearly explained within the valuation question specifically when payments involve long periods of time. The research should also consider how the information should be presented in order to be understandable to respondents and to avoid providing unintended clues that may bias welfare estimates.

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APPENDIX A

PREVENTION PROGRAM

I. PREVENTION questionnaire

City: _____

WILD FOREST FIRES OF BLACK PINE IN CATALONIA

DATE: / / 2007

INTERVIEWER'S NAME: _____

INTERVIEW STARTS (24 HOUR CLOCK) ____

Good morning/afternoon:

We would like to hear your opinion about some current topics. It's for a study being done by the Autonomous University of Barcelona. It won't take much time. Would you be willing to answer some questions?

a) Yes
b) No

The information provided in this survey will only be used for analysis in this study.

Thank you for your participation.

[SHOW CARD 1]

1. *Let's start by talking about some current topics. Some may be important to you, others may not. In a scale from 1 to 5, what is the level of concern you personally feel for each of the following categories?* ***[1 MEANING NOT CONCERNED AT ALL, 2 SLIGHTLY CONCERNED, 3 MODERATELY CONCERNED, 4 VERY CONCERNED, 5 EXTREMELY CONCERNED]***

	Not concerned at all	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned	Don't know
Immigration	1	2	3	4	5	
Housing cost	1	2	3	4	5	
Environment Protection	1	2	3	4	5	
Unemployment	1	2	3	4	5	

We will now speak specifically about forests. In Catalonia 40% of the surface is covered by forests. **[SHOW CARD 2].** The green color on the map shows the corresponded area covered by forests.

2. Have you visited any forest in Catalonia during the past 12 months? **[CIRCLE THE ANSWER]**

a) Yes
b) No
c) Don't know

In any case, there are different types of forests in Catalonia, some are dominated by one specie and others are mixed forests.

[SHOW CARD 3]

According to its abundance holm oak's forest are the dominant specie followed by oaks, then the scots pine forest and then the *black pine* forest.

3. Which of the following types of forests (if any) do you think you know or have visited?

a) Holm oak pine
b) Oaks forests
c) Scots pine
d) Black pine
e) None
f) Don't remember

In this survey we will focus on the *black pine* forests. **[SHOW CARD 4]** The picture shows a *black pine* forest.

Black pine are the fourth most abundant forests in Catalonia and predominate in the area marked with green color on the map. **[SHOW CARD 5]**

On average these pine forests are 50 years old and are about 20 meters in height, forming dense forests that accumulate vegetation under the trees. These characteristics make the *black pine* forests at risk of forest fires.

In case of a forest fire, it could spread at high speeds and with high intensity, as it has happened in the past.

4. Are you aware of the consequences of the wild forest fires?

a) Yes
b) No
c) Don't know

Scientists estimate that 30% of the *black pine* hectares will be burned in Catalonia within the next 10 years due to wild fires.

When a wild fire occurs a long period of time has to pass for the forest to regenerate. During this time the forest cannot provide all the ecological

functions and benefits to animals and humans which they normally would.

With the occurrence of a wild fire, it would take 50 years for the forest to regenerate. Nevertheless, in 15 years after the fire there would be a young forest.

5. Do you understand that it would take time for the forest to regenerate?
a) Yes
b) No
c) Don't know

A non profit foundation is promoting a **SPECIAL PROGRAM** with the aim of protecting *black pine* forests wild from forest fires of in the central surface of Catalonia.

The program is based on a technical plan for the immediate detection and extinguishing of fires, as well as fire prevention, with the development of roads and water points in the *black pine* forest.

If the prevention program were to be put in affect, the *black pine* forests would be protected, otherwise it is expected that 30% of the hectares of *black pine* forests would decrease.

6. Do you understand where the prevention program is proposed to be carried out?
a) Yes
b) No
c) Don't know

Well, this **SPECIAL PREVENTION PROGRAM** has a cost that would have to be covered by all residents of Catalonia through annual payments over the next 10 years. The money collected would only be used for this **PREVENTION PROGRAM** and the payments would start in 2008.

