Public Preferences and Willingness to Pay for Forest Disease Control in the UK

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Abstract

Forest pests and diseases impose a range of costs on society, related to losses in timber values, impacts on recreational opportunities and effects on forest biodiversity. Since the social costs of pests and diseases likely outweigh the private costs, it is relevant to ask whether the social benefits of disease control programmes outweigh the costs of disease control actions to the public and private sectors. The preferences and willingness to pay of the UK general public for forest disease control measures was investigated via a discrete choice experiment. In total, 605 respondents completed both the quiz and eight-card choice experiment. Some 55% to 69% of the respondents have heard about tree diseases. When prompted to name some diseases they know, 54% of respondents cite Dutch elm tree disease and 28% know about ash dieback. About 11% of the respondents protest against the choice experiment set-up saying that the costs of tree disease control should be paid exclusively by the forest industry. We find that disease control programs for publicly-owned forests and forests owned by charitable trusts are more likely to be supported than programs for private commercial forests. Higher income, greater ex-ante knowledge about tree diseases, and more frequent visits to forests are correlated with higher willingness to support disease control programs. Among those who complete the experiment, there is a strong negative sentiment against some disease control measures, such as clear felling of a forest, and chemical and biocide spraying. These results are independent from either forest type or scientific uncertainty about disease characteristics.

JEL Codes: C35, Q23, Q57. Key words: Invasive species, discrete choice experiment, willingness to pay, preferences, tree diseases, disease control measures, forest benefits.

Introduction

Forest pests and diseases damage trees in forests and woodlands, cities and towns, and nurseries and private gardens. In the UK, for example, over 750 pests and pathogens are currently recorded on Defra's Plant Health Risk Register[1]. Internationally, the number and frequency of pest and disease outbreaks in forests has been rising over time, with factors such as increases in international trade, climate change and the introduction of exotic species outside of their normal ranges being implicated for this increase (DEFRA, 2013). Such pests and diseases have multiple negative consequences ranging from losses to timber business, to considerably-reduced recreational possibilities, effects on biodiversity, and declines in landscape quality in the affected areas (THPBET, 201. Although prevention of a disease spreading would be the best management strategy, prevention measures will never be 100 per cent effective, and so in situ management strategies are still needed (NISC, 2008). Once the disease has established, control and management procedures are required to limit or slow down a disease's spread. And costs of these measures are likely to be substantial, especially in view of the increasing risk of new tree diseases arriving to the UK. Whilst the forest industry would pay considerable part of the costs, the government is also very likely to be involved in dealing with this problem. First, about 35% of all forests and woodlands in Britain are owned by the public; and second, tree diseases can affect trees right across the UK, whether they are located in commercial plantations, in other kinds of woodland, on farmland, or in hedgerows in urban areas. So some of the disease control costs would have to be paid for by taxes, and this is why we find it is important to investigate what the British public thinks about tree diseases and disease control strategies, as well as the preferred degree of the state involvement in the control process.

(Born, Rauschmayer, & Bräuer, 2005) note that uncertainty is a central characteristic of the alien species invasions and forest diseases, and they should be better accounted for in economic valuation process. In particular, there is scientific uncertainty about the speed of spread of potential new diseases, or about their severity, or about efficiency of the disease control measures. So we are interested not only in eliciting public preferences about supporting government-financed tree disease control programs, but also in testing how sensitive such preferences are with respect to uncertainty about a disease or its

[1] See https://secure.fera.defra.gov.uk/phiw/riskRegister/

effect, or with respect to a different forest type, or ownership, or a forest-provided benefit that would be affected by a disease. We also aim to test if the ex-ante knowledge about the tree disease would have any impact on the preferences of the choice experiment respondents.

The rest of the paper is organized as follows. The first section provides an overview of the existing literature on the invasive species and tree diseases in particular. The next section describes the experiment, which is followed by sample overview and preliminary analysis of respondent answers. Then we summarize our findings about forest usage and ex-ante knowledge about tree diseases by the respondents. This section is followed by model estimation results and the section with summary and conclusions.

