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# Can Virtual Reality Enhance Scope Sensitivity? Experimental Evidence from the Amazon Rainforest*

November 2025

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**Abstract**

High-quality video presentations generate scope-sensitive willingness to pay (WTP) for Amazon rainforest conservation as effectively as immersive virtual reality (VR), while offering greater accessibility and lower cost. Using a preregistered 2×2 between-subjects experimental design, participants were randomly assigned to VR or video presentations and asked their WTP for conservation programmes protecting 20% and 50% of the Amazon rainforest. Both formats successfully elicited scope-sensitive valuations, with scope elasticities of 0.588 for VR and 0.576 for video, within the empirically plausible range for environmental goods. With equivalent scope sensitivity, video represents the recommended approach for most stated preference applications. Exploratory within-VR analyses revealed that presence, realism, and discomfort moderated scope sensitivity, with higher presence and realism strengthening scope responsiveness and discomfort weakening it. These findings validate immersive VR as capable of eliciting scope-sensitive valuations for remote ecosystems with high non-use values, while establishing video's equivalent performance at substantially lower implementation costs.

**Keywords**: Virtual Reality, Stated Preference, Contingent Valuation, Scope Sensitivity

**JEL Codes:** Q51, Q57, C91

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# 1 Introduction

The Amazon rainforest is approaching ecological tipping points, thresholds beyond which additional disturbances could trigger abrupt and potentially irreversible losses in ecosystem services (Lovejoy & Nobre, 2018; Wunderling et al., 2022). Despite its vital function as the world's major carbon sink, climate regulator, and biodiversity habitat, approximately 20% has already been deforested (Gatti et al., 2021), with projections suggesting up to 47% may face compounding disturbances by 2050 (Flores et al., 2024). Given the Amazon's ecological importance, accurately valuing its conservation benefits is critical for informed policy decisions. For non-local populations, these benefits consist predominantly of non-use values – existence, bequest, and altruistic values – as most individuals will never directly experience the rainforest (Navrud & Strand, 2018; Brouwer et al., 2022). Contingent valuation (CV), the primary tool for measuring such non-market benefits, traditionally relies on textual descriptions and static images. However, this approach faces a persistent challenge of scope insensitivity, where stated values fail to vary proportionally with environmental scale (OECD, 2018).

This poses fundamental validity concerns, as economic theory predicts WTP should increase with conservation scope where protecting 50% of the Amazon should be valued more than protecting 20%. However, respondents frequently fail to distinguish between conservation scales, particularly for remote ecosystems they have never experienced (Burrows et al., 2017; Kahneman, Ritov & Schkade, 1999). This may stem partly from experiential deficits in traditional survey methods, where respondents must mentally reconstruct environments from text and images, a process prone to cognitive simplification and heuristic reliance (Kahneman, 2003; Lopes & Kipperberg, 2020). Recent technological advances such as VR offer promising solutions. Theoretical arguments suggest VR's immersive, multi-sensory environment may help respondents better grasp environmental scale by providing quasi-real encounters that lessen cognitive abstraction (Patterson et al., 2017). However, whether VR provides measurable benefits over video presentations for eliciting scope-sensitive estimates remains an open question.

This study compares immersive VR and high-quality video presentations for Amazon rainforest conservation. It examines whether VR elicits scope-sensitive valuations and whether any benefits justify its higher cost, and explores heterogeneity within VR responses to identify experiential factors that moderate scope sensitivity. Results show that VR and video produce statistically equivalent scope-sensitive valuations, with empirically valid scope elasticities, indicating that visual communication of environmental scale – rather than full sensory immersion – is sufficient to elicit WTP responses. Video produces comparable valuations while offering substantially lower cost and complexity for most environmental valuation applications. Within VR, higher presence and realism were associated with greater responsiveness, whereas discomfort was associated with weaker responsiveness. Overall, immersive VR is validated as capable of eliciting scope-sensitive valuations for remote ecosystems with high non-use values, while high-quality video achieves equivalent outcomes at much lower implementation costs. The remainder of the paper is organised as follows. Section 2 reviews literature, Section 3 describes the experimental design, Section 4 presents results, and Section 5 concludes.

# 2 Literature Review

## 2.1 The Scope Insensitivity Problem

CV is a survey-based stated preference technique that elicits individuals' WTP for changes in non-market goods through hypothetical scenarios (Mitchell & Carson, 1989; OECD, 2018). The primary advantage of CV lies in its ability to capture both use values – which can include provisioning, regulating, and cultural services – and non-use values – such as existence, bequest, and altruistic values – of environmental goods. For ecosystems like the Amazon, non-use values often dominate for non-local populations who will never directly experience the ecosystem. For instance, Brouwer et al. (2022) found that 62% of the Amazon's total value consists of non-use values. Studies of UK and Italian populations also revealed households willing to pay £39 annually for Amazon conservation programmes protecting 20% of the forest (Horton et al., 2003), while Navrud and Strand (2018) estimated that European households would contribute approximately €8.4 billion annually to prevent the loss of 25% of forest coverage relative to 1970s levels.

Despite the widespread application of CV, it faces persistent validity concerns, most notably scope insensitivity. This occurs when the stated values fail to vary with the scale or magnitude of benefits provided, contrary to economic theory (OECD, 2018). Protecting more rainforest should command higher values, but in practice, this relationship frequently breaks down. The comprehensive review by Burrows et al. (2017) found that 27 of 59 studies examining non-use values failed external scope tests, with 7 of 11 forest valuation studies exhibiting scope insensitivity. This challenge becomes especially acute when valuing tipping-point phenomena, where conditions marginally above or below critical thresholds carry vastly different implications. If respondents cannot distinguish between protecting 20% versus 50% of the Amazon, valuation studies may systematically underestimate the benefits of preventing ecosystem collapse.

### 2.1.1 Explanations for Scope Insensitivity

Four key explanations have emerged from the literature explaining this challenge (Lopes & Kipperberg, 2020). While diminishing marginal utility offers an explanation for why additional environmental units yield decreasing incremental value (Rollins & Lyke, 1998; Kontoleon & Swanson, 2003), familiarity and knowledge, too, affect sensitivity, as respondents with greater environmental knowledge demonstrate better scope discrimination (Heberlein et al., 2005; Alevy et al., 2011; Giguere et al., 2020). Similarly, behavioural mechanisms like the 'warm glow' effect, where respondents derive satisfaction from contributing rather than from specific outcomes, can mask scope sensitivity (Kahneman & Knetsch, 1992; Nunes & Schokkaert, 2003).

Most relevant to this study is the representational inadequacy in how environmental goods are presented. Traditional CV surveys rely on textual descriptions or static images that may inadequately capture complex environmental systems, potentially affecting perceived realism and understanding of the environmental good (Carson, 1997; Lopes & Kipperberg, 2020; Whitehead, 2016). This creates an experiential gap where environments are reduced to abstract representations and respondents cannot form the rich mental models necessary for scope discrimination. Instead, they rely on heuristics and form prototypical images of the rainforest regardless of quantity (Tversky & Kahneman, 1974; Kahneman, Ritov & Schkade, 1999). Without access to sensory cues that define these environments, respondents struggle to meaningfully distinguish between conservation levels, particularly for remote ecosystems they have never experienced. If representational inadequacy contributes to scope insensitivity, enhanced presentation methods may offer solutions.