Some people have accepted the program, and others have not.

Now I would like to ask you if you would be willing to pay [x] € for this **PREVENTION PROGRAM**. This [x] € would increase each year to adjust for inflation. Thus, if the next year inflation rose by 3%, the next year you would pay [x] € and each year it would rise with general prices.

Before I ask you this question I would like to ask you to consider the level of your income, since it would imply compulsory annual payments over the next 10 years starting in 2008.

Please remember that the program has the aim of preventing wild forest fires in 30% of the hectares of [x] forests with the aim of protecting this type of forests and to avoid the loss of services that they would produce this wild fire.

7. Would you be willing to pay [x] euros every year for the next 10 years for this prevention program?

a) Yes
b) No
c) Don't know

8. On a scale of one to five, how confident are you that you would actually pay over the next 10 years? **[SHOW CARD 6]** ***[1 MEANING NOT CONFIDENT AT ALL, 2 SLIGHTLY CONFIDENT, 3 MODERATELY CONFIDENT, 4 VERY CONFIDENT, 5 EXTREMELY CONFIDENT]***

1	2	3	4	5
Not confident at all	Slightly confident	Moderately confident	Very confident	Extremely confident

[IN CASE HE/SHE WOULD PAY FOR THE PROGRAM]

9. A. Please indicate the reasons why you are willing to pay [x] euros for the next 10 years for this program. **[SHOW CARD 7]** *He/she may choose more than one*

a) It is important to protect the black pine forests
b) For the wild animals living in the forest
c) For improving the environment
d) To contribute to a good cause
e) Because the forests provide recreational options and rural tourism
f) For the future generations
g) Other (specify):

[IN CASE HE/SHE WOULD NOT BE WILLING TO PAY FOR THE PROGRAM]

9. B. Why you would not be willing to pay [x] euros for this program? **[SHOW CARD 8]**
a) This plan is not worth anything to me
b) I don't think the program will be successful
c) Should be paid by recreational users
d) I cannot afford the program at this time
f) Should be paid from existing taxes
g) Other:

[IF HE/SHE DOESN'T KNOW]

9.C. Why did you choose this category? **[SHOW CARD 9]** *He/she may choose more than one*
a) I would need more information to be sure or to make a decision
b) The situation is too hypothetical
c) Other

10. When you decided if you would be willing to pay for the program. How much did you take into account the following aspects?. **[SHOW CARD 10, CIRCLE THE ANSWER]**

	Not at all	**A little**	**Some**	**More**	**A lot**	Don't know
The time the forest would take to recover (50 years)	1	2	3	4	5	00
Your personal income	1	2	3	4	5	00
The regeneration of the environment	1	2	3	4	5	00
The payment time over the 10 years	1	2	3	4	5	00
The payment would rise to match with inflation	1	2	3	4	5	00

Finally I have a few questions for statistical purposes

11. How long have you lived at this address? **[READ OUT AND CIRCLE]**
a) Less than 6 months
b) From 6 months to 2 years
c) From 2 years to 5 years
d) More than 5 years

12. How many people live in your household including yourself? _____

13. Do you have children?

a) Yes. How many of them are under the age of 18?_____
b) No

14. What is your date of birth? _____

15. What is the highest level of education you have completed? **[SHOW CARD 11]** _____

16. Which of the following best describes your personal montly income? **[SHOW CARD 12]** _____

17. Your phone number _____

18. Your name _____

Thank you very much for your participation.