Literature Overview

Invasive species can have substantial impacts on land uses, through effects on agricultural production, biodiversity, ecosystem services, infrastructure and communities ((Rolfe & Windle, 2014), Pimentel et al., 2005; Lovell et al., 2006). Furthermore, (Born et al., 2005) argued that assessing the costs of invasive species is challenging because most involve direct use, indirect use and non-use components, especially those involving reduced impacts on the protection of environmental assets.

In the process of valuation of environmental goods and services, or in the course of evaluation of some proposed environmental policy it is important to assess how much the people who will participate in the survey know about the good or policy in question. Some measure of the ex-ante knowledge can provide a researcher with a rough assessment of understanding of a survey's topic by respondents, and so with some understanding of the degree of credibility of the survey results and policy conclusions.

(Fuller, Marzano, Peace, Quine, & Dandy, 2016) implemented a survey to assess the British public's knowledge about tree diseases. They found that although the majority of respondents identified themselves as concerned about the threat of pests and tree diseases, the level of the general knowledge about some diseases is very low. In particular, *Phytophthora ramorum* was the least heard of (96.0% of respondents), while ach dieback (or *Chalara*, 69.9%) was among the relatively more known diseases.

(LaRiviere, Czajkowski, Hanley, & Simpson, 2015) and (Sandorf, Campbell, & Hanley, 2015) use the respondents' prior knowledge about a valuation good to amend the valuation estimates. As the measure of the prior knowledge, they used the number of correct responses in a multiple-choice quiz that was administered before a choice experiment.

Experiment Description

The online version of the survey was prepared using Sawtooth Software. The choice experiment design was generated in Ngene via a two-step procedure: first, a design for a pilot experiment was generated assuming MNL model; and second, this design was updated based on the results of RPL model fitted to the pilot data. This updated design was then used to run the main experiment. The respondents to the choice experiment came from a panel provided by Toluna UK, which ensure that the respondent sample was balanced according to geographic distribution and demographic characteristics of the UK population.

The initial design was generated assuming underlying conditional logit model with zero coefficients for all attributes. After the pilot data on 48 respondents were collected, we estimated a mixed (or random parameters) logit model and used its results to form the priors for coefficient distributions in the design model. We chose D-efficiency measure as a criteria for the design selection in order to minimize standard errors of the model's parameter estimates. A new D-efficient experiment design was generated for a mixed logit model, and the resulting design with five blocks with eight choice cards in each block was used in the main experiment.

The survey consists of three parts. In the first part, the respondents are asked about their recreation habits and preferences to spend time in forests, as well as several questions testing their general knowledge of plant diseases and disease prevention measures. The second part is the choice experiment, consisting of eight choice cards with two unlabelled options that describe possible tree disease control policy measures and an opt-out option in each card (see Figure 1).

In the introduction to the choice experiment, the respondents are informed that they will be offered choices between options for how the UK should respond to the problem of new tree diseases in the UK. Each option refers to a specific disease control program which could span a 10-year period. These programs would help to control many diseases. However, scientific knowledge about the speed of spread and degree of damage for new and existing diseases is incomplete, so the description of the disease control programs includes an attribute that reflects this scientific uncertainty.

Each policy option is defined by six attributes, one of which is an extra tax per household per year. The non-monetary attributes describe who owns a forest or woodland, what is the type and size of a woodland, what disease control measures are considered, what could be a scientifically less known feature of future tree diseases, and what kind of benefits from forests may be most badly affected by a disease (see Table 1 for more details on the attributes and their levels). By these attributes we intend to describe a situation when a possible new forest disease would have a broad enough range of negative consequences, so that not only forestry or timber businesses but also a wide spectre of the UK general public would be affected, either via loss of recreational opportunities or via landscape changes. Similarly, the disease control measures that we include in the experiment are both generalized enough and at the same time very standard in the UK forestry practice.

In the third part we ask the respondents to contemplate how they make their decisions and inform us if they have ignored some of the attributes and what has been the subjective ranking of the characteristics of the policy options. The last, fourth part of the survey contains the questions on respondents' demographic and social details.

