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Exploring the willingness to pay for forest ecosystem services by residents of the Veneto Region

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Abstract. Forests produce a wide array of goods, both private and public. The demand for forest ecosystem services is increasing in many European countries, yet there is still a scarcity of data on values at regional scale for Alpine areas. A Choice Experiment survey has been conducted in order to explore preferences, uses and the willingness of the Veneto population to pay for ecosystem services produced by regional mountain forests. The results show that willingness to pay is significant for recreation and C-sequestration but not for biodiversity conservation, landscape and other ecosystem services. These findings question the feasibility of developing market-based mechanisms in Veneto at present and cast light on the possible role of public institutions in promoting policy actions to increase the general awareness of forest-related ecosystem services.

Keywords. Payments for Ecosystem Services, choice experiments, multi-nomial logit, latent class models.

JEL Codes. Q23, Q56

1. Introduction

The evidence was provided long ago that, in addition to wood and non-wood products, Italian forests deliver Ecosystem Services (ES) like soil protection, recreation and landscape amenity (Di Bérenger, 1965). Today, driven also by global forces, this list has expanded to include services such as climate mitigation, biodiversity conservation and effects on water quality and quantity (Croitoru *et al.*, 2005; Tempesta and Marangon, 2004; Gios *et al.*, 2006; Goio *et al.*, 2008). Most of these services are, for different reasons, public goods and are therefore enjoyed by the population free of charge. Some are provided through uncompensated mandatory instruments; in 1923, for example, Italian legislation imposed strong limits on felling in all mountain forests in order to protect soils from erosion. Similarly, a constraint to preserve landscape amenity was enforced in 1985. Other services like recreation and climate mitigation are public goods mostly because of a poor enforcement of property rights.

When the provision of ES is not rewarded through suitable mechanisms, forest owners do not include them in their management objectives unless constrained by command-and-

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control policies. As a result, in the best cases forest management regimes rarely achieve a social optimum. In the worst cases, forest owners cease management activities and abandon their forests. This results in a general environmental degradation and the occurrence of negative externalities, like loss of landscape quality or biodiversity (Croitoru *et al.*, 2005).

Increasing the revenues of the benefit providers and improving forest management from the perspective of society is therefore essential if good levels of forest and environmental quality are to be secured. Since it has been shown that traditional command and control measures may not always give the best results (Merlo *et al.,* 2000), achieving these objectives requires new policy tools. One solution could be to identify forms of marketing for the ES, under the umbrella concept generally known as Payments for Ecosystem Services (PES) (Wunder *et al.*, 2008; Gómez-Baggethun *et al.*, 2010).

An essential step in designing PES mechanisms is the assessment of the values at stake (Millennium Ecosystem Assessment, 2005; TEEB, 2010; UK National Ecosystem Assessment, 2011), which can aid the process of turning the good into a product by providing a basis for the definition of its price. This assessment process involves determining if, and to what extent, 'consumers' of forest ES perceive their value, whether a Willingness To Pay (WTP) exists, who is willing to pay, for what and how much.

Assessing the value of forest ecosystems and incorporating them into appropriate policy mechanisms are the objectives of the EU-funded NEWFOREX project. The project involves several universities and research institutes throughout Europe and aims to provide more accurate ES values for the most important types of forest regions in Europe (Mediterranean, Atlantic, Boreal, Central-European and mountainous) and identify new tools for the remuneration of service providers. This paper presents the results from the initial phases of the project, focused on assessing the existence and extent of WTP for forest ES. Geographically, the evaluation is targeted at the Alpine areas of the Veneto Region, North-eastern Italy, taken as case-study for the mountainous forest region investigated by NEWFOREX.

Despite the vast literature at the European level on forest values and consumer characteristics/perceptions and demand for forest ES, attempts to estimate different forest ES and their trade-offs are still rather scarce on a regional scale and especially in the Alpine context. This research seeks to contribute to filling this gap, mostly with an operational goal, in the sense that the evaluation effort is aimed at producing values and indications to aid the design of appropriate PES mechanisms supporting ES provision.

The paper is organised as follows: a literature review introduces ES valuations in the Alps; the methodology section presents the method used to assess the value of mountain forest ES, i.e. Choice Experiments (CE), and the related econometric models; a results and discussion section follows and, lastly, the conclusions provide some reflections on the scope for PES development in the light of the WTP results.

2. Evaluation of forest ES in the Alps: a brief overview

A review of the studies in Alpine areas shows a wide variability in the *focus* – i.e. the type (or types) of ES – *scale* – from local to regional to national – and *nature* – use and/or non use values – of the ES under evaluation. Because of this variability, framing the results of the studies within any analytical scaffolding or attempting a cross-comparison of values is a rather arduous task. One simple key to reviewing the studies and their results is the type of ES evaluated; another is to focus on the studies' methodological implications. Both of these approaches have been used here.

To our knowledge, studies on biodiversity values in the Alpine region are very limited. Soliva and Hunziker (2009) evaluated biodiversity protection in Switzerland. Getzner (2000) focused on specific protected areas such as the Hohe Tauern National Park in Austria. Scarpa and Menzel (2005) measured the WTP for the implementation of new biodiversity protection programmes. Studies on the recreational services generated in Alpine mountain areas have been published by Scarpa and Thiene (2005) and by Scarpa *et al.* (2007), who analysed choice patterns and determinants of demand for different climbing destinations in the North-Eastern Alps.

As regards landscape, a study published by Tangerini and Soguel in 2004 found that the landscape attribute considerably affects the final price of real estate properties in the Swiss Alps: positive changes in landscape are appreciated both by locals and tourists, while a loss of landscape quality linked to the development of tourism infrastructure can negatively affect real estate values in the opinion of the residents.