[TO BE FILLED OUT AT THE END OF THE ENTERVIEW]

TIME ENTERVIEW ENDS (24 HOUR CLOCK) ☐

1. Respondent's gender

Woman ☐ Man ☐

2. How serious was the answer made by the respondent?
a) Very serious
b) Serious
c) Somewhat serious
d) Not al all serious

3. How well did the respondent understand the information of the survey before deciding if he/she would be willing to pay for the prevention of wild fires in *black pine* forests?

a) Understood perfectly
b) Understood very well
c) Understood well
d) Understood little
e) Undertstood very little
f) Did not understand nothing at all

4. How well the respondent understood the valuation question? (question 8)
a) Understood completely
b) Understood somewhat. Why she has had difficulties?:

_____

c) Did not understand at all. Why she has had difficulties?

_____

[WRITE ANY ADDITIONAL COMMENT ABOUT THE RESPONDENT]

_____

_____

_____

_____

APPENDIX B

COMPENSATORY PROGRAM

I. COMPENSATION *(location 1)*

City: _____

PLANTATION OF BLACK PINE IN CATALONIA

DATE: / / 2007

INTERVIEWER'S NAME: _____

INTERVIEW STARTS (24 HOUR CLOCK) ____

Good morning/afternoon:

We would like to hear your opinion about some current topics. It's for a study being done by the Autonomous University of Barcelona. It won't take much time. Would you be willing to answer some questions?

c) Yes
d) No

The information provided in this survey will be kept for analysis only.

Thank you for your participation.

[SHOW CARD 1]

2. *Let's start by talking about some current topics. Some may be important to you, others may not. In a scale from 1 to 5, what is the level of concern you personally feel for each of the following categories?* **[1 MEANING NOT CONCERNED AT ALL, 2 SLIGHTLY CONCERNED, 3 MODERATELY CONCERNED, 4 VERY CONCERNED, 5 EXTREMELY CONCERNED]**

	Not concerned at all	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned	Don't know
Environment Protection	1	2	3	4	5	
Immigration	1	2	3	4	5	
Housing cost	1	2	3	4	5	
Unemployment	1	2	3	4	5	

Now I will give you some information about forests and later I will ask your opinion about a program that could be implemented.

There are different types of forests in Catalonia, some are dominated by one specie and others are mixed forests. **[SHOW CARD 2]**

According to its abundance holm oak's forest are the dominant specie followed by oaks, then the scots pine forest and then the *black pine* forest.

2. Which of the following types of forests (if any) do you think you know or have visited?

f) Holm oak pine
g) Oaks forests
h) Scots pine
i) Black pine
j) None
f) Don't remember

In this survey we will focus on the *black pine* forests. **[SHOW CARD 3]** The picture shows a *black pine* forest.

Black pine are the fourth most abundant forests in Catalonia and predominate in the area marked with green color on the map. **[SHOW CARD 4]**

On average these pine forests are 50 years old forming dense forests that accumulate vegetation under the trees. These characteristics make the *black pine* forests at risk of forest fires.

3. On a scale of 1 to 5, What is the level of concern you would say you feel for forest fires in Catalonia? **[SHOW CARD 5] [1 MEANING NOT CONCERNED AT ALL, 2 SLIGHTLY CONCERNED, 3 MODERATELY CONCERNED, 4 VERY CONCERNED, 5 EXTREMELY CONCERNED]**

1	2	3	4	5
Not concerned at all	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned

In past years 30% of the *black pine* hectares have been burned in a large forest fire. The red color on the map shows the area of the wild fire. **[SHOW CARD 6]**

When a wild fire occurs a long period of time has to pass for the forest to regenerate. During this time the forest cannot provide all the ecological functions and benefits to animals and humans which they normally would.

Scientists estimate that it would take 50 years for the forest to regenerate.

4. Do you understand that it would take time for the forest to regenerate?
a) Yes
b) No
c) Don't know

Since the affected forest takes 50 years to mature, a non profit foundation is promoting a **SPECIAL PROGRAM** to offset the loss of *black pine* forest during those 50 years in the central part of Catalonia.