Sample and Choices Overview

In total 605 respondents completed the survey and 180 respondents dropped out of the survey at different stages. Half of the dropouts took place immediately after the survey's introduction page, with further 19% abandoning the survey before the start of tree disease quiz, which indicates that the most frequent reason for non-participation in the choice experiment was disinterest in its topic and not a flaw in the experiment design.

Demographic characteristics of the sample are summarized in Table 2. Women constitutes slightly more than half of the sample (51%). The age distribution of the sample follows closely the UK national demographic distribution, with the sample's average and median age being 47 years and modal age estimated at 54 years. About 34% of the respondents are parents in families with small children, and the average family size is 2.7 persons. The median education level is a college degree, while the mode of the education level is a university degree. The sample's median gross monthly income lies in the range of £2001-£2500, while the modal gross income is somewhat lower at £1001-£1500 per month.

Initial analysis of the choices made by the survey respondents in the choice experiment part shows that there is no systematic bias in the design of the experiment. Overall the choices of alternatives are well balanced, with both alternative 1 and alternative 2 being selected in 32% of choice situations, although the status quo option was selected somewhat more frequently (in 36% of cases). As the share of the respondents who chose the opt-out option in all eight cards amounts to 21%, we can say that the majority (59%) of the total number of status quo choices are submitted by those respondents. About half of them (53%) explained that their choices are protest voting because they think that tree diseases management should be financed exclusively by forest owners and not via general taxes. In addition, 16% of the opt-out voters consider the issue of plant diseases not important, and 11% do not believe that the disease control measures included in the policy options of the choice experiment will be efficient.

Forest Use and Knowledge about Tree Diseases

Most of the respondents are rather moderate forest users who live at a distance of 10-12 miles from the nearest woodland and visit forests only several times a year (46% of respondents) or never (16% of respondent). On the other side of the spectrum are relatively active forest users who visits forests on a daily (5%) or weekly (10%) basis.

When asked about their awareness of tree diseases (see Table 3) in general and in their neighbourhood in particular, 69% of the respondents say they have heard about tree diseases in the UK, but only 15% know anything about tree diseases near to where they live. We found very weak negative correlation between the distance to the nearest forest and the respondents' general knowledge about tree diseases (correlation -0.10) or their knowledge about tree diseases nearby (-0.05).

To test the respondents' ex ante knowledge about tree diseases studied in our project, we asked them to answer five multiple choice questions about four specific diseases (Table 3). The scientific names of the diseases are: *Phythophthora ramorum, Dothistroma septosporum, Hymenoscyphus fraxinea* (also known as Chalara), and *Heterobasidion annosum* (root and butt rot). The respondents are relatively more aware about general tree diseases-related issues, such as tree disease causes (55% answered correctly), susceptible tree species (64% correct), and measures to minimize the risk of disease spread (56% correct answers). The level of specific tree disease knowledge is much lower, as there are only 36% and 29% respondents who give correct answers for needle blight and ash dieback questions, respectively. This conclusion is further supported by the outcome of the question in which the respondents are prompted to name the diseases they know. Here Dutch elm tree disease is the most known disease and is mentioned in 54% of the answers. It is followed by ash dieback (or Chalara, 28%), while other tree diseases are mentioned in only one to five per cent of answers. Overall, 61% of respondents answer correctly two or three quiz questions.

Econometric Model

The modeling of people preferences elicited via discrete choice experiments is based on the assumption that a respondent maximizes her utility over each of the alternatives presented in a choice card. The standard reference for application of the utility theory to the repeated discrete choice experiments and derivation of a multinomial (conditional) and random parameters logit models is (Train, 2009).