## 2.2 Enhanced Presentation Technologies

VR offers a qualitatively different approach by creating quasi-real experiences that enable experiential rather than abstract environmental understanding (Patterson et al., 2017). Unlike text and images, which require mental reconstruction of environments – a process prone to cognitive simplification – VR provides direct perceptual experiences that engage spatial cognition and reduce abstraction. Two mechanisms explain VR's potential for improving scope sensitivity. First, VR enhances representation quality by reducing reliance on prototypical heuristics and minimising cognitive heterogeneity. When respondents encounter abstract descriptions of unfamiliar ecosystems, they construct idiosyncratic mental representations based on prototypical images, which can override their ability to distinguish environmental quantities (Kahneman, Ritov & Schkade, 1999). By providing direct perceptual experiences, VR fosters a more consistent understanding across respondents, enhancing construct validity and supporting more accurate scope-sensitive valuations.

VR's realistic and navigable environments address both challenges simultaneously. VR has been shown to enhance spatial perception and comprehension of scale, volume, and depth more effectively than text or images in educational contexts, with potential applications extending to environmental contexts (Azarby & Rice, 2022; Sun, Wu & Cai, 2019). Simultaneously, VR provides standardised, rich representations that limit idiosyncratic interpretation. When respondents share similar virtual experiences, their valuations are more likely to reflect the actual environmental good, further improving construct validity and enabling better scope discrimination (Zhu, Guo & Zhao, 2020).

Second, VR creates a sense of presence, defined as the subjective feeling of 'being there' (Steuer, 1992). Empirical evidence supports VR's ability to generate authentic experiences, with virtual tours eliciting spatial presence and emotional engagement comparable to physical presence (Wagler & Hanus, 2018), and VR forest environments producing psychological and physiological responses similar to actual forests (Nukarinen et al., 2022). Multi-sensory enhancements such as touch, smell, and temperature further increase presence and realism (Covaci et al., 2018; Yuan, Ghinea & Muntean, 2014; Ranasinghe et al., 2017, 2018). For non-use valuation of unfamiliar resources, presence is crucial, as respondents must value existence or bequest benefits without direct experience. Stronger feelings of 'being there' allow participants to better visualise conservation areas and grasp different program scopes intuitively. VR thus bridges the experiential gap, transforming abstract notions such as 'the Amazon should exist' into a concrete understanding that 'this specific forest I virtually explored should be preserved.'

Recognising that scope insensitivity may partly stem from inadequate representation of environmental goods, researchers have explored whether improved visual presentation can enhance respondents' comprehension of environmental scale. Studies using visual aids – including graphical displays and risk ladders – have demonstrated modest improvements in scope sensitivity (Corso, Hammitt & Graham, 2001; Alberini et al., 2004), while presentation format choices such as absolute versus relative measures can affect scope discrimination (Ojea & Loureiro, 2011). However, despite these improvements, evidence of scope insensitivity often persists, suggesting that traditional visual aids remain limited in conveying the multi-dimensional spatial aspects of environmental goods. This raises the question of whether immersive presentation technologies could overcome these barriers.

Within stated preference research more broadly, VR has shown positive effects on choice certainty, consistency, and realism. For discrete choice experiments (DCE), immersive VR has improved choice quality and reduced decision error compared to traditional formats (Mokas et al., 2021; Birenboim et al., 2019; Arellana et al., 2020). For environmental valuation specifically, Bateman et al. (2009) found that 3D computer environments reduced error variance and loss aversion in land use, though scope sensitivity was not examined. Matthews, Scarpa and Marsh (2017) conducted the most relevant study for scope effects, using DCE to investigate coastal erosion programme preferences in New Zealand. They compared computer-generated virtual environments displayed as videos on 2D screens with text and static images. The virtual environment group showed reduced choice error and higher engagement, with marginally better scope sensitivity to dune restoration scale but not to seawall length, suggesting attribute-specific effects where visually distinguishable changes (dune size) showed stronger scope responses than less apparent variations (seawall length).

## 2.3 Research Gaps and Contributions

This review reveals a significant gap where no study has directly tested whether immersive VR with multi-sensory enhancement can reduce scope insensitivity in CV settings. Matthews, Scarpa and Marsh (2017) came closest, but despite being termed a 'virtual environment,' their approach involved videos displayed on 2D screens without head-mounted displays, multi-sensory enhancements, or interactive navigation. The defining characteristics of immersive VR – spatial presence, embodied navigation, and multi-sensory experience – remain untested for scope sensitivity. Equally important is a practical question regarding whether VR's added expense and complexity provide measurable benefits over video. VR implementation involves substantial costs such as equipment, technical expertise, participant time, and logistical constraints that may limit its applicability for large-scale surveys or resource-constrained contexts. Video, while less immersive, offers dynamic visual information with far greater accessibility and scalability.

This study addresses both questions through three main contributions. First, it provides the first direct comparison of immersive VR versus video for scope sensitivity in CV, directly addressing the practical question of whether VR justifies its additional implementation costs. While prior work has compared text with video-based virtual environments, no study has tested whether full immersion with head-mounted VR and multi-sensory stimuli produces different valuation outcomes than high-quality video presentations of identical content. This comparison directly addresses the practical question facing researchers of whether VR justifies its additional implementation costs. Second, it contributes to the economic valuation of the Amazon rainforest, one of Earth's most critical biodiversity hotspots facing imminent tipping points. If successful in achieving scope-sensitive valuations for this remote ecosystem with high non-use values, the study would demonstrate that enhanced visual presentations can improve the validity of stated economic values for large-scale conservation programmes. This is particularly timely given international commitments to protect 30% of natural ecosystems by 2030 and the growing role of carbon markets in forest protection.

Third, through exploratory analyses of heterogeneity within VR responses, it investigates which experiential factors moderate scope sensitivity. These analyses examine whether presence, realism, emotional engagement, and discomfort relate to respondents' ability to discriminate between different conservation scales. By identifying which aspects of immersive experiences promote scope-sensitive valuations, these findings contribute to best practices for researchers who choose to implement VR in stated preference studies for specific research objectives.

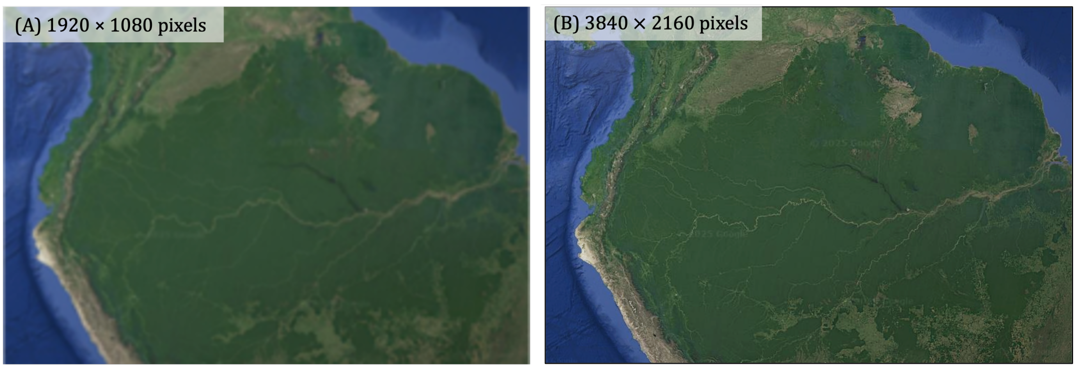
# 3 Methods

The study was preregistered and approved by the Research Ethics Committee of the London School of Economics and Political Science. All methods were carried out according to the relevant guidelines and regulations of the Research Ethics Board.