The issue of assessing the value of watershed protection in the Alps has long challenged environmental economists. Due to the large presence of steep slopes and unstable soils, this is a crucial service; however, it is also the most difficult one to evaluate, given the complexity of the cause-effect relationships between forest management and downstream water uses (Hamilton, 2008). Pettenella *et al.* (2006) measured the economic value produced by an appropriate forest management affecting the quality and regularity of water flows. Croitoru (2007a) provided values for the watershed protection services in Mediterranean countries, including Alpine countries such as Italy, France and Slovenia. Notaro (2001) evaluated watershed protection, relating the value of fresh water in rivers to the level of fishable species.

Instead of measuring values for single services, other authors have attempted to measure the overall value of forest ES. Examples are the papers published by Croitoru (2007a; 2007b), who focused on the Total Economic Value of Mediterranean areas; or by Goio *et al.* (2008), who measured the value of the traditional production – i.e. timber – in the Alpine forests of Trento province and compared it to the value of ES, showing the much higher economic value of the latter. Lastly, reviewing previous ES valuation works, Grêt-Regamey *et al.* (2008) provided a broad perspective on values of ES for the Alpine area, reporting on evaluations for scenic beauty, recreation, biodiversity, avalanche protection and C-sequestration: in some cases the authors provided values for single ES, and in others aggregated values. The review confirmed the wide variability among values, even when studies dealt with similar ES. There are many reasons for this variability, including the distribution of environmental risks and uncertainties like natural hazards (Grêt-Regamey *et al.*, 2012). The authors concluded by highlighting how difficult is to distinguish, in the values, the effect of actual preference heterogeneity from that of the methods used to estimate them.

Analysing the published studies from a methodological perspective, a pattern can be discerned in the approaches used, following the general evolution of the discipline: especially in the field of recreation values, older studies focused on use values and mostly used Travel Costs (Merlo, 1982) or Hedonic Pricing (Tangerini and Soguel, 2004). More recent contributions (Scarpa and Menzel, 2005; Scarpa and Thiene, 2005; Scarpa *et al.*, 2007) have merged Travel Cost with CE, aiming at a greater reliability of the evaluation process. However, approaches have also been used based on provision costs (Croitoru, 2007a; Pettenella *et al.*, 2006), Benefit Transfer (Croitoru, 2007b; Goio *et al.*, 2008) or on mixed approaches (Notaro, 2001).

Only recently, the focus of researchers has shifted towards a better understanding of consumer behaviour as a basic component of environmental services demand. Methods like CE have been developed in order to overcome the limits of Contingent Valuation (CV) (Hausman, 1993; Diamond and Hausman, 1994) and have also focused on the Alpine context: to our knowledge, however, these methods have so far only been applied here at a local scale and, more especially, never to all of the most important forest ES at the same time.

3. Methodology

3.1. Choice Experiment background

The use of CE in environmental economics dates back more than fifteen years, with the first proposals by Louviere (1992), Adamowicz (1995), Boxall *et al.* (1996) and Hanley *et al.* (1998). Since then, the method has spread and many authors now consider it preferable to CV approaches. While CV targets the study of WTP for a specific event like a policy change, CE considers complex goods, such as environmental resources, as made up of single attributes, each one representing specific conditions of the good itself. Combinations of different attributes can be created, each one reflecting a certain status of the resource or simulating the results of a policy change. The person interviewed can compare and choose one of the policy alternatives within a choice set, usually composed of different scenarios, plus the *Status Quo* (SQ). Hence, instead of having to answer to a complex bidding question as in CV, the respondent has to select one out of a certain number of choice sets (Louviere, 1992) corresponding to the preferred policy alternative.

CE models have their roots in the random utility model (Train, 2003), which states that the utility U_{ijt} which a given individual i gets from the alternative j in the choice situation t can be divided into a deterministic part V_{ijt} and a stochastic term ε_{ijt}. The deterministic part is generally specified as linear and may be written as a product of the vector describing the situation under study (1):

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} = \beta' X_{ijt} + \varepsilon_{ijt} \qquad (1)$$

where X_{ijt} is the vector of attributes linked to the individual i who chooses the alternative j within the choice situation t, while β' is the vector of the betas. The respondent in a CE choice set will maximise his/her utility by choosing the scenario (or alternative) j among the other k within the choice set if the scenario j has higher utility than the others. Hence, the probability of choosing the alternative j over the other k may be described as:

$$Prob(j|C) = Prob(U_{ijt} > U_{ikt}) = Prob\{[(V_{ijt} - V_{ikt}) > (\varepsilon_{ikt} - \varepsilon_{ijt})];\ j,k \in C;\ j \neq k\} \qquad (2)$$

where C represents the complete set of choices.

To estimate equation (2) the error distribution must be assumed, usually Gumbel-distributed and Independently and Identically Distributed (IID), hence the probability of choosing *j* is given by

$$P_{ijt} = \frac{e^{\mu\beta' X_{ijt}}}{\sum_{k \in C} e^{\mu\beta' X_{ikt}}} \tag{3}$$

where μ is the scale parameter (usually set at 1 to keep constant error variance).

Appendix 1 presents the characteristics of the models used in more detail, i.e. Multi Nomial Logit (MNL) and Latent Class Models (LCM), while the following sections describe the steps taken for the application of the methodology, including the study area, attribute selection and description, statistical design of the pilot and full survey and characteristics of the sample and target population.