One of the most widely used models is the random parameters logit (RPL) model, often called the mixed logit model, as its specifications are versatile enough to model a wide spectre of respondent behaviour. The model formulation is similar to the multinomial logit model (MNL) for choices of an individual i who faces a choice situation t with J alternatives described by K attributes:

$$\Pr(y_{it} = j) = \frac{\exp(\alpha_{ij} + \boldsymbol{\beta}_i'\mathbf{x}_{ijt})}{\sum_{q=1}^{J}\exp(\alpha_{iq} + \boldsymbol{\beta}_i'\mathbf{x}_{iqt})}, \qquad (0.1)$$

where choice-specific constants and individual-specific taste parameters vary around fixed means and are modelled as follows:

$$\begin{aligned} \beta_{ik} &= \beta_k + \boldsymbol{\delta}'_k \mathbf{z}_i + \sigma_k \nu_{ik}, \\ \alpha_{ij} &= \alpha_j + \boldsymbol{\delta}'_j \mathbf{z}_i + \sigma_j \nu_{ij}, \end{aligned} \tag{0.2}$$

and where β_k is the population mean, ν_{ik} is the individual specific heterogeneity, with mean zero and standard deviation one, and σ_k is the standard deviation of the distribution of β_{ik} around β_k (in this paper we assume the normal distribution). The means of the parameter distributions are also allowed to be heterogeneous with observed demographic data z_i. This demographic data set contains not only the standard demographic variables, such as age, gender, education, and income, but also the variables that reflect the respondents' familiarity with forests and ex-ante knowledge about tree diseases in their neighbourhood.

In our experiment, choice situations are characterized by attributes that can be best represented as categorical variables with several levels. To account for this, each attribute with L_k levels is modelled as a set of $(L_k - 1)$ dummies, where each dummy corresponds to a level of a categorical variable. Thus the model contains four dummies corresponding to the levels of the Ownership attribute, three dummies for the Forest Type attribute, three dummies for the Disease Control attribute, three dummies for the Unpredictable Feature attribute, and four dummies for the Affected Benefit attribute. The base levels, for which the dummies are omitted from the model, are 'family', 'individual trees', 'combination of disease control measures', 'unpredictable efficiency of control measures', and 'carbon storage'. Only the Extra Tax attribute is modelled as a continuous variable. In addition, we assume that the taste coefficients for all the dummy variables show no individual specific heterogeneity and thus are fixed across the sample, while the Status Quo constant and the Cost coefficient are assumed to vary across individuals according to the normal distribution.

Estimation Results

We estimated several discrete choice experiment models, ranging from the conditional logit to random parameter logit to latent class random parameter logit. All estimation are done with NLOGIT software. The best fit model is the random parameters logit (mixed logit) model with attributes represented as level dummies and which includes interactions with income and disease knowledge variables. We report the estimates for this and several other models in Table 4.

The Status Quo constant, which in the mixed logit model with continuous attributes reflect the utility of not supporting either of the proposed alternatives, in the model with level dummy variables interacts with the utility of the base line option, "Family-owned individual trees for which a disease affects carbon storage capacity, subject to a combination of disease control measures with unpredictable efficiency". The SQ constant is negative and significant in the continuous-attribute mixed logit model, which indicates that on average the respondents are willing to support some of the disease control programs. The constant is not significant in the level dummies model, thus indicating that the dummies from the base line combination are not significant.

Looking at the interactions of the SQ constant with demographic and knowledge variables, we see that several of them are significant. A negative interaction with income means that the respondents with higher income are more willing to support a disease control program. Similar effect have the variables that reflect the ex-ante knowledge about tree diseases, good performance in the pre-experiment quiz, and self-reported familiarity with Chalara disease. Notably, the effect of the frequency of visits to forest (defined as a few times a week, a month, a year) is very well differentiated: the more often the respondents go to woodlands of forests, the more willing they are to support anti-disease controls.

On the other hand, the respondents who go to the forest every day have lower sensitivity to an increase in taxes, as the estimates show that the price coefficient is less negative for such frequent forest visitors. The interactions of the extra tax parameter with other, lower frequencies, as well as with income are not significant.

Parameter estimates for the non-monetary attributes demonstrate that the preferences vary significantly across different combination of choice attribute levels. For the Ownership attribute, the estimates show that the respondents will support disease control programs for only publicly-owned forests and woodlands, as only the taste coefficients for charity and local and national governments are positive and significant.

Among these three, the charity- and nationally-owned forests are the most preferable forests.