## 3.1 Virtual Reality and Video Design

The core content was developed using immersive 360° videos of the Amazon rainforest obtained from multiple online sources, including VRGorilla, Google Earth Studio, and AirPano. These videos were edited and stitched together using Final Cut Pro. The resulting 2K resolution was upscaled to 4K using Topaz AI to enhance visual clarity and immersion (Figure 1). The final production incorporated spatial audio and interactive hotspots containing Amazon facts and figures, all assembled using 3DVista Pro before deployment to an offline cloud server.

Figure 1: Resolution enhancement of VR footage using Topaz AI




(a): Original 2K resolution showing pixelated detail and texture

(b): Enhanced 4K after upscaling showing enhanced clarity and texture

*Source: Google Earth Studio – Satellite Imagery of Amazon rainforest*

The final product followed a structured narrative of nine minutes, a duration chosen to allow sufficient spatial immersion while minimising motion sickness risks that increase beyond 10 minutes (Zhang et al., 2018; Chang et al., 2020). Using a Meta-Quest 3 VR headset, participants were presented with diverse Amazon ecosystems featuring wildlife encounters such as a sloth climbing a tree, a snake swimming in the river, indigenous community interactions, river journeys, and contrasting scenes of logging and deforestation. The experience ended with a global satellite visualisation in which participants were presented with two conservation scenarios, one protecting 20% of the Amazon and the other protecting 50%. The visualisation automatically adjusted viewing scale based on each conservation programme's scope, zooming to show the geographical extent and relative impact of different protection levels. This dynamic scaling helps participants distinguish between different conservation efforts. The presentation order of these conservation scenarios was randomised according to the experimental group to which the participants were assigned.

Specifically for the VR group, environmental conditions were controlled with humidity levels set at 70% and temperature at 32°C. A custom petrichor scent accord was administered to recreate the smell of rain and wet soil in a rainforest. Throughout the VR experience, participants could navigate using head movements for 360° views, use a joystick to zoom in and out, and interact with information hotspots using gaze-based selection or controller pointing to learn additional facts about the Amazon ecosystem and conservation challenges. To ensure participants encountered key content despite free 360° exploration, explicit tutorial instructions emphasised engaging with hotspots, and highly salient pulsating red icons were used to minimise missed interactions. Audio was delivered directly through the integrated speakers of the VR headset.

Figure 2: Experimental Room Set Up

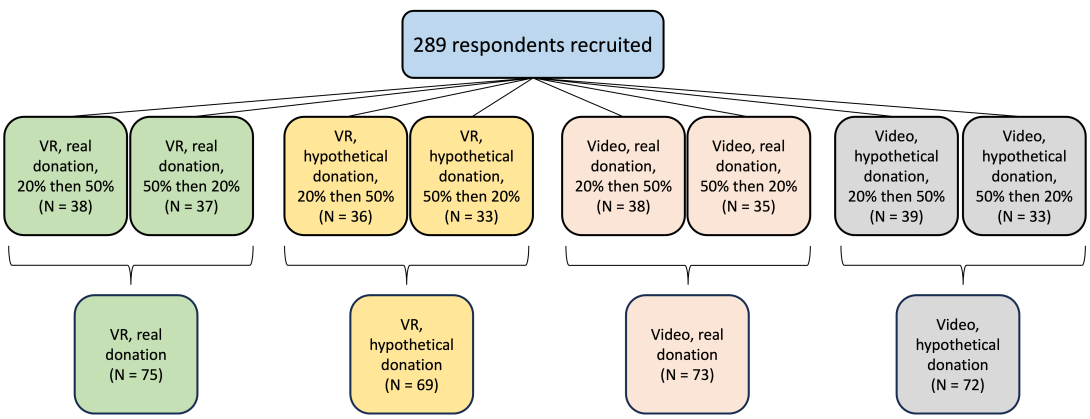

The video condition was created by recording the VR environment and delivering it in full high-definition 2D format via iPad. A predetermined viewing path presented all interactive hotspots at fixed timestamps, ensuring identical informational exposure while restricting navigation. While VR participants could freely explore the 360° environment, video participants followed a fixed sequence, a difference preserved to reflect natural usage of each format. Video duration matched the nine-minute VR session with playback controls disabled. The video preserved all key environmental features and audio but omitted VR's climate controls and petrichor scent. This design ensured comparable informational content while preserving each format's unique characteristics.

## 3.2 Experimental and Survey Design

This study used a 2×2 factorial design with a primary focus on investigating how different presentation mediums – VR versus video – affect WTP for Amazon rainforest conservation programmes. The second factor, donation, manipulated whether participants made binding donations from their personal budgets or provided hypothetical valuation responses. Analysis of this manipulation is addressed in a separate paper. The ordering of conservation programmes (20% vs. 50%) was randomised as a control measure rather than treated as an explicit factor for investigation, helping to account for potential ordering effects (Day et al., 2012; Halvorsen, 1996; Clark & Friesen, 2008). This resulted in eight distinct experimental blocks combining medium type, donation type, and programme presentation order.

Participants were sequentially randomised to medium type, donation condition, and presentation order of conservation programme. To control for time-of-day effects, session scheduling was balanced across morning and afternoon slots for all treatment combinations, ensuring that variations in participant alertness or engagement were evenly distributed across all conditions (Nelson, DeVries & Prendergast, 2024). Although the randomisation protocol created eight distinct experimental blocks by including conservation programme ordering, data analysis focused on the primary 2×2 factorial design, as the randomisation of presentation order balances potential order effects between conditions (Figure 3).[1] The final sample sizes varied minimally across conditions due to normal study attrition.

Figure 3: Randomisation Process




1. To test for potential ordering effects, a mixed-effects model was estimated with participant random intercepts, including *Order* ($p = 0.481$) and the *Scope* × *Order* interaction ($p = 0.103$). Neither coefficient was statistically significant, suggesting that the presentation order of scope levels did not influence WTP responses.

Adherent to best practices (Mitchell & Carson, 2013; Johnston et al., 2017; OECD, 2018), the survey followed question sequencing consistent with existing valuation studies.[2] The survey began with a consent section, where respondents received information about the survey objectives and their data rights. All participants were then exposed to a 2-minute non-environmental VR scenario – a touristic view of Alhambra in Spain – designed to standardise familiarity with the technology and mitigate potential novelty effects (Miguel-Alonso et al., 2023). After this standardisation phase, an attitudinal section assessed participants' level of concern for forests. This was followed by a knowledge component with questions on general forest understanding, before transitioning to a behavioural section that gathered data on respondents' environmental practices and forest-conservation specific behaviours.

The valuation section began with participants experiencing a VR or video presentation on the rainforest, followed by real or hypothetical donation opportunities. Those in the real donation condition received information that they could make binding donations to WWF's conservation programmes from their personal budgets. Since each participant provided two WTP values for both 20% and 50% conservation programmes, one amount was randomly selected as binding. Participants completed their donations through a personalised link upon concluding the experiment, receiving a WWF certificate acknowledging their contribution. In contrast, those in the hypothetical donation condition provided WTP values without the opportunity to make actual donations. To mitigate hypothetical bias, a cheap talk script was implemented, cautioning participants about potential overestimation in both real and hypothetical valuation contexts, and a budget reminder was provided to emphasise the implications for their disposable income (Cummings & Taylor, 1999).