3.2 Study area and attribute selection

Forests in Veneto are mostly located in the northern part of the region, in the mountainous areas of the Alpine range, where, according to the last Forest Census (Ministero delle Politiche Agricole Alimentari e Forestali, 2005), they are an essential component of landscape, covering 436,000 ha out of 784,000 ha of the regional territory. Mountain areas and their forests are common destinations for recreational activities: 4.8 million day-visits were registered in the mountainous areas of Veneto in 2012 (Regione Veneto, 2013). Forests also play an essential role in protecting steep slopes from soil erosion and contribute towards biodiversity conservation: as many as 146,000 ha of forests in the region are in the Natura 2000 network (Ministero delle Politiche Agricole Alimentari e Forestali, 2005). In addition, given that only 33% of the regional annual forest growth is harvested (Pierobon *et al.*, 2011), forests also represent a significant carbon sink.

Based on these considerations, a preliminary selection was made of forest-based ES for defining the CE attributes. The initial list comprised landscape, biodiversity conservation, carbon sequestration, recreation, soil erosion and landslide prevention.

An expert consultation process was set up in order to verify the suitability of this preliminary selection and to identify the most effective way to present the attributes and their levels to the public. More than 30 experts were recruited, in three fields: i) forest ecology and silviculture; ii) natural science and landscape ecology; and iii) environmental economics. The experts were first interviewed individually, then invited to a joint discussion in three thematic focus groups. This complex procedure was implemented in order to ensure that the final choice of attributes and levels was based on the broadest possible consensus, attempting to avoid any bias related to the experts' selection process. Agreement was reached on the following attributes: i) forest structure view; ii) carbon sequestration; iii) important species for biodiversity conservation; iv) landscape; v) forest recreation; and vi) costs. The meaning of each attribute and the reasons for its choice are briefly discussed below:

i. Forest structure view: an on-going debate amongst forest managers is focused on which forest structure (coppice, or different types of high forests) would be most appropriate in relation to more multi-functional forest management. While the present forest structure, i.e. monoplane high forest (representing the SQ in the choice set) is primarily for timber production, it is argued that other forest structures – including coppice or multi-plane high forests – have higher aesthetic values. This attribute refers to the view enjoyed by a visitor walking in the forest when looking at different forest structures. It is completely different from the 'landscape mosaic' attribute, which is the perception of landscape on a larger scale, on which the forest structure has no influence whatsoever (a 'patchwork' of forest types in the landscape would have the same effect regardless of their structure, which impacts only on a finer scale of observation).

ii. Carbon sequestration: the capacity of offsetting carbon emissions through appropriate forest management is an issue that has received a great deal of attention from the regional authorities (Pierobon *et al.*, 2011). The focus group experts suggested expressing the attributes by making reference to the percentage of the resident population whose C-emissions would be offset by the growing forest. The experts estimated that, with the current trends in forest area dynamics and management, forests in the region will be able to offset the emissions of up to 5.5% of the current resident population (SQ).

iii. Important species for biodiversity conservation: forests in the region are home to a large number of species of fauna and flora. The disappearance of forest ecosystems associated to land use changes driven by urban and tourist developments, and, in addition, simple alterations of the delicate mature forest ecosystem equilibrium due to various human disturbances will strongly affect the number of species living in the forest areas. Although residents in the region are not very familiar with biodiversity, the attribute was considered because of the general increasing demand for experiences in the wild, with the desire to see a return of the typical flora and fauna of the Alps. The biodiversity attribute was designed according to the popular concept of biodiversity communicated by the media, i.e. the number of endangered Alpine species that would be lost or gained depending on the implementation of specific forest conservation policies. The focus group experts estimated that, continuing with present trends, as many as 50 species would be lost in the next ten years (SQ).

iv. Landscape mosaic: the typical Alpine landscape is composed of a balanced mosaic of forest and open areas (pastures, meadows and rocks). The abandonment of crops and dairy farming activities coupled with the lack of appropriate policies is leading towards a rapid natural expansion of forests with a shift to a more 'closed' landscape (Bonsembiante and Merlo, 1999). Active forest and pastureland management could maintain the desired balance of forests and open areas, while it has been estimated that 5% of the present proportion of open areas will be lost within the next 10 years due to the natural expansion of forests on abandoned farmland (SQ).

v. Forest recreation: recreation in forests is typically envisaged by the ordinary visitor as the possibility of having family outings and picnics in open areas under the shade of forest trees. A smaller percentage perceive forest recreation as the opportunity for trekking or hiking, which is made possible by the availability of an adequate network of forest paths. This attribute is therefore expressed through the provision by forest authorities of recreational facilities such as picnic tables, car parks and path signs. The SQ is represented by no provision of recreational facilities.

vi. Costs: the experts identified the best payment vehicle as an annual regional tax paid by each household to support the application of a regional forest policy producing the desired level of attributes in ten years' time. The wide range of cost levels was suggested by the economists in the focus group in order to have less repetition among the alternatives, at the same time keeping the number of choice sets as low as possible.

The experts advised against including in the survey the issues related to the effects of forests on soil erosion and landslide prevention that had been included in the initial list. Serious flooding had occurred in some areas of the region in the winter of 2010, damaging many crops, and residential and commercial properties. Farmers and households who had suffered damage were still waiting for compensation from the regional authorities. The population was therefore still too sensitive about this issue and, especially, highly critical of any kind of soil conservation policy implemented by the regional government. Since soil erosion and landslide prevention is a very important service produced by forests, its exclusion from the list of attributes and therefore from the evaluation exercise represents a limitation of this work.

The final list of attributes, with their levels, is presented in Table 1: the list shows that our CE is based on both continuous variables and dummies.