There seems to be a weak negative sentiment against supporting timber business, but this result is not statistically significant. However, this conclusion is additionally supported by the above-mentioned finding that the main reason for some respondents to select the opt-out option in all eight cards is that the tree diseases management should be financed exclusively by forest owners, and not via tax.

The respondents also dislike Clear Felling and Biocide/chemical spraying as the possible Disease Control options. The coefficients for these level dummies are negative and significant, with the estimate for the Clear Felling being more negative. The estimates for Thinning and Combination of measures parameters are not significant.

Among the most negatively affected Forest Benefits, the respondents care most about Wildlife Biodiversity. For other benefits, the average preference coefficient estimates are non-significant. Such results are somewhat surprising, as we expect that the negative impact on the landscape visual attractiveness or reduced recreational possibilities would be more significant. However, this is likely the result of large individual heterogeneity of the preference parameters, which is shown by the significant estimates of standard deviation for the parameter distributions.

The coefficient estimates for two attributes, Type of the Woodland and Unpredictable Feature, are not significant for any of their level dummies. The estimates show that the taste parameters for Unpredictable Features have significant individual heterogeneity that is not fully explained in our model.

Public Support for Tree Disease Control Programs

Marginal Willingness to Pay values express the relative importance of a unit change in an attribute in monetary terms. For the model with attribute level dummies, WTP is the monetary value for a change from the baseline attribute levels to the level in question. As we can see from Table 5, the marginal WTP values for the significant attribute coefficients lie in the range of £4.90 – £9.93, where the WTP for the Local Authority ownership and Biodiversity benefit are on the lower end of the range, and the WTP for the Charity and National Government ownership are on the higher end. There is also a demand for monetary compensation of £5.99 – £6.10 if Clear Felling or Biocides are adopted as tree disease control measures. The marginal WTP values for forest frequent (daily) visitors are higher than the values for the infrequent visitors, but these differences are not statistically significant.

Table 6 reports WTP estimates for different possible disease control programs. The WTP per policy varies in the range of approximately £66 – £70 per year per household, though the variation across different policies does not seem very large. Even though these WTP numbers may be overestimated due to hypothetical bias, from these estimates we can conclude that the government can get enough extra taxes for financing of the disease control policies.

Conclusions

In this paper we investigated the preferences and knowledge of the UK general public about tree diseases and disease control measures with the help of a quiz with questions about tree diseases and a repeated discrete choice experiment in which choice situations consisted of two disease control alternatives and an opt-out option. In total, 605 respondents completed both the quiz and eight-card choice experiment. According to the quiz results, 69% of the respondents have heard about tree diseases and 55-64% can correctly identify their causes, susceptible trees, and anti-spreading measures. Among the respondents who know about tree diseases, 54% identify Dutch elm tree disease and 28% name ash dieback as the most familiar disease. The latter seems to be the only currently spreading disease that is relatively well known to the British public.

Analysis of the choice experiment answers show that slightly more than 11% of the respondents protest against the choice experiment set-up saying that the costs of tree disease control should be paid exclusively by the forest industry. Also, the disease control programs for publicly-owned forests are more likely to be supported. Higher income, ex-ante knowledge about tree diseases, and more frequent visits to forests are correlated with higher willingness to support disease control programs. And finally, the estimates show that the British public have large enough willingness to pay for the government to be able to finance a disease control program similar to those considered in the choice experiment.

Among those who complete the experiment, there is a strong negative sentiment against both large-impact disease control measures, such as clear felling of a forest, and chemical and biocide spraying. These results are independent from either forest type or incomplete knowledge about some of disease characteristics.

We found only limited correlation between the distance to the nearest forest and the respondents' knowledge about tree diseases. However, the significance of interactions of the frequency of forest visits variable with choice attributes and significant heterogeneity of the coefficients for the affected forest benefits suggest that the respondents' geographic location will likely have an impact on the individual preferences for the disease control. Thus a more detailed analysis of preference heterogeneity using different proxies for the geographic location can be a promising and important route for future research.