Additional inquiries regarding participants' motivations for their willingness, or lack thereof, to pay were incorporated after the valuation section. Debriefing questions on VR usage and experience immediately followed before concluding with standard demographic questions. To ensure experimental integrity across all conditions, the study implementation followed strict protocols. Throughout all participant interactions, the researcher maintained strictly neutral language to avoid creating any form of expectations. A standardised script was rigorously followed during all experimental sessions to ensure consistency.[3]

## 3.3 Data Collection

Participants were recruited through the LSE Behavioural Research Lab from a panel of over 3,000 participants. Each participant received £10 in Amazon vouchers as compensa-

2. Full survey is presented in section 7.11 in Supplementary Materials.
3. Refer to section 7.2 in Supplementary Materials.

tion and was entered into a lottery for a £25 Amazon voucher. Two experimental rooms – one for VR and the other for video – were set up in the lab and kept consistent throughout the data collection period. To prevent unintended influence on participant expectations, the study was advertised using neutral language, avoiding priming terms such as VR or virtual environment (Orne, 1962). Following a pilot study (N=35) that confirmed technical functionality, the main data collection occurred from December 2024 to April 2025. No exclusion criteria were imposed on the subject pool to maximise participation rate.

## 3.4 Manipulation Checks Measures

Three manipulation checks were selected to verify that VR created a psychologically distinct experience from video, measuring presence, emotional engagement, and perceived realism. These measures were chosen based on theoretical and empirical evidence that VR induces greater psychological immersion than traditional media (Slater, 2009; Slater et al., 2020; Newman et al., 2022; van Gisbergen et al., 2019), which may influence content validity in stated preference contexts (OECD, 2018; Sajise et al., 2021).

First, presence was assessed using the question “Feeling of being in the rainforest” rated on a 7-point scale (0 = not at all, 7 = extremely). Presence captures participants’ subjective sense of psychological immersion or ‘being there’ in the virtual environment (Steuer, 1992) and represents VR’s foundational construct (Slater, 2009; Slater et al., 2020). In CV contexts, presence may enhance content validity by strengthening respondents’ engagement with and belief in hypothetical scenarios, although evidence linking presence specifically to stated preference validity remains limited (Sajise et al., 2021).

Second, emotion was measured using “To what extent did you feel emotionally moved by the rainforest experience?” (0 = not at all, 7 = extremely). This captures the intensity of affective response to the virtual environment that VR’s multi-sensory and interactive qualities are known to evoke (Somarathna, Bednarz & Mohammadi, 2023). The role of emotions in stated preference studies remains mixed, with some research finding minimal effects on WTP (Hanley et al., 2017; Xu et al., 2025), while others demonstrate significant emotional influences for environmental goods (Notaro et al., 2019; Notaro & Grilli, 2022). This measure serves to confirm that VR generates stronger emotional responses than video and to enable exploratory investigation of whether emotional engagement moderates scope sensitivity.

Third, perceived realism was measured through “How do you find the overall survey? Is it realistic?” (0 = definitely not, 7 = definitely yes). This measure directly assesses content validity by examining whether respondents perceived the survey questionnaire, virtual environment, conservation scenarios, and payment mechanism as credible and plausible. In CV, realism typically refers to the credibility of the policy scenario and payment mechanism (OECD, 2018; Sajise et al., 2021). In this study, it additionally captures the perceived authenticity of the experience – how real the forest and overall task felt to respondents – reflecting the experiential dimension of VR realism.

## 3.5 Scope Sensitivity Measurement

This study employs standard scope tests and scope elasticity as complementary measures of scope sensitivity. Standard scope tests examine whether WTP differs significantly across scope levels (Carson, 1997), providing a binary assessment of statistical significance. Scope elasticity quantifies the proportional change in WTP corresponding to proportional changes in environmental scope, providing both statistical and economic significance assessment (Whitehead, 2016). Given two discrete scope levels (20% and 50% conservation area), arc scope elasticity is calculated as:

$$\varepsilon_{\mathrm{WTP},Q} = \frac{\Delta \mathrm{WTP}}{\Delta Q} \times \frac{\bar{Q}}{\overline{\mathrm{WTP}}} \tag{1}$$

where $\Delta$WTP represents the change in WTP between scope levels, $\Delta Q$ represents the change in conservation scope (0.30), and $\bar{Q}$ and $\overline{\mathrm{WTP}}$ represent the midpoint values of scope (0.35) and WTP respectively. Elasticity values between 0 and 1 indicate partial scope sensitivity, with higher values representing stronger responsiveness to scope changes. For instance, an elasticity of 0.7 indicates that a 10% scope increase corresponds to a 7% WTP increase. Empirical applications across environmental contexts have found scope elasticities ranging from 0.15 to 0.88 (Whitehead, 2016; Kipperberg et al., 2024), providing benchmarks for evaluating scope sensitivity in this study.

## 3.6 Empirical Strategy

Given that true zero WTP responses comprised 26% of the data after excluding protest responses, the analysis employed a two-part hurdle model (Cragg, 1971). Following this framework, payment behaviour was conceptualised as two distinct processes. The first stage models the participation decision – whether respondents are willing to donate anything at all – using a binary choice model. The second stage models the conditional payment amount, that is, the donation among those with positive WTP (Wooldridge, 2010; Belotti et al., 2015). This two-part structure has been widely adopted in CV research as it allows different factors to influence participation and amount decisions (Fosgerau & Bjørner, 2000; Chu et al., 2020; Guo et al., 2023).

In most applications, the second stage is estimated using truncated normal regression, which assumes that the error term of the latent variable is normally distributed and homoskedastic. However, visual and statistical diagnostics of the present data indicate that positive WTP values are highly right-skewed and heteroskedastic, suggesting that these assumptions may not hold.[4] For these reasons, Tobit regression may be inappropriate and could produce biased or inefficient estimates. Thus, following similar studies (Kuhn, Ihtiyor & Moritz, 2024; Wei, Guan & Zhu, 2016; Clinch & Murphy, 2001; Carvalho, 2020), the second stage was estimated using generalised linear model (GLM) with a log link and Gamma distribution as suggested by Wooldridge (2011), and a separate OLS with log-normal WTP was included as robustness check (Cortés-Espino, Langle-Flores & Gauna Ruíz de León, 2023; Soler & Borzykowski, 2021). Specifically, the first and second stages were modelled as follows:

$$\mathrm{P}(\mathrm{WTP}_{it} > 0) = \Phi(\alpha_0 + \alpha_1 VR_i + \alpha_2 Scope_{it} + \alpha_3 Donation_i + \alpha_4 (VR \times Scope)_{it} + \delta' \mathbf{Z}_i)) \tag{First stage}$$

$$\log(E[\mathrm{WTP}_{it} | \mathrm{WTP}_{it} > 0]) = \beta_0 + \beta_1 VR_i + \beta_2 Scope_{it} + \beta_3 Donation_i + \beta_4 (VR \times Scope)_{it} + \Gamma' \mathbf{Z}_i \tag{Second stage}$$

where:

- $\mathbf{P(WTP}_{it} > \mathbf{0)}$ is the probability that respondent $i$ has positive willingness to pay for scope scenario $t$
- $\mathbf{WTP}_{it}$ is respondent $i$'s willingness to pay amount for scope scenario $t$ (conditional on being positive)
- $\mathbf{VR}_i$ is a dummy variable equal to 1 if respondent $i$ was in the VR treatment, 0 if video treatment
- $\mathbf{Scope}_{it}$ is a dummy variable equal to 1 for 50% conservation scenario, 0 for 20% conservation scenario
- $\mathbf{Donation}_i$ is a dummy variable equal to 1 if respondent $i$ was in the real donation treatment, 0 if hypothetical treatment
- $\mathbf{(VR \times Scope)}_{it}$ is the interaction term between virtual reality and scope treatments
- $\mathbf{Z}_i$ is a vector of control variables including environmental concern, environmental knowledge, environmental behaviour, gender, education, and log income
- $\Phi(\cdot)$ is the cumulative distribution function of the standard normal distribution