3.3 Statistical design of pilot and full surveys

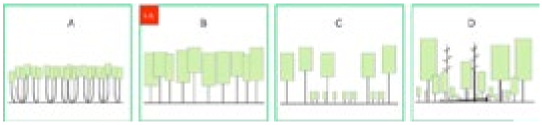
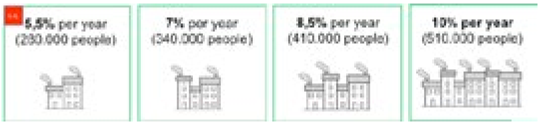
After the utility function specifications with the variables reported in Table 1, we built the statistical design with Ngene©®, following Bliemer and Rose's (2009) approach. The CE exercise was run in two stages: a pilot and a final survey (Sandor and Wedel, 2001; Bliemer and Rose, 2005; Ferrini and Scarpa, 2007). We first created the statistical design for the pilot survey in order to estimate preliminary betas (priors). The priors, estimated with Multi Nominal Logit (MNL), were used to develop the final statistical design for the main survey (Street *et al.*, 2005). In the pilot, we drafted, by way of Ngene, a Dz-efficient design, using priors equal to zero, rather than an orthogonal design. The benefit of this procedure is the possibility of combining dummy coded and continuous variables in the same design, as well as weighting the maximum and minimum values of continuous variables.

The pilot version of the questionnaire was submitted to 74 people in six provinces in Veneto. Out of these, 16 were dropped from the pilot analysis because they either refused to answer or provided answers that were considered strategic according to a set of specific set of control-questions; the priors were therefore estimated with the remaining 58 respondents. Based on the pilot CE answers, we estimated the MNL model betas to be used as priors in the final statistical design using the utility function.

Lastly, we checked the presence of dominant alternatives, finding limited dominant effects in the estimated design, and a similar distribution in the choice frequencies from the questionnaire, with a higher ratio in those having higher probability of being chosen in the estimated design.

During the CE, respondents were asked to answer six choice tasks out of the twelve resulting from the CE statistical design, which was designed according to D-efficiency as proposed by Bliemer and Rose (2009) (Appendixes 2 and 3). We opted to have two blocks in order to reduce the answering load on the respondents; hence, to split the choice tasks

Table 1. Attributes of the CE survey.

Attribute	Levels	
Forest structure view from forest paths	*Icons* 	
	Description	*Model code*
	A= thick stand forest (coppice);	viewA
	B= even-aged forest – SQ;	
	C= uneven-aged forest;	viewC
	D= uneven-aged forest with dead trees	viewD
Carbon sequestration by forests in terms of % of carbon-neutral Veneto resident population	*Icons* 	
	Description	*Model code*
	Level 1= 5.5% of residents – SQ;	
	Level 2= 7% of residents;	CO_2 7%
	Level 3= 8.5% of residents;	CO_2 8.5%
	Level 4= 10% (all the forest area is left to natural evolution)	CO_2 10%
Change in number of important species for biodiversity conservation	*Icons* 	
	Description	*Model code*
	Level 1= -50 species – SQ;	
	Level 2= -25 species;	BIO -25
	Level 3= 0 species lost;	BIO 0
	Level 4= +2 species gained from surrounding regions.	BIO +2

(continued)

homogeneously, a further attribute, i.e. the block column, was introduced in the statistical design and balanced against the other attributes.

3.4 Sample and target population

The target for the CE survey is the resident population of the Veneto Region, the potential payers of the regional tax proposed as payment vehicle. Six hundred and thirty-seven (637) people participated in the full survey. Data was collected through face-to-face interviews, from July to October 2011.

In order to maximise representativeness, we designed the survey sample using two main strata, namely the place of residence – whether the person lived in the mountain areas or not – and the size of the municipality of residence: four levels were used in this

Table 1. (continued).

Attribute	Levels	
Landscape mosaic	*Icons* 	
	Description	*Model code*
	Level 1= -10% of grassland;	LAND-10
	Level 2= -5% of grassland – SQ;	
	Level 3= 0% of grassland;	LAND 0
	Level 4= +2% of grassland	LAND +2
Forest recreation	*Icons* 	
	Description	*Model code*
	Level 1= No service – SQ;	
	Level 2= Tourist facilities;	recrST
	Level 3= Path signs;	recrS
	Level 4= Tourist facilities and path signs	recrSST
COST	Levels= 0 (SQ) 25, 50, 75, 100, 125, 150, 175, 200 €/household/year	

Attributes and levels representation have been defined with reference to the following works: Nielsen *et al.*, 2007 for forest structure view; Mogas *et al.*, 2006, for C-sequestration; Lethonen *et al.*, 2003, Christie *et al.*, 2006, Jacobsen *et al.*, 2008 for biodiversity conservation; Tempesta and Thiene, 2004, Tempesta and Marangon, 2004, Grêt-Regamey *et al.*, 2008 for landscape; Christie *et al.*, 2007 for recreation.

case, based on the number of inhabitants: i) up to 5,000; ii) from 5,000 to 10,000; iii) from 10,000 to 100,000; and iv) the seven provincial capitals in the region.

The geographical distribution of the sample covered 63 municipalities, i.e. 10.3% of the regional total. Chi-squared was used to test similitude of the sample population to the target one. The difference did not exceed 5% for gender balance, age class and household size. Vice versa, for two characteristics – i.e. income and education – comparisons were not possible due to information gaps. Italians are very reluctant to reveal information on their income and this information is considered sensitive by the public authorities and therefore not disclosed. Hence, the income distribution in the target population was unknown. For the sample, information on income was collected according to four broad categories of annual net income: i) up to 30,000 €; ii) from 30,000 to 60,000 €; iii) from 60,000 to 120,000 €; and iv) over 120,000 €. Education, on the other hand, was not considered in the statistical design and the proportion of people in the sample without formal education proved to be lower than in the target population. Therefore, one potential bias of the research could be the failure to reach people with little education.