Similarly interesting research extension may be a study which will include not only tree disease control options, but also different recovery/replanting possibilities. Woodland rehabilitation options can considerably change the outcome of a disease control program, and thus the British taxpayers may be more willing to support such extended programs regardless of woodland ownership.

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Table 1. Attributes of the policy options

Attributes	Levels
Forests or woodlands owned by	family, timber production or land investment business, wildlife charity or trust, local authority, the national government
Type of forest or woodland	large woods (bigger than 5 acres), small woods (smaller than 5 acres), hedgerow trees, individual trees
Disease control actions	clear felling (cutting down all the trees in a forest), thinning (just cutting down some of the trees), chemical or biocide spraying, combination of these measures
What is most unpredictable about the disease?	speed of spread between forests, extent of damage caused by disease, efficiency of control measures, likelihood to jump to other tree species
What kinds of benefits are most badly affected by the disease?	timber production, recreation, wildlife biodiversity, visual appearance of landscape, carbon storage
Additional tax costs for households (per year)	£15, £30, £45, £60, £100

Table 2. Socio-demographic characteristics of the respondents.

	Sample	UK population
Share of females	0.51	0.51
Age group shares:		
18-24	0.12	0.11
25-34	0.19	0.17
35-44	0.14	0.16
45-54	0.19	0.19
55+	0.37	0.37
Age summary (years):		
mean	47	
median	47	40
mode	54	
Avg. Family size (incl. children)	2.7	2.3
Share of families with children	0.34	
Education level:		
median	college degree	41% of adults with college degree
mode	university degree	
Income distribution (gross, monthly):		
median	£2001-£2500	£1700
mode	£1001-£1500	

Note: The UK national average numbers come from UK 2011 Census and Office for National Statistics data

Table 3. Respondent knowledge about tree diseases and their forest visiting.

Question	Share of "yes" or correct answers
Have you heard about any tree diseases in the UK?	0.69
Do you know anything about tree diseases near to where you live?	0.15
What diseases do you know? (self-reported names)	
Dutch elm tree disease	0.54
Ash dieback (*Chalara*)	0.28
Phytophthera ramorum	0.01
Wood rot	0.01
Chestnut blight or bleeding canker	0.04
Acute oak decline and other oak diseases	0.05
Quiz questions:	
1. Which trees can these diseases infect?	0.64
2. What are the causes of these diseases?	0.55
3. Which disease is sometimes called 'needle blight'?	0.36
4. Which disease is sometimes called 'ash dieback'?	0.29
5. What would you recommend to do to minimize the risk that you will spread tree diseases such as *Phytophthera ramorum* between forests?	0.56
Quiz summary:	
No correct answers	0.03
One correct answer	0.20
Two correct answers	0.33
Three correct answers	0.28
Four correct answers	0.14
Five correct answers	0.03
How often do you visit woods or forests each year?	
Every day	0.05
A few times each week	0.10
A few times each month	0.23
A few times a year	0.46
Never	0.16

Note: All quiz questions are related to four of the diseases that are being studied in the project. The scientific names of these are: *Phythophthora ramorum, Dothistroma septosporum*, *Hymenoscyphus fraxinea* (also known as Chalara), *Heterobasidion annosum* (root and butt rot).

Table 4. Estimation results for Conditional Logit and Random Parameter Logit models with continuous and attribute level-dummy variables (incl. selected demographic variables).