4. Refer to section 7.5.1 in Supplementary Material for visual and Shapiro–Wilk test diagnostics.

- $\mathbf{E}[\cdot]$ denotes the expected value

Clustering at the participant level is handled through bootstrap resampling. The preregistered hypotheses are then tested using combined marginal effects from the two-part model. Prior to the main analysis, protest responses (N=26) which comprised 9% of total responses were identified and removed. These were characterised by zero WTP values accompanied by justifications expressing distrust in the implementing organisation, such as "I do not believe WWF will use my donation wisely", rather than true zero valuations (OECD, 2018). Second, speedsters (N=14), defined as responses below the completion time of 17 minutes 30 seconds were excluded to ensure response quality.[5]

Third, outliers (N=3) were removed by excluding the 99th percentile of the WTP distribution, corresponding to values greater than £100. This approach is supported by previous economic benchmarks from a comparable conservation study of a similar protection area. Specifically, Horton et al. (2003) reported WTP of £39 for 20% Amazon rainforest conservation among the UK and Italian general population with approximately £60-£65 in 2025 inflation-adjusted terms. Given that general populations typically have higher WTP than student samples and considering the larger conservation scope of 50% in this study, the £100 threshold provides a reasonable upper bound for plausible valuations.

Finally, this study used exact payment card values as point estimates rather than intervals. This approach maintains methodological consistency between both donation conditions, since participants in the real donation condition paid the precise amount they selected. Notwithstanding, in line with existing studies using payment card data, interval regression was performed only for hypothetical donations as a robustness check (OECD, 2018; Sajise et al., 2021). After data cleaning, the final analytical sample consisted of 246 participants with 492 observations.

# 4 Results

## 4.1 Summary Statistics

Table 1 presents the demographic characteristics of the final sample after data cleaning. The participants were predominantly female (68.7%) and highly educated, with 89.4% having at least a bachelor's degree. The sample was young, with 52.9% aged 18-24 years, followed by 32.5% aged 25-34, and smaller proportions in older age brackets. The racial composition included Asian or Asian British (47.6%), White (37.0%), mixed or multiple

5. This threshold of 17 minutes and 30 seconds was derived by summing the minimum plausible time required to engage meaningfully with each survey component: 30 seconds (consent form), 9 minutes (fixed-duration VR exposure), 3 minutes (VR pre-exposure), and 5 minutes (main survey). Responses faster than this total were excluded as implausible due to inattentiveness or failure to comprehend the questions.

ethnicity (7.3%), other ethnic groups (4.1%), and Black, Caribbean or African British (3.3%). Given that it was a lab experiment, the majority were students (68.3%) without children (93.9%) and predominantly in the lower-income bracket.

Table 1: Summary Statistics

| Variable | N | % |
|---|---|---|
| Education | | |
| No degree | 26 | 10.57 |
| Bachelor's degree | 76 | 30.89 |
| Graduate/Professional degree | 144 | 58.54 |
| Gender | | |
| Male | 77 | 31.30 |
| Female | 169 | 68.70 |
| Total Income/Allowance (£) | | |
| Less than £300 | 50 | 20.33 |
| £300 - £599 | 38 | 15.45 |
| £600 - £899 | 33 | 13.41 |
| £900 - £1,199 | 35 | 14.23 |
| £1,200 - £1,999 | 40 | 16.26 |
| £2,000+ | 35 | 14.23 |
| Prefer not to say | 15 | 6.10 |
| Age Group | | |
| 18-24 | 130 | 52.85 |
| 25-34 | 80 | 32.52 |
| 35-44 | 18 | 7.32 |
| 45-54 | 10 | 4.07 |
| 55-64 | 7 | 2.85 |
| 65-74 | 1 | 0.41 |
| Race | | |
| Asian or Asian British | 117 | 47.56 |
| Black or Black, Caribbean or African British | 8 | 3.25 |
| Mixed or multiple ethnic groups | 18 | 7.32 |
| Other ethnic group | 10 | 4.07 |
| White | 91 | 36.99 |
| Prefer not to say | 2 | 0.81 |
| Student | | |
| Yes | 168 | 68.29 |

Continued on next page

Table 1 – continued from previous page

| Variable | N | % |
|---|---|---|
| No | 78 | 31.71 |
| Children | | |
| Yes | 15 | 6.10 |
| No | 231 | 93.90 |
| No. of Participants | 246 | 100 |

## 4.2 Balance Tests

In assessing the equivalence of the experimental conditions, balance tests were carried out (Table 2). Generally, balance was achieved to varying degrees. For the VR intervention, randomisation produced groups that were statistically equivalent in all factors. However, for the donation conditions, some imbalances emerged in education level, gender, and environmental knowledge. Specifically, the real donation group had significantly higher levels of education and marginally higher environmental knowledge, while the hypothetical donation group had a marginally higher proportion of men. To account for these imbalances, subsequent analyses included these variables as controls.

Table 2: Balance Tests for Experimental Groups

| | Media Type | | | Donation Type | | |
|---|---|---|---|---|---|---|
| Variable | Video Mean | VR Mean | Diff. (p-value) | Hypothetical Mean | Real Mean | Diff. (p-value) |
| Education | 2.538 | 2.426 | 0.112 | 2.374 | 2.585 | -0.211** |
| | | | (0.197) | | | (0.015) |
| Gender (Male=1) | 0.350 | 0.279 | 0.071 | 0.366 | 0.260 | 0.106* |
| | | | (0.230) | | | (0.074) |
| Log Income | 6.575 | 6.391 | 0.183 | 6.506 | 6.448 | 0.059 |
| | | | (0.243) | | | (0.708) |
| Environmental Behaviour | 2.692 | 2.667 | 0.026 | 2.650 | 2.707 | -0.057 |
| | | | (0.840) | | | (0.654) |
| Environmental Knowledge | 3.137 | 3.140 | -0.003 | 3.000 | 3.276 | -0.276* |
| | | | (0.986) | | | (0.071) |
| Environmental Concern | 4.953 | 5.074 | -0.121 | 5.041 | 4.992 | 0.049 |
| | | | (0.452) | | | (0.761) |

Continued on next page

Table 2 – continued from previous page

| Variable | Media Type: Video Mean | Media Type: VR Mean | Media Type: Diff. (p-value) | Donation Type: Hypothetical Mean | Donation Type: Real Mean | Donation Type: Diff. (p-value) |
|---|---|---|---|---|---|---|
| Age Group | 1.752 | 1.705 | 0.047<br>(0.717) | 1.740 | 1.715 | 0.024<br>(0.850) |
| Participants | 117 | 129 | | 123 | 123 | |

Notes: The construction of all preregistered indices such as environmental behaviour, knowledge, concern, and categorised variables of education, income and age group is detailed in the preregistration plan. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

## 4.3 Manipulation Checks

Manipulation checks verified experimental effectiveness across three psychological dimensions measured on 7-point scales. Table 3 shows that VR participants reported significantly higher presence, emotional engagement, and perceived realism than those in the video condition.