The interviews were carried out using a questionnaire in four parts. The first part focused on attitudes towards, and frequency of use, of mountain ES. The second part introduced the attributes and attribute levels and thoroughly explained them, to ensure that the respondents had sufficient background information to correctly make their choices, and ended with the six choice tasks of the CE. The third part was a debriefing section aimed at understanding the respondent's impressions of the questionnaire. The last part collected socio-demographic data.

4. Results and discussion

In general, 57.9% of respondents stated that they visit mountain forests at least once a year. However, only 29.4% chose a forest area in the region as destination, the remainder preferred destinations outside the region. As many as 97.5% of visitors to the regional forests made only day-trips, without an overnight stay.

One aspect that emerged from the pilot survey was that the majority of respondents had a poor awareness of the ES produced by forests. Therefore, after having introduced the CE attributes and let the respondent become familiar with the issues, we initially asked what level of each attribute the respondents would choose in the absence of an environmental tax. Even in these conditions, they tended more frequently to select the less costly alternatives, generally related to the SQ. The results are reported in Table 2. Only some respondents chose the higher level (L4) on biodiversity maintenance, carbon sequestration and tourism infrastructure. Moreover, the 'landscape mosaic' attribute was chosen with an opposite trend to that documented in the literature, where open areas have been found to be more desirable than forest areas (Tempesta and Thiene, 2004): in this survey, landscapes with more forest area were preferred to those with more open areas and meadows.

Table 2. Attribute level choice before and during CE: frequency table.

Attribute	Before CE				CE choices				Differences				
	L 1	L 2	L 3	L 4	L 1	L 2	L 3	L 4	Δ L 1	Δ L 2	Δ L 3	Δ L 4	Chi-test
view	9.1	33.0	34.4	23.5	16.6	50.7	15.5	17.2	7.5	17.7	-18.8	-6.4	4.1e-06
CO2	22.5	19.4	18.2	39.9	44.8	13.8	16.3	25.1	22.3	-5.6	-1.9	-14.7	1.8e-06
BIO	14.8	11.0	33.2	41.1	54.3	16.5	13.8	15.4	39.5	5.5	-19.4	-25.6	3.3e-29
LAND	31.8	26.5	26.3	15.5	17.7	45.8	19.4	17.1	-14.1	19.3	-6.8	1.6	5.6e-05
recr	17.4	14.6	27.0	41.1	47.5	15.8	19.5	17.2	30.2	1.1	-7.5	-23.8	1.1e-14

Note: Serial non-participants were excluded in the compilation of this table. The columns 'Before CE' were calculated by Ngene, while 'CE choices' were calculated, according to the methodology reported in the Ngene manual, by summing the frequency of the chosen alternative containing the specific attribute level. The SQ levels are in grey. See Table 1 for the attribute code meanings. L = Level. L1 - L4 has the same order as the attribute levels reported in Table 1.

Once the cost attribute was introduced (see 'CE choices' columns), the frequency of the choice of SQ increased dramatically. This strongly affected the model outputs, especially in terms of attribute significance.

The estimation of a general model for the Veneto Region population was the first step in data analysis. Applying the basic MNL model (McFadden, 1974), we initially obtained rather weak results (Table 3) at the aggregated level. Model 1.1 (all respondents) shows the general unwillingness to pay for the majority of attributes, except for recreation facilities and path signs (recrSST variable). Alternative Specific Constant (ASC) represents the hidden characteristics that the respondent does not see in the choice task. A significant and negative ASC means they want to change the present SQ.

Slight improvements to Model 1.1 have been obtained by introducing dummy variables. For example, 61 respondents to the full survey – i.e. those always opting for the SQ and also answering positively to some control questions – were classified as either 'serial non-participants' (von Haefen *et al.*, 2005) or even 'protesters' (Meyeroff and Liebe, 2008). When the vector of the chosen attributes is multiplied by a dummy for the 'non-protester' respondents (i.e. excluding the 61 serial non-participants and protesters, hereinafter 'protesters') as in Model 2.1, the results show a general willingness to change from the present situation (ASC < 0) and a better fitness of the model, with the majority of attributes significant at 5%.

Table 3. MNL model outputs.

Variables	MNL				
	Model 1.1 (all respondents)	Model 2.1 (dummy for non-protest)	Model 3.1 (dummy for non-protest & users)	Model 4.1 (dummy for non-protest & non-users)	Model 5.1 (interaction with edu & dummy for non-protest)
ASC	0.045	-0.684***	0.457***	0.307***	-0.065
viewA	-0.003	0.106**	0.103*	-0.200**	0.008**
viewC	0.030	0.130**	0.145**	-0.105	0.014***
viewD	-0.005	0.086*	-0.034	-0.001	2e-5
CO2	0.052	0.112**	-0.143***	0.297***	-0.001
BIO	0.003	0.006**	0.019***	-0.015***	0.001***
LAND	-0.005	-0.010*	0.001	-0.013	-0.823
recrST	0.048	0.119**	-0.050	0.204**	0.004
recrS	0.011	0.065	0.291***	-0.400***	0.011**
recrSST	0.223***	0.441***	0.211***	0.270***	0.025***
COST	-0.009***	-0.010***	-0.013***	-0.006***	-0.012***
Obs.	3822	3822	3822	3822	3822
Log-L	-4172.47	-4172.47	-4172.47	-4172.47	-4172.47
R-sqrd	0.05928	0.09962	0.08795	0.06130	0.09186
Adj. R-sqrd	0.05792	0.09833	0.08694	0.06003	0.09055

Note: p-value : * = 0.10, ** = 0.05, *** = 0.001. See Table 1 for the attribute code meanings.