	MNL (CL) cont. var.	RPL cont. var.	RPL cont. var. + demogr.	MNL (CL) dummies	RPL dummies	RPL dummies + demogr.
Status Quo Constant	-0.334** (0.133)	-2.406*** (0.297)	1.552** (0.645)	-0.544*** (0.133)	-2.906*** (0.313)	0.951 (0.751)
+ Income			-0.0005*** (0.0001)			-0.0006*** (0.0002)
+ Heard of Disease="yes"			-1.306*** (0.405)			-1.027* (0.530)
+ Quiz Score above median						-1.158** (0.454)
+ Know Chalara = "yes"						-1.136* (0.626)
+ Visits to forest = Day			-1.766 (1.221)			-1.714 (1.589)
+ Visits to forest = Week			-3.922*** (0.824)			- 3.383*** (0. 899)
+ Visits to forest = Month			-2.348*** (0.689)			-1.999** (0.752)
+ Visits to forest = Year			-2.004*** (0.616)			-1.736*** (0.671)
Extra annual tax	-0.016*** (0.001)	-0.046*** (0.003)	-0.044*** (0.007)	-0.016*** (0.001)	-0.044*** (0.003)	-0.045*** (0.007)
+ Visits to forest = Day			0.040*** (0.012)			0.040*** (0.013)
Ownership (base level – Family)	0.067*** (0.014)	0.102*** (0.023)	0.107*** (0.023)			
Timber business = 1				0.020 (0.097)	-0.020 (0.142)	-0.021 (0.143)
Wildlife charity = 1				0.309*** (0.096)	0.433*** (0.146)	0.431*** (0.140)
Local authority = 1				0.046 (0.081)	0.221** (0.104)	0.222** (0.112)
National gov't = 1				0.291*** (0.079)	0.408*** (0.111)	0.409*** (0.108)
Type of forest (base level – Individual trees)	0.004 (0.020)	0.018 (0.029)	0.014 (0.027)			
Large woods = 1				-0.039 (0.073)	-0.033 (0.109)	-0.030 (0.097)
Small woods = 1				-0.065 (0.074)	0.033 (0.110)	0.037 (0.109)
Hedgerow = 1				-0.104 (0.071)	-0.109 (0.095)	-0.108 (0.093)
Disease control (base level – Combination)	0.044** (0.018)	0.074*** (0.026)	0.075*** (0.026)			
Clear felling = 1				-0.171*** (0.066)	-0.401*** (0.089)	-0.399*** (0.085)
Thinning = 1				-0.086	-0.050	-0.045

				(0.078)	(0.120)	(0.107)
Biocide = 1				-0.191**	-0.272**	-0.271**
				(0.089)	(0.129)	(0.120)
Unpredictable feature	-0.041**	-0.019	-0.025			
(base level – Control efficiency)	(0.020)	(0.032)	(0.031)			
Speed of spread = 1				0.113	-0.126	-0.119
				(0.081)	(0.113)	(0.112)
Extent of damage = 1				0.077	-0.083	-0.078
				(0.078)	(0.106)	(0.102)
Likelihood to jump = 1				0.091	-0.008	-0.006
				(0.079)	(0.103)	(0.103)
Badly affected benefit	0.030**	0.038*	0.038*			
(base level – Carbon storage)	(0.015)	(0.022)	(0.021)			
Timber production = 1				-0.065	-0.032	-0.032
				(0.081)	(0.108)	(0.105)
Recreation = 1				-0.020	0.101	0.101
				(0.103)	(0.155)	(0.143)
Wildlife biodiversity = 1				0.132	0.296*	0.289*
				(0.091)	(0.159)	(0.154)
Landscape = 1				0.040	0.045	0.045
				(0.086)	(0.127)	(0.121)
Std Dev of Random params.						
std.dev (ASC)		5.241***	5.044***		3.983***	4.720***
		(0.334)	(0.313)		(0.429)	(0.297)
std.dev (Extra Tax)		0.047***	0.045***		0.044***	0.043***
		(0.003)	(0.003)		(0.003)	(0.003)
std.dev (Ownership)		0.293***	0.296***			
		(0.033)	(0.034)			
std.dev (Forest type)		0.024	0.096			
		(0.097)	(0.059)			
std.dev (Disease control)		0.207***	0.182***			
		(0.046)	(0.051)			
std.dev (Unpredict. Feat.)		0.263***	0.257***			
		(0.050)	(0.051)			
std.dev (Affected benefit)		0.154***	0.149***			
		(0.034)	(0.035)			
Model fit						
Nr of observations	4840	4840	4840	4840	4840	4840
McFadden Rsq	0.04	0.34	0.35	0.04	0.34	0.35
AIC/n	2.11	1.45	1.45	2.11	1.46	1.45

Notes: 1. The comprehensive list of attributes and their levels is provided in Table 1.
2. To keep the table concise, we do not report non-significant interaction terms for the Extra annual tax parameter.