Table 3: Manipulation Checks for VR Treatment

| Variable | Video Mean | VR Mean | Diff. (p-value) |
|---|---|---|---|
| Presence (Feeling of being in rainforest) | 3.778 | 5.264 | 1.486***<br>(0.000) |
| Realism (How realistic is the survey) | 4.906 | 5.248 | 0.342**<br>(0.023) |
| Emotion (Feeling emotionally moved) | 4.350 | 4.736 | 0.386**<br>(0.036) |
| Participants | 117 | 129 | |

Notes: All manipulation check variables are measured on 7-point Likert scales and performed using a one-tailed test. Higher values indicate stronger presence, realism, and emotional response. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

The difference was most apparent for presence, indicating a shift from moderate to high immersion, while emotional engagement and realism showed smaller but significant increases. These results confirmed that experimental manipulation was effective in altering the psychological experience of the participants, aligning with the existing literature (Mancuso et al., 2023; Gilpin, Gain & Lipinska, 2021; Hidaka, Qin & Kobayashi, 2017).

### 4.4 Mean and Median Willingness To Pay

Participants assigned to VR had an average WTP of £7.20 for a conservation programme protecting 20% of the rainforest, increasing to £12.76 for 50% protection. For the video treatment, corresponding figures were £6.27 and £10.49. Mean WTP increased by 67% for video and 77% for VR when scope expanded from 20% to 50%, while median WTP increased from £3 to £5 in both formats (67% increase). This consistency between mean and median changes suggests that the observed scope sensitivity was not driven by outliers. Quantile regression confirmed these median increases were statistically significant (Video: $\beta = 1.80$, $p = 0.011$; VR: $\beta = 1.66$, $p = 0.004$), with no difference between formats (interaction $p = 0.775$).

Table 4: Willingness to Pay by Treatment Conditions (£)

| **Scope** | **Format** | **Hypothetical Donation** | **Real Donation** | **Mean** | **Median** |
|---|---|---|---|---|---|
| 20% | Video | 10.34 (1.47) | 2.27 (0.37) | 6.27 (0.84) | 3.00 |
| | VR | 12.00 (1.41) | 2.33 (0.44) | 7.20 (0.85) | 3.00 |
| 50% | Video | 17.53 (2.37) | 3.56 (0.66) | 10.49 (1.38) | 5.00 |
| | VR | 21.35 (2.56) | 4.03 (0.73) | 12.76 (1.54) | 5.00 |

Notes: Standard errors are shown in parentheses. Mean values are averages across donation conditions (hypothetical and real). WTP did not differ significantly between VR and video conditions, regardless of Scope ($p = 0.276$; $p = 0.440$) or Donation ($p = 0.418$; $p = 0.921$).

Beyond scope effects, the data revealed important differences between donation conditions. Real donations consistently produced lower estimates across both media formats and protection areas, providing evidence of substantial hypothetical bias. Hypothetical donations were inflated by factors of 4.6 and 4.9 for video participants (20% and 50% scope, respectively), while these inflation factors increased to 5.2 and 5.3 for VR participants, suggesting that immersive technology might exacerbate hypothetical bias. These differences are explored further in a subsequent paper.

### 4.5 Regression Analysis

Using a two-part model, two separate regressions were conducted to test the preregistered hypotheses.[6] Results are interpreted with average marginal effects (AME) for both the first stage and population level. These findings are shown in Tables 5 and 6, where the latter incorporates an additional interaction term.[7] Given the consistent results across both models, the subsequent analysis focuses on Table 6.

6. See section 7.3 for construction of independent variables and indices used in the regressions.
7. Full two-part models are presented in section 7.4 in Supplementary Materials.

Table 5: Average Marginal Effects - Model 1

| | First Stage (Probit) | | Population Level | |
|---|---|---|---|---|
| Variables | AME | 95% CI | AME | 95% CI |
| $Scope_{ij}$ | 0.056*** | [0.018, 0.094] | 4.693*** | [3.332, 6.055] |
| | (0.019) | | (0.695) | |
| $VR_i$ | 0.050 | [-0.044, 0.144] | 1.431 | [-0.777, 3.640] |
| | (0.048) | | (1.127) | |
| $Donation_i$ | -0.301*** | [-0.395, -0.208] | -14.427*** | [-18.009, -10.846] |
| | (0.048) | | (1.827) | |
| Environmental Concern | 0.043** | [0.006, 0.081] | 0.809 | [-0.323, 1.940] |
| | (0.019) | | (0.577) | |
| Environmental Knowledge | 0.046** | [0.003, 0.090] | 0.903 | [-0.217, 2.024] |
| | (0.022) | | (0.572) | |
| Environmental Behaviour | 0.021 | [-0.033, 0.076] | 0.129 | [-1.524, 1.782] |
| | (0.028) | | (0.843) | |
| Male | -0.084 | [-0.195, 0.028] | -0.939 | [-4.215, 2.336] |
| | (0.057) | | (1.671) | |
| Education | 0.010 | [-0.060, 0.080] | 1.895** | [0.247, 3.544] |
| | (0.036) | | (0.841) | |
| Log Income | 0.058*** | [0.019, 0.096] | 1.703*** | [0.552, 2.854] |
| | (0.020) | | (0.587) | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); population-level models unconditional WTP in £**. Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. First stage shows marginal effects on donation probability. Population-level marginal effects combine both the participation decision (first stage) and donation amount conditional on participation (second stage). $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 6: Average Marginal Effects - Model 2

| | First Stage (Probit) | | Population Level | |
|---|---|---|---|---|
| Variables | AME | 95% CI | AME | 95% CI |
| $Scope_{ij}$ | 0.056*** | [0.018, 0.094] | 4.610*** | [3.298, 5.921] |
| | (0.019) | | (0.669) | |
| $VR_i$ | 0.050 | [-0.044, 0.144] | 1.450 | [-0.776, 3.676] |
| | (0.048) | | (1.136) | |
| $Donation_i$ | -0.301*** | [-0.395, -0.208] | -14.428*** | [-18.008, -10.848] |
| | (0.048) | | (1.827) | |

Continued on next page

Table 6 – continued from previous page

| | First Stage (Probit) | | Population Level | |
|---|---|---|---|---|
| Variables | AME | 95% CI | AME | 95% CI |
| $VR_i \times Scope_{ij}$ | 0.002 | [-0.075, 0.079] | 0.866 | [-1.651, 3.382] |
| | (0.039) | | (1.284) | |
| Environmental Concern | 0.043** | [0.006, 0.081] | 0.809 | [-0.322, 1.940] |
| | (0.019) | | (0.577) | |
| Environmental Knowledge | 0.046** | [0.003, 0.090] | 0.903 | [-0.218, 2.024] |
| | (0.022) | | (0.572) | |
| Environmental Behaviour | 0.021 | [-0.033, 0.075] | 0.129 | [-1.526, 1.785] |
| | (0.028) | | (0.845) | |
| Male | -0.084 | [-0.195, 0.028] | -0.938 | [-4.215, 2.340] |
| | (0.057) | | (1.672) | |
| Education | 0.010 | [-0.060, 0.080] | 1.895** | [0.246, 3.544] |
| | (0.036) | | (0.841) | |
| Log Income | 0.058*** | [0.019, 0.096] | 1.702*** | [0.550, 2.855] |
| | (0.020) | | (0.588) | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); population-level models unconditional WTP in £**. Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. First stage shows marginal effects on donation probability. Population-level marginal effects combine both the participation decision (first stage) and donation amount conditional on participation (second stage). The conditional AME of Scope for video and VR is 4.149 ($p < 0.01$) and 5.014 ($p < 0.01$) respectively. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Referring to Table 6, the first-stage AME revealed interesting insights about donation behaviour. As expected, larger scope, greater environmental concern, knowledge, and log income increased the probability of donating by 5.6%, 4.3%, 4.6%, and 5.8%, respectively. In contrast, the real donation treatment substantially reduced this probability by 30.1%, indicating that participants were significantly less likely to donate when faced with actual financial consequences compared to hypothetical scenarios.