Following the idea of use and non-use values, we also tested the differences between the 'users' and 'non-users' of mountain areas (Model 3.1 and 4.1 respectively) (Adamowicz *et al.*, 1998). As expected, people with a direct interest in a given good also have a higher propensity to pay for it; in Model 3.1 we see an increasing interest in biodiversity maintenance and in even-aged managed forests, although the respondents' main attention is focussed on what they 'use' more: tourist facilities and path signs. Nevertheless, the present state of the environment does not encourage the mountain users towards a high willingness to change, as the ASC is positive and significant. Non-use values is another crucial piece of information for the policymaker targeting ES provision at regional scale. Model 4.1 shows the presence of a low WTP by mountain non-users, though limited to recreation infrastructure and carbon sequestration. Finally, the role of education (number of years of schooling) was tested in Model 5.1: the differences from Model 1.1 highlight the role of education in the general WTP.

In a further step, the models were re-estimated after recoding CO2, BIO and LAND in dummy coded variables taking the SQ for each variable as a reference level. The results obtained showed a non-linear pattern, explaining only average respondents' behaviour on a single level. In general, the recoding highlighted the respondents' propensity to pay greater attention to the extreme levels of the attributes.

There is a rather important difference between mountain users and non-users on biodiversity conservation, landscape and path maintenance. The former are more willing to pay for what they regularly visit or, in other words, for the things they get more utility from. The latter care more for what they know from the mass media (i.e. carbon sequestration - CO2 10%) or for what they may possibly use in the future (i.e. recreational facilities – recrST). In model 5.2 the role of education is tested through the interaction with the number of years of school attended by a given respondent. People with higher education generally consider in a proper way the attributes (an example of this interaction is visible in the attributes *view* and *recr* in Table 4, where the first is considered in model 5.2 and not in model 2.2; for recreation, the respondents understand that the benefits coming from recrSST derive from the sum of recrST and recrS).

Lastly, LCM has been estimated (Table 5), with results in line with the major previous findings. The LCM model displayed two groups of people differing by their willingness to support the changes. Group 1 is characterised by those inclined to leave forests to natural evolution (viewD) and to support carbon sequestration policies and an abundant supply of recreational infrastructure, while considering actions for biodiversity conservation, maintaining the open landscape and providing path signs superfluous. Group 2 shows the opposite inclination and hence favours having more path signs, landscape maintenance and coppiced forest. Nevertheless, in general the idea of paying for a change from the SQ does not hold, as ASC is positive and significant. This behaviour can be explained by looking at the λ values: Group 2 comprises mountain users and highly educated people, while Group 1 includes the non-users and the poorly educated.

After the MNL estimations, we calculated the WTP marginal values as the ratio between the coefficient attributes and the negative coefficient of prices as reported above (Tables 6 and 7). A different approach was only needed for Model 5.1, as education level differed throughout the sample so the attribute coefficient had to be weighted with the sample frequency (Hidrue *et al.*, 2011; Martinez-Cruz, 2012).

The overall WTP for ES provision in Veneto can be calculated as the positive marginal variation of each attribute within the given model; the values range from a minimum of € 48 (Model 1.1 in Table 6) to a maximum of € 313 per household per year (this last figure is the total positive WTP for all of the variables in Model 2.2 in Table 7).

Table 4. MNL model outputs for recoded variables.

Variables	MNL				
	Model 1.2 (all resp.)	Model 2.2 (dummy for protest)	Model 3.2 (dummies for non-prot. & user)	Model 4.2 (dummies for non-prot. & non-user)	Model 5.2 (interaction with edu & dummy for non-protest)
viewA	0.042	0.239***	0.201**	-0.228**	0.015**
viewC	0.159**	0.175**	0.032	0.194*	0.013**
viewD	-0.167**	-0.098	-0.076	-0.351***	-0.010**
CO2 +7%	0.294***	0.417***	0.176	0.464***	0.030***
CO2 +8.5%	-0.317***	-0.502***	-0.383***	-0.203*	-0.035***
CO2 +10%	0.263***	-0.074	0.109	1.014***	0.004
BIO -25	0.007	0.094	-2e4	0.302**	0.007
BIO 0	0.151**	0.508***	0.451***	-0.465***	0.034***
BIO +2	-0.055	0.267**	0.182*	-0.734***	0.014**
LAND -10%	-0.090	-0.252***	-0.021	-0.083	-0.016***
LAND 0%	0.085	0.434***	0.369**	-0.266*	0.029***
LAND +2%	-0.103	-0.156**	-0.171*	-0.062	-0.011**
recrST	0.013	-0.174**	-0.190*	0.271**	-0.011*
recrS	0.048	0.240***	0.169**	-0.285**	0.015**
recrSST	0.289***	0.417***	0.302***	0.452***	0.030***
COST	-0.009***	-0.017***	-0.010***	-0.004***	-0.014***
Obs.	3822	3822	3822	3822	3822
Log-L	-4172.47	-4172.47	-4172.47	-4172.47	-4172.47
R-sqrd	0.06599	0.10818	0.08756	0.10277	0.10139
Adj. R-sqrd	0.06403	0.10631	0.08564	0.10077	0.09950

p-value : * = 0.10, ** = 0.05, *** = 0.001.

5. Conclusions

The research sought to understand if and to what extent the population of the Veneto Region was aware of the ES produced by the regional forest area and, especially, if it was prepared – and willing – to pay for them. Information on values and WTP provides a solid basis for the further development of policy tools to support the provision of ES, especially if they were to be modelled according to a PES approach. Since forest policies in the Veneto Region are designed and implemented on a regional scale, our target population was rather broad, being represented by all residents of the region. A further source of complexity was due to the attempt to estimate four ES – carbon sequestration, biodiversity, recreation and landscape (the last at two different scales) – at the same time. This complexity is both a strength and a weakness of the approach. The strength lies in the improvement of information on ES values in the Alps, whereas the works published to

Table 5. Latent Class Model.