Table 5. Marginal Willingness to Pay values (£ per unit change).

	RPL dummies (average)	RPL dummies: forest infrequent visitors	RPL dummies: forest frequent visitors
Ownership (base level – Family)			
Timber business = 1	-0.45	-0.46	-0.47
Wildlife charity = 1	9.84***	9.54***	9.93***
Local authority = 1	5.02**	4.90**	5.10**
National gov't = 1	9.28***	9.06***	9.43***
Type of forest (base level – Individual trees)			
Large woods = 1	-0.75	-0.67	-0.70
Small woods = 1	0.74	0.83	0.86
Hedgerow = 1	-2.47	-2.38	-2.48
Disease control (base level – Combination)			
Clear felling = 1	-9.10***	-8.83***	-9.20***
Thinning = 1	-1.13	-0.99	-1.03
Biocide = 1	-6.19**	-5.99**	-6.23**
Unpredictable feature (base level – Control efficiency)			
Speed of spread = 1	-2.87	-2.63	-2.74
Extent of damage = 1	-1.88	-1.73	-1.81
Likelihood to jump = 1	-0.18	-0.14	-0.15
Badly affected benefit (base level – Carbon storage)			
Timber production = 1	-0.73	-0.70	-0.73
Recreation = 1	2.30	2.23	2.32
Wildlife biodiversity = 1	6.73*	6.40*	6.67*
Landscape = 1	1.01	0.99	1.03

Note: Significance is marked according to the significance levels of attribute coefficients.

Table 6. Willingness to Pay values for different tree disease control programs (£ per program, for RPL model with attribute level dummies).

Disease control policy	WTP
Family, individual trees, combination of measures, control efficiency, carbon	67.63
Charity, small woods, clear fell, control efficiency, wildlife biodiversity	66.80
Local authorities, small woods, clear fell, control efficiency, wildlife biodiversity	67.44
National gov't, small woods, clear fell, control efficiency, wildlife biodiversity	66.86
Charity, small woods, biocides, control efficiency, wildlife biodiversity	66.33
Local authorities, small woods, biocides, control efficiency, wildlife biodiversity	66.97
National gov't, small woods, biocides, control efficiency, wildlife biodiversity	66.39
Charity, large woods, clear fell, control efficiency, wildlife biodiversity	67.06
Local authorities, large woods, clear fell, control efficiency, wildlife biodiversity	67.70
National gov't, large woods, clear fell, control efficiency, wildlife biodiversity	67.12
Charity, large woods, clear fell, control efficiency, timber production	68.05
Local authorities, large woods, clear fell, control efficiency, timber production	68.69
National gov't, large woods, clear fell, control efficiency, timber production	68.11
Charity, hedgerow, clear fell, control efficiency, landscape attractiveness	68.11
Local authorities, hedgerow, clear fell, control efficiency, landscape attractiveness	68.75
National gov't, hedgerow, clear fell, control efficiency, landscape attractiveness	68.17
Charity, hedgerow, biocide, control efficiency, carbon	67.77
Local authorities, hedgerow, biocide, control efficiency, carbon	68.41
National gov't, hedgerow, biocide, control efficiency, carbon	67.83

Figure 1. An example choice card.

Which of the following options for new tree diseases' control during the next 10 years would you prefer?

	Option A	**Option B**	
Forests or woodlands owned by	family	timber production or land investment business	I would NOT choose either of these options, because
Type of forest or woodland	large woods (bigger than 5 acres)	large woods (bigger than 5 acres)	
Disease control actions	clear felling (all the trees)	thinning (felling some trees)	I prefer that the *government* takes NO extra ACTIONS about this problem.
What is most unpredictable about the disease?	speed of spread between forests	likelihood to jump to other tree species	
What kinds of benefits are most badly affected by the disease?	timber production	wildlife biodiversity	
Additional tax costs for households (per year)	£15	£30	NO additional TAXES
YOUR CHOICE:	◯	◯	◯