At the population level, the AME showed a statistically significant negative coefficient for donation, indicating substantial hypothetical bias in which participants donated approximately £14.43 less when real money was at stake compared to hypothetical scenarios. Socioeconomic and attitudinal variables demonstrated expected relationships with WTP. The coefficients for education, environmental concern, environmental knowledge, and environmental behaviour exhibited the expected positive relationship with WTP, although the latter three variables did not reach statistical significance. Similarly, the statistically significant coefficient for log income indicates that a 1% increase in income corresponds to a £0.017 increase in WTP. These findings and their expected signs align well with previous forest valuation literature (Horton et al., 2003; Mendonça & Tilton, 2000; Ariyo, Okojie & Ariyo, 2018). Although statistically insignificant, gender differences are notable, with men exhibiting approximately £0.94 lower WTP than women, potentially reflecting stronger environmental preferences and greater willingness to contribute among women, although the literature on gender disparities in WTP remains mixed (López-Mosquera, 2016; Torgler, Gracia-Valiñas & Macintyre, 2008; Dupont, 2004).

Regarding experimental treatments, the VR coefficient suggests that this exposure is associated with a modest increase in WTP of approximately £1.45. However, this effect lacked statistical significance, indicating that VR exposure alone did not significantly influence participants' WTP. The unconditional scope AME demonstrates that WTP increases by £4.61 for a larger conservation area, with corresponding conditional AMEs of £4.15 for video and £5.01 for VR, respectively. The positive AME of scope provides initial evidence of scope sensitivity in the sample. The following section formally tests this finding and examines whether the relationship varies between experimental conditions.

## 4.6 Hypotheses on Scope Sensitivity

H1 hypothesised that participants do not exhibit scope sensitivity regardless of the experimental group. The formal test using Model 1 in Table 5 revealed an AME of scope of 4.69, which is highly significant. This allows for rejection of the null hypothesis of scope insensitivity, where participants pay on average £4.69 for a larger conservation area. This finding demonstrates validity across two key dimensions. First, the positive and significant scope effect satisfies construct validity by confirming the theoretical prediction that donation amounts should increase with the quantity of environmental good provided (OECD, 2018; Sajise et al., 2021). Second, the magnitude of the scope elasticity (0.593) provides evidence of convergent validity, falling within the typical range identified by Whitehead (2016), who found scope elasticities between 0.15 and 0.88 across environmental valuation studies.[8]

Having established overall scope sensitivity in the sample, the analysis next examined whether this effect exists specifically within the video group. H2 tests the null hypothesis that participants who viewed the video presentation do not exhibit scope sensitivity. As shown in Model 2, Table 6, this hypothesis is strongly rejected, indicating that participants in the video condition demonstrated significant sensitivity to scope. In practical terms, the conditional AME of scope shows that participants were willing to pay £4.15 (95% CI: [2.50, 5.80], $p < 0.01$) more for a larger conservation area. The corresponding arc slope elasticity is 0.576, marginally lower than the overall sample's average.[9]

8. Scope elasticity $\rightarrow (\Delta\text{WTP}/\Delta Q) \times (\overline{Q}/\overline{\text{WTP}}) = (4.69/0.30) \times (0.35/9.22) = 0.593$
9. Scope elasticity $\rightarrow (\Delta\text{WTP}/\Delta Q) \times (\overline{Q}/\overline{\text{WTP}}) = (4.15/0.30) \times (0.35/8.40) = 0.576$

Following rejection of H2, H3 examined whether VR can generate scope-sensitive estimates. The analysis strongly rejected the null hypothesis (conditional AME of scope for VR = 5.014, 95% CI: [3.06, 7.03], $p < 0.01$), providing evidence that participants exposed to VR exhibited significant scope sensitivity. Specifically, VR participants were willing to pay approximately £5 more for a larger conservation area, compared to £4.15 for video participants. This corresponds to a scope elasticity of 0.588 for VR participants, compared to 0.576 for the video group, suggesting that VR participants exhibited marginally higher scope elasticity.[10]

The next question becomes whether this sensitivity differed significantly from that observed in the standard video condition. To address this, H4 tests the $\text{VR}_i \times \text{Scope}_{ij}$ interaction term, hypothesising that there is no difference in scope responsiveness between VR and video groups. The interaction coefficient of 0.866 ($p > 0.05$) represents the additional scope effect when participants experience VR relative to video. This corresponded to the VR group having a scope elasticity of 0.588 compared to 0.576 for the video group. Although VR participants showed slightly higher responsiveness to scope changes, this 2% difference in elasticity was not statistically significant. This study therefore fails to reject H4, indicating that while both presentation methods successfully elicit scope sensitivity, VR did not significantly amplify participants' responsiveness to conservation scope.[11]

## 4.7 Heterogeneity within VR – Exploratory Analyses

While VR and video achieved equivalent scope sensitivity, exploratory analyses examined within-VR heterogeneity for two purposes. First, to validate VR as a presentation format for eliciting scope-sensitive valuations across real and hypothetical contexts. Second, to identify experiential moderators informing implementation when researchers employ immersive technologies for specific research objectives. Table 7 illustrates that scope sensitivity was present in both real and hypothetical settings, although with modest differences.

Table 7: Hypothetical Bias Across Conservation Scope Level

| Variables | Population level AME | 95% CI |
|---|---|---|
| $\text{Scope}_{ij}$ | 5.297***<br>(1.020) | [3.298, 7.296] |

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10. Scope elasticity → $(\Delta\text{WTP}/\Delta Q) \times (\overline{Q}/\overline{\text{WTP}}) = (5.01/0.30) \times (0.35/9.94) = 0.588$
11. A series of robustness checks including alternative model specifications, residual diagnostics, interval regressions for payment card responses, and sensitivity analyses excluding outliers confirmed that the main findings were robust. Full details are provided in the Supplementary Materials (section 7.5).

Table 7 – continued from previous page

| Variables | Population level AME | 95% CI |
|---|---|---|
| Donation$_i$ | -13.955*** | [-17.992, -9.919] |
| | (2.059) | |
| Scope$_{ij}$ × Donation$_i$ | -7.366*** | [-11.361, -3.758] |
| | (1.926) | |
| Environmental Concern | 0.559 | [-1.240, 2.358] |
| | (0.918) | |
| Environmental Knowledge | 1.078 | [-0.831, 2.988] |
| | (0.974) | |
| Environmental Behaviour | -0.599 | [-3.012, 1.814] |
| | (1.231) | |
| Male | 0.365 | [-5.010, 5.741] |
| | (2.743) | |
| Education | 2.362* | [-0.009, 4.733] |
| | (1.210) | |
| Log Income | 1.631* | [-0.110, 3.372] |
| | (0.888) | |

Notes: **Dependent variable is unconditional WTP in £.** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Population-level marginal effects combine both the participation decision (first stage) and donation amount conditional on participation (second stage). The conditional AME of Scope for real and hypothetical donation are 1.524 ($p < 0.05$) and 8.890 ($p < 0.01$) respectively. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

In the hypothetical donation, participants' WTP increased by £8.90 (95% CI: [5.32, 12.46], $p < 0.01$) for a larger conservation programme, corresponding to a scope elasticity of 0.616.[12] For real donation, WTP also increased, but by a smaller amount of £1.52 (95% CI: [0.35, 2.70], $p < 0.05$), yielding an elasticity of 0.584.[13] The statistically significant negative interaction term (Scope$_{ij}$ × Donation$_i$) confirmed that the increase in WTP for a larger conservation programme was significantly smaller in the real donation condition. The corresponding elasticity difference of 0.032 is modest, suggesting that VR experiences effectively elicit scope sensitivity regardless of whether financial commitments are real or hypothetical. For comparison, parallel within-video analyses demonstrated similar patterns, with scope sensitivity in both real (£1.36, 95% CI: [0.67, 2.06] $p < 0.01$) and hypothetical donation contexts (£7.70, 95% CI: [3.91, 11.48], $p < 0.01$)[14].