Variables	Group 1 (prob. 53.3%)	Group 2 (prob. 46.7%)
ASC	-1.114***	1.489***
viewA	-0.112	-0.111**
viewC	-0.050	0.018
viewD	0.722***	0.061
CO2	0.785***	-0.052
BIO	-0.026***	0.007*
LAND	-0.065***	0.013**
recrST	0.030	-0.063
recrS	-0.677***	0.244***
recrSST	1.777***	0.035
COST	-0.051***	-0.004**
Prob. model	λ1	λ2 (reference)
Constant	1.142***	0
Protest	32.032	0
Mount. User	-1.014***	0
Education	-0.050**	0
Obs.	3822	
Log-L	-2968.79	
R-sqrd	0.29296	
Adj. R-sqrd	0.29045	

p-value : * = 0.10, ** = 0.05, *** = 0.001. See Table 1 for the attribute code meanings.

date in the literature were undertaken at a site-specific scale with samples selected among the users of the good or the service. The weakness lies in the difficulty of choice tasks, which were challenging for the respondents, who sometimes faced options that they did not completely understand and for which they therefore opted for a no-change solution.

We used Multi Nomial Models and Latent Class Models. Yet not all the models tried were successful in explaining whether WTP exists and what its determinants are. Accordingly, the results must be viewed with caution. Where the models showed higher attribute significance, we obtained interesting insights into the ES values. In general, our results showed that most residents perceive some forest ES as something they already have rights to, or which at least should be provided without any cost to the beneficiaries. This was the case for landscape quality and biodiversity conservation, for which WTP was very low, while people were more prone to pay for some recreational benefits. However, when the models focused on explaining the behaviour of non-users, the presence of some option and existence values emerged for specific ES, showing a perceived potential scarcity

Table 6. WTP marginal values (€/unit).

Variables	MNL				
	Model 1.1 (all respondents)	Model 2.1 (dummy for non-protest)	Model 3.1 (dummy for non-protest & users)	Model 4.1 (dummy for non-protest & non-users)	Model 5.1 (interaction with edu & dummy for non-protest)
ASC					
viewA	0	21.28	0	-62.22	14.46
viewC	0	25.98	20.91	0	24.18
viewD	0	0	0	0	0
CO2	0	11.21	-10.30	46.20	0
BIO	0	0.62	1.37	-2.41	0.87
LAND	0	0	0	0	0
recrST	0	23.69	0	63.33	0
recrS	0	0	41.96	-124.62	19.68
recrSST	48.43	88.00	30.33	84.05	44.35

See Table 1 for the attribute code meanings.

Table 7. WTP marginal values for recoded variables (€/unit).

Variables	MNL				
	Model 1.2 (all resp.)	Model 2.2 (dummy for non-protest)	Model 3.2 (dummies for non-prot. & user)	Model 4.2 (dummies for non-prot. & non-user)	Model 5.2 (interaction with edu & dummy for non-protest)
viewA	0	27.74	38.71	-104.46	23.30
viewC	32.71	20.29	0	0	20.79
viewD	-34.44	0	0	-160.17	-16.39
CO2 +7%	60.48	48.46	0	211.95	46.27
CO2 +8.5%	-65.39	-58.31	-73.86	0	-55.76
CO2 +10%	54.07	0	0	462.49	0
BIO -25	0	0	0	137.81	0
BIO 0	31.02	58.96	86.77	-212.40	52.75
BIO +10	0	31.05	0	-334.87	21.28
LAND -10%	0	-29.27	0	0	-24.96
LAND 0%	0	50.37	71.08	0	45.55
LAND +2%	0	-18.18	0	0	-18.18
recrST	0	-20.25	0	123.48	0
recrS	0	27.87	32.57	-130.27	24.22
recrSST	59.52	48.38	58.22	206.27	46.96

See Table 1 for the attribute code meanings.

among residents in the region, 83% of whom, after all, live in the urbanised Po plain, at a two-three hours driving distance from Alpine areas.

With the exception of the field of recreational services, these results pose a serious challenge for the development of PES tools, whose foundations rest on the existence of a demand and the related WTP by consumers. The possibility of implementing market mechanisms for biodiversity or landscape conservation seems far in the future, if not even in question by itself. Overall, the study has shown a widespread lack of appreciation by the average respondent for the role that forests play at present – and will play in the future – in the provision of ecosystem services. In this regard, initial policy actions could focus on increasing general environmental awareness, as a more advanced knowledge on forest-related services is certainly a pre-requisite for the introduction of mechanisms to support ES providers.

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Appendix 1. Models used in the CE

Equation (3) in section 3.1 can be estimated through a multi-nomial logit (MNL) regression only if independence for irrelevant alternatives (IIA) holds, which means that the ratio of choice probability of a given alternative is not affected by any other alternative, because the utility is set up systematically with the statistical design (Ben-Akiva and Lerman, 1985). Nevertheless, IIA is seldom respected. The average WTP for a given attribute is calculated with the ratio between the beta parameters of interest and the beta parameters of cost (Train, 2003), as follows:

$$WTP = c\frac{\beta_a}{\beta_c} \tag{4}$$

where c is a constant term. Only in the case of effect-coded variables, (4) has to be multiplied by a constant term equal to 2 (Bech and Gyrd-Hansen, 2005).