The **REPAIRING** program proposes specific *black pine* planting efforts. **[SHOW GREEN AREA ON CARD 7]**

5. Do you understand what the planting efforts would achieve and where they are proposed to be done?

a) Yes
b) No
c) Don't know

According to recent studies [q] hectares of black pine could be planted in the green coloured area on the map. The area to be planted represents [q]% of the burned area. **[SHOW CARD 8]**

6. Do you understand that the [q] hectares planted would represent [q]% *of the burned area?*

a) Yes
b) No
c) Don't know

Well, this **REPAIRING PROGRAM** has a cost that would have to be covered by all residents of Catalonia through annual payments over the next 10 years.

If the citizens would accept this payment, the *black pine* trees would be planted, otherwise, they would not be planted.

Some people have accepted the program, and others have not.

Now I would like to ask you whether you would be willing to pay [x] € for this **REPAIRING PROGRAM** for the next 10 years. This [x] € would increase each year to adjust for inflation. Thus, if the next year inflation rose by 3%, the next year you would pay [x] € and each year it would rise with general prices.

Before I ask you this question I would like to ask you to consider the level of your income, since it would imply compulsory annual payments over the next 10 years starting in 2008.

7. Would you be willing to pay [x] euros every year for the next 10 years for this program?

a) Yes
b) No
c) Don't know

8. On a scale of one to five, how confident are you that you would actually pay over the next 10 years? **[SHOW CARD 9]**
[1 MEANING NOT CONFIDENT AT ALL, 2 SLIGHTLY CONFIDENT, 3 MODERATELY CONFIDENT, 4 VERY CONFIDENT, 5 EXTREMELY CONFIDENT]

1	2	3	4	5
Not confident at all	Slightly confident	Moderately confident	Very confident	Extremely confident

[IN CASE HE/SHE WOULD PAY FOR THE PROGRAM]

9. A. Please indicate the reasons why you are willing to pay [x] euros for the next 10 years for this program. **[SHOW CARD 10]** *He/she may choose more than one*

a) It is important to protect the black pine forests
b) For the wild animals living in the forest
c) For improving the environment
d) To contribute to a good cause
e) Because the forests provide recreational options and rural tourism
f) For the future generations
g) Other (specify):

[IN CASE HE/SHE WOULD NOT BE WILLING TO PAY FOR THE PROGRAM]

9. B. Why you would not be willing to pay [x] euros for this program? **[SHOW CARD 11]**
a) This plan is not worth anything to me
b) I don't think the program will be successful
c) Should be paid by recreational users
d) I cannot afford the program at this time
f) Should be paid from existing taxes
g) Other:

[IF HE/SHE DOESN'T KNOW]

9.C. Why did you choose this category? **[SHOW CARD 12]** *He/she may choose more than one*

a) I would need more information to be sure or to make a decision
b) The situation is too hypothetical
c) Other

*10. When you decided if you would be willing to pay for the program. How much did you take into account the following aspects?.***[SHOW CARD 13, CIRCLE THE ANSWER]**

	Not at all	**A little**	**Some**	**More**	**A lot**	Don't know
The time the forest would take to recover (50 years)	1	2	3	4	5	00
The amount of hectares to be planted	1	2	3	4	5	00
Your personal income	1	2	3	4	5	00
The regeneration of the environment	1	2	3	4	5	00
The payment time over the 10 years	1	2	3	4	5	00
The payment would rise to match with inflation	1	2	3	4	5	00

Finally I have a few questions for statistical purposes

11. How long have you lived at this address? **[READ OUT AND CIRCLE]**
a) Less than 6 months
b) From 6 months to 2 years
c) From 2 years to 5 years
d) More than 5 years

12. How many people live in your household including yourself? _____

13. Do you have children?

a) Yes. How many of them are under the age of 18?_____

b) No

14. What is your date of birth? _____

15. What is the highest level of education you have completed? **[SHOW CARD 14]** _____

16. Which of the following best describes your personal monthly income? **[SHOW CARD 15]** _____

17. Your phone number _____

18. Your name _____

Thank you very much for your participation.