In order to overcome this problem, we also used the Latent Class Model (LCM) (Boxall and Adamowicz, 2002), in which the presence of a certain number of segment *s* in the population sample, which has *S* segments in total, is considered. Thus, the utility function of an individual *i* who belongs to a particular segment *s* and chooses the alternative *j* within the choice situation *t*, can be written as:

$$U_{ijt\backslash s} = V_{ij\backslash s} + \varepsilon_{ijt\backslash s} = \beta_S' X_{ijt} + \varepsilon_{ijt\backslash s} \tag{5}$$

where β_S is the vector that explains the homogeneity within the segment *s* and the heterogeneity among the segments *S*. Assuming the same error distribution as in (3), the probability that individual *i* belonging to segment *s* chooses the alternative *j* is given by:

$$P_{ijt\backslash s} = \frac{e^{\mu_s \beta'_s X_{ijt}}}{\sum_{k \in C} e^{\mu_s \beta'_s X_{ikt}}} \tag{6}$$

Nevertheless (6) provides only partial information on the individual choices. The likelihood of an individual *i* belonging to a given segment *s* within a finite number *S* depends on socio-economic characteristics, personal knowledge and attitudes, in general *Z*, thus membership likelihood function may be represented as:

$$M_{is} = \lambda_s Z_i + \xi_{is} \tag{7}$$

where λ_s is a segment of the vector λ and ξ_{is} is the error term. Assuming IID of the error term, the probability of the individual *i* to belong to segment *s* is:

$$P_{is} = \frac{e^{\mu_s \lambda_s Z_i}}{\sum_{k \in C} e^{\mu_s \lambda_h Z_i}} \tag{8}$$

where (*h=1,2,..S*) are the segment-specific parameters that have to be estimated for each individual. The sum of all the segments is one, so the *s-th* varies from zero to one.

When (6) and (8) are put together, we obtain the probability of the individual *i* belonging to segment *s* and choosing alternative *j* within the choice situation *t*; this can be written as:

$$P_{ijts} = P_{ijt\backslash s} \cdot P_{is} = \frac{e^{\mu_s \beta'_s X_{ijt}}}{\sum_{k \in C} e^{\mu_s \beta'_s X_{ikt}}} \cdot \frac{e^{\mu_s \lambda_s Z_i}}{\sum_{k \in C} e^{\mu_s \lambda_h Z_i}} \tag{9}$$

Appendix 2. Survey statistical design

	Alternative 1						Alternative 2						
Choice situation	Forest structure	Carbon sequestration	Extinction rate	Grassland open areas	Recreation	Cost	Forest structure	Carbon sequestration	Extinction rate	Grassland open areas	Recreation	Cost	Block
1	D	5.5%	-50 species	-10%	Tourist facilities & path signs	75€	C	8.5%	10 species	0%	Tourist facilities	150€	1
2	B	10%	10 species	2%	Tourist facilities & path signs	25€	C	5.5%	-25 species	-10%	Path signs	125€	2
3	C	10%	-50 species	0%	Path signs	25€	A	7%	10 species	-5%	Tourist facilities & path signs	200€	1
4	A	7%	0 species	2%	No service	125€	B	10%	0 species	-10%	Path signs	50€	1
5	D	10%	10 species	-5%	No service	75€	B	5.5%	-50 species	0%	Tourist facilities & path signs	75€	1
6	C	5.5%	-25 species	-5%	Tourist facilities & path signs	200€	A	8.5%	-50 species	0%	Tourist facilities	50€	2
7	D	7%	0 species	0%	Tourist facilities	150€	A	10%	-25 species	-5%	No service	25€	2
8	C	8.5%	-25 species	-10%	No service	50€	D	10%	10 species	2%	Path signs	100€	2
9	B	8.5%	0 species	2%	Path signs	100€	D	7%	-25 species	-10%	Tourist facilities	25€	1
10	B	5.5%	-25 species	-5%	Tourist facilities	100€	C	8.5%	0 species	2%	Tourist facilities & path signs	100€	2
11	A	8.5%	-50 species	0%	Path signs	50€	B	5.5%	0 species	-5%	No service	175€	2
12	A	7%	10 species	-10%	Tourist facilities	175€	D	7%	-50 species	2%	No service	75€	1

Appendix 3. Alternative choice frequency: difference between estimated and real choices

Choice situation	Estimated			Real			Differences		
	Alt 1	Alt 2	SQ	Alt 1	Alt 2	SQ	Δ alt 1	Δ alt 2	Δ SQ
1	33.67	30.94	35.39	34.91	22.01	43.08	1.24	-8.93	7.69
2	59.93	15.34	24.72	65.20	19.44	15.36	5.27	4.09	-9.36
3	37.88	26.71	35.41	60.69	16.67	22.64	22.81	-10.04	-12.77
4	16.53	51.29	32.18	14.15	47.17	38.68	-2.38	-4.12	6.49
5	43.75	23.66	32.59	22.64	27.36	50.00	-21.11	3.69	17.41
6	23.32	31.58	45.10	16.30	44.83	38.87	-7.02	13.25	-6.23
7	24.68	38.99	36.34	21.00	52.98	26.02	-3.67	13.99	-10.32
8	33.49	35.30	31.21	23.51	26.65	49.84	-9.98	-8.65	18.63
9	24.07	44.83	31.10	22.33	53.14	24.53	-1.74	8.32	-6.58
10	18.45	47.67	33.88	15.67	28.53	55.80	-2.78	-19.14	21.92
11	31.94	17.33	50.73	37.30	17.87	44.83	5.36	0.54	-5.90
12	33.50	20.44	46.06	16.04	30.19	53.77	-17.46	9.75	7.71

Note: the choice situation of block 2 is shaded in grey