[TO BE FILLED OUT AT THE END OF THE ENTERVIEW]

TIME ENTERVIEW ENDS (24 HOUR CLOCK) ☐

1. Respondent's gender

Woman ☐ Man ☐

2. How serious was the answer made by the respondent?
a) Very serious
b) Serious
c) Somewhat serious
d) Not al all serious

3. How well did the respondent understand the information of the survey before deciding if he/she would be willing to pay for the prevention of wild fires in *black pine* forests?

a) Understood perfectly
b) Understood very well
c) Understood well
d) Understood little
e) Undertstood very little
f) Did not understand nothing at all

4. How well the respondent understood the valuation question? (question 7)
a) Understood completely
b) Understood somewhat. Why she has had difficulties?:

_____

c) Did not understand at all. Why she has had difficulties?

_____

[WRITE ANY ADDITIONAL COMMENT ABOUT THE RESPONDENT]

_____

_____

_____

_____

APPENDIX C

COMPENSATORY REMEDIATION:

DISTANCE DECAY EFFECTS

I. COMPENSATION *(Two locations)*
City: _____

PLANTATION OF BLACK PINE IN CATALONIA

DATE: ____/____/ 2007

INTERVIEWER'S NAME: _____

INTERVIEW STARTS (24 HOUR CLOCK) ____

Good morning/afternoon:

We would like to know your opinion about some current topics. It's for a study being done by the Autonomous University of Barcelona. It won't take much time. Would you be willing to answer some questions?

e) Yes
f) No

The information provided in this survey will be kept for analysis only.

Thank you for your participation.

[SHOW CARD 1]

3. *Let's start by talking about some current topics. Some may be important to you, others may not. In a scale from 1 to 5, what is the level of concern you personally feel for each of the following categories?* **[1 MEANING NOT CONCERNED AT ALL, 2 SLIGHTLY CONCERNED, 3 MODERATELY CONCERNED, 4 VERY CONCERNED, 5 EXTREMELY CONCERNED]**

	Not concerned at all	Slightly concerned	Moderately concerned	Very concernid	Extremely concerned	Don't know
Housing cost	1	2	3	4	5	
Unemployment	1	2	3	4	5	
Environment Protection	1	2	3	4	5	
Immigration	1	2	3	4	5	

Now I will give you some information about forests and later I will ask your opinion about a program that could be implemented.

There are different types of forests in Catalonia, some are dominated by one specie and others are mixed forests. **[SHOW CARD 2]**

According to its abundance holm oak's forest are the dominant specie followed by oaks, then the scots pine forest and then the *black pine* forest.

2. Which of the following types of forests (if any) do you think you know or have visited?
k) Holm oak pine
l) Oaks forests
m) Scots pine
n) Black pine
o) None
f) Don't remember

In this survey we will focus on the *black pine* forests. **[SHOW CARD 3]** The picture shows a *black pine* forest.

Black pine are the fourth most abundant forests in Catalonia and predominate in the area marked with green color on the map. **[SHOW CARD 4]**

On average these pine forests are 50 years old forming dense forests that accumulate vegetation under the trees. These characteristics make the *black pine* forests at risk of forest fires.

3. On a scale of 1 to 5, What is the level of concern you would say you feel for forest fires in Catalonia? **[SHOW CARD 5] [1 MEANING NOT CONCERNED AT ALL, 2 SLIGHTLY CONCERNED, 3 MODERATELY CONCERNED, 4 VERY CONCERNED, 5 EXTREMELY CONCERNED]**

1	2	3	4	5
Not concerned at all	Slightly concerned	Moderately concerned	Very concerned	Extremely concerned

In past years 30% of the *black pine* hectares have been burned in a large forest fire. The red color on the map shows the area of the wild fire. **[SHOW CARD 6]**

When a wild fire occurs a long period of time has to pass for the forest to regenerate. During this time the forest cannot provide all the ecological functions and benefits to animals and humans which they normally would.

Scientists estimate that it would take 50 years for the forest to regenerate.

4. Do you understand that it would take time for the forest to regenerate?
a) Yes
b) No
c) Don't know

Since the affected forest takes 50 years to mature, a non profit foundation is promoting a **SPECIAL PROGRAM** to offset the loss of *black pine* forest during those 50 years in the central part of Catalonia.

The **REPAIRING** program proposes specific *black pine* planting efforts. **[SHOW THE TWO GREEN AREAS ON CARD 7]**

5. Do you understand what the planting efforts would achieve and where they are proposed to be done?

a) Yes
b) No
c) Don't know

According to recent studies *black pine* could be planted in two possible locations. **[SHOW CARD 8]** The green areas show the areas in which this forest would be planted.

The first is area 1, **[INDICATE NUMBER 1 ON CARD 8]** the [q] hectares of black pine represent [q] % of the burned area.

The other location to plant [q] hectares of black pine forest is area 2 **[INDICATE NUMBER 2 ON CARD 8].** The area planted would represent [q]% of the burned area.

6. Just looking at the two sites, would you prefer one over the other?

a) Yes. Which one? _____

b) No

6. A Why?

_____

_____

Well, if this **REPAIRING PROGRAM** were to be in affect, the plantation would have a cost that would have to be covered by all residents of Catalonia through annual payments over the next 10 years.

Therefore, it is important to know whether you would be willing to pay an annual contribution in a special fund during the next 10 years.

If citizens would accept this payment, the *black pine* trees would be planted, otherwise, they would not be planted.

Some people have accepted the program, and others have not.

Now I would like to ask you whether you would be willing to pay for this **REPAIRING PROGRAM** for the next 10 years. This amount would increase each year to adjust for inflation. Thus, each year the payment would rise with general prices.

Before I ask you this question I would like to ask you to consider the level of your income, since it would imply compulsory annual payments over the next 10 years starting in 2008.

7. If the plantation of [q] hectares of black pine in site 1 **[INDICATE NUMBER 1 ON CARD 8]** *were the only alternative available, Would you pay [x] euros every year for the next 10 years for this program?*

a) Yes
b) No
c) Don't know

8. On a scale of one to five, how confident are you that you would actually pay over the next 10 years? **[SHOW CARD 9]**
[1 MEANING NOT CONFIDENT AT ALL, 2 SLIGHTLY CONFIDENT, 3 MODERATELY CONFIDENT, 4 VERY CONFIDENT, 5 EXTREMELY CONFIDENT]

1	2	3	4	5
Not confident at all	Slightly confident	Moderately confident	Very confident	Extremely confident

[IN CASE HE/SHE WOULD PAY FOR THE PROGRAM]

9. A. Please indicate the reasons why you are willing to pay [x] euros for the next 10 years for this program. **[DON'T READ THE ANSWERS. ALLOW RESPONDENT TO ANSWER SPONTANEOUSLY AND CHOOSE THE MOST APPROPRIATE FROM THE LIST]** *He/she may choose more than one*

a) It is important to protect the black pine forests
b) For the wild animals living in the forest
c) For improving the environment
d) To contribute to a good cause
e) Because the forests provide recreational options and rural tourism
f) For the future generations
g) Other (specify):

[IN CASE HE/SHE WOULD NOT BE WILLING TO PAY FOR THE PROGRAM]

9. B. Why you would not be willing to pay [x] euros for this program? **[DON'T READ THE ANSWERS. ALLOW RESPONDENT TO ANSWER SPONTANEOUSLY AND CHOOSE THE MOST APPROPRIATE FROM THE LIST]**
a) This plan is not worth anything to me
b) I don't think the program will be successful
c) Should be paid by recreational users
d) I cannot afford the program at this time
f) Should be paid from existing taxes
g) Other:

[IF HE/SHE DOESN'T KNOW]

9.C. Why did you choose this category? **[DON'T READ THE ANSWERS. ALLOW RESPONDENT TO ANSWER SPONTANEOUSLY AND CHOOSE THE MOST APPROPRIATE FROM THE LIST]** *He/she may choose more than one*

a) I would need more information to be sure or to make a decision
b) The situation is too hypothetical
c) Other

10. Now, thinking about the planting of [q] hectares of black pine in site 2, if this program were the only alternative available, **[INDICATE NUMBER 2 ON CARD 8]** *Would you pay [x] euros every year for the next 10 years for this program?*

a) Yes
b) No
c) Don't know

11. On a scale of one to five, how confident are you that you would actually pay over the next 10 years? **[SHOW CARD 9]**
[1 MEANING NOT CONFIDENT AT ALL, 2 SLIGHTLY CONFIDENT, 3 MODERATELY CONFIDENT, 4 VERY CONFIDENT, 5 EXTREMELY CONFIDENT]

1	2	3	4	5
Not confident at all	Slightly confident	Moderately confident	Very confident	Extremely confident

[IN CASE HE/SHE WOULD PAY FOR THE PROGRAM]

12. A. Please indicate the reasons why you are willing to pay [x] euros for the next 10 years for this program. **[DON'T READ THE ANSWERS. ALLOW RESPONDENT TO ANSWER SPONTANEOUSLY AND CHOOSE THE MOST APPROPRIATE FROM THE LIST]** *He/she may choose more than one*

IN CASE HE/SHE WOULD NOT BE WILLING TO PAY FOR THE PROGRAM]

12. B. Why you would not be willing to pay [x] euros for this program? **[SHOW CARD 11]**

[IF HE/SHE DOESN'T KNOW]

12.C. Why did you choose this category? **[SHOW CARD 12]** *He/she may choose more than one*

*13. When you decided if you would be willing to pay for the program. How much did you take into account the following aspects?.***[SHOW CARD 13, CIRCLE THE ANSWER]**

	Not at all	**A little**	**Some**	**More**	**A lot**	Don't know
The time the forest would take to recover (50 years)	1	2	3	4	5	00
Your personal income	1	2	3	4	5	00
The amount of hectares to be planted	1	2	3	4	5	00
The location of the plantations	1	2	3	4	5	00
The payment time over the 10 years	1	2	3	4	5	00
The payment would rose to match with inflation	1	2	3	4	5	00

Finally I have a few questions for statistical purposes

14. How long have you lived at this address? **[READ OUT AND CIRCLE]**
a) Less than 6 months
b) From 6 months to 2 years
c) From 2 years to 5 years
d) More than 5 years

15. How many people live in your household including yourself? _____

16. Do you have children?

a) Yes. How many of them are under the age of 18?_____
b) No

17. What is your date of birth? _____

18. What is the highest level of education you have completed? **[SHOW CARD 14]** _____

19. Which of the following best describes your personal monthly income? **[SHOW CARD 15]**

_____

20. I need to ask you for your name and phone number in case my supervisor wants to check my work

20. Phone number _____

21. Name _____

Thank you very much for your participation

[TO BE FILLED OUT AT THE END OF THE ENTERVIEW]

TIME ENTERVIEW ENDS
(24 HOUR CLOCK) ☐

1. Respondent's gender

Woman ☐ Man ☐

2. How serious was the answer made by the respondent?
a) Very serious
b) Serious
c) Somewhat serious
d) Not al all serious

3. How well did the respondent understand the information of the survey before deciding if he/she would be willing to pay for the prevention of wild fires in *black pine* forests?

a) Understood perfectly
b) Understood very well
c) Understood well
d) Understood little
e) Undertstood very little
f) Did not understand nothing at all

4. How well the respondent understood the valuation question? (question 7 and 10)
a) Understood completely

b) Understood somewhat. Why she has had difficulties?:

_____

c) Did not understand at all. Why she has had difficulties?

_____

[WRITE ANY ADDITIONAL COMMENT ABOUT THE RESPONDENT]

_____

_____

_____

_____