Three moderators, presence, realism, and emotion, were subsequently tested in separate models to evaluate their individual contributions to scope sensitivity. These rep-

12. Scope elasticity → $(\Delta\text{WTP}/\Delta Q) \times (\overline{Q}/\overline{\text{WTP}}) = (8.90/0.30) \times (0.35/16.85) = 0.616$
13. Scope elasticity → $(\Delta\text{WTP}/\Delta Q) \times (\overline{Q}/\overline{\text{WTP}}) = (1.52/0.30) \times (0.35/3.04) = 0.584$
14. Full results for video are provided in section 7.6.2 in Supplementary Materials

resent distinct psychological constructs but complementary mechanisms in creating an immersive VR experience (Jung & Lindeman, 2021; Slater, 2009).[15]

Table 8: Within-VR Heterogeneity in Scope Sensitivity (Emotion, Presence, Realism)

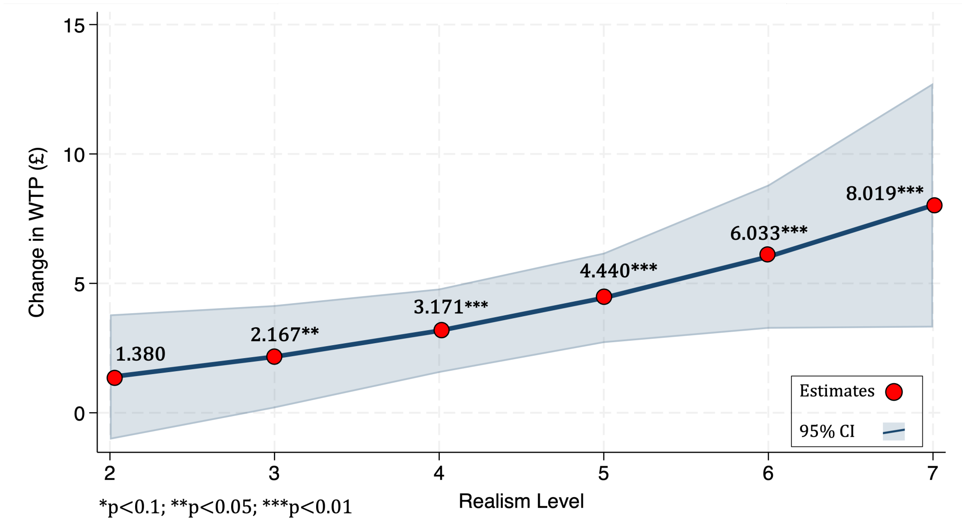
| | Population Level Average Marginal Effects | | | | | |
|---|---|---|---|---|---|---|
| Variables | Model A (Emotions) | | Model B (Realism) | | Model C (Presence) | |
| | AME | 95% CI | AME | 95% CI | AME | 95% CI |
| $\text{Scope}_{ij}$ | 4.971*** | [3.054, 6.888] | 4.929*** | [3.010, 6.848] | 5.027*** | [3.073, 6.981] |
| | (0.978) | | (0.979) | | (0.997) | |
| $\text{Donation}_i$ | -16.165*** | [-21.934, -10.396] | -15.784*** | [-21.209, -10.358] | -16.018*** | [-21.722, -10.313] |
| | (2.943) | | (2.768) | | (2.910) | |
| Environmental Concern | 0.442 | [-1.323, 2.208] | 0.252 | [-1.439, 1.943] | 0.588 | [-1.251, 2.428] |
| | (0.901) | | (0.863) | | (0.939) | |
| Environmental Knowledge | 1.102 | [-0.771, 2.976] | 0.960 | [-0.803, 2.723] | 0.924 | [-0.973, 2.820] |
| | (0.956) | | (0.899) | | (0.968) | |
| Environmental Behaviour | -0.718 | [-3.123, 1.686] | -0.545 | [-2.823, 1.732] | -0.538 | [-2.904, 1.828] |
| | (1.227) | | (1.162) | | (1.207) | |
| Male | 1.379 | [-4.201, 6.960] | 1.484 | [-4.094, 7.061] | 1.046 | [-4.532, 6.624] |
| | (2.847) | | (2.846) | | (2.846) | |
| Education | 2.224* | [-0.272, 4.720] | 2.277* | [-0.112, 4.665] | 2.261* | [-0.205, 4.728] |
| | (1.273) | | (1.219) | | (1.258) | |
| Log Income | 1.537* | [-0.206, 3.279] | 1.293 | [-0.456, 3.043] | 1.512* | [-0.266, 3.291] |
| | (0.889) | | (0.893) | | (0.907) | |
| Emotion | 0.886 | [-0.327, 2.100] | – | – | – | – |
| | (0.619) | | | | | |
| $\text{Scope}_{ij} \times$ Emotion | 0.569 | [-0.470, 1.608] | – | – | – | – |
| | (0.530) | | | | | |
| Realism | – | – | 1.379* | [-0.046, 2.803] | – | – |
| | | | (0.727) | | | |
| $\text{Scope}_{ij} \times$ Realism | – | – | 1.328** | [0.094, 2.562] | – | – |
| | | | (0.630) | | | |
| Presence | – | – | – | – | 0.573 | [-0.838, 1.985] |
| | | | | | (0.720) | |
| $\text{Scope}_{ij} \times$ Presence | – | – | – | – | 1.030** | [0.035, 2.025] |
| | | | | | (0.508) | |

Notes: **Dependent variable is unconditional WTP in £.** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Scope coefficient shows the average marginal effect of increasing conservation from 20% to 50% across all participants, not conditioned on specific moderator values. For emotion, conditional AME of scope for those with lowest (0) and highest (7) emotion level are 2.659 ($p > 0.05$) and 6.642 ($p < 0.01$) respectively. For realism, conditional AME of scope for those with lowest (2) and highest (7) realism level are 1.380 ($p > 0.05$) and 8.019 ($p < 0.01$) respectively. For presence, conditional AME of scope for those with lowest (0) and highest (7) presence level are -0.074 ($p > 0.05$) and 7.137 ($p < 0.01$) respectively. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

15. The separate modelling approach reflects the theoretical understanding that presence, realism, and emotion work complementarily to produce immersion in VR, rather than competing for explanatory variance. Testing each moderator individually examines whether it moderates scope sensitivity, whereas a combined model would test whether each uniquely contributes beyond the others. Given that these constructs are moderately correlated (r = 0.50–0.70) likely because they represent interrelated aspects of immersive experience, a combined specification (presented in Supplementary Materials section 7.6.3) is less informative. The non-significant interactions in the combined model reflect shared variance among complementary mechanisms, while conditional effects remain substantively consistent with separate models (Scope AME = 6.72 at high presence, $p < 0.05$; 7.12 at high realism, $p < 0.01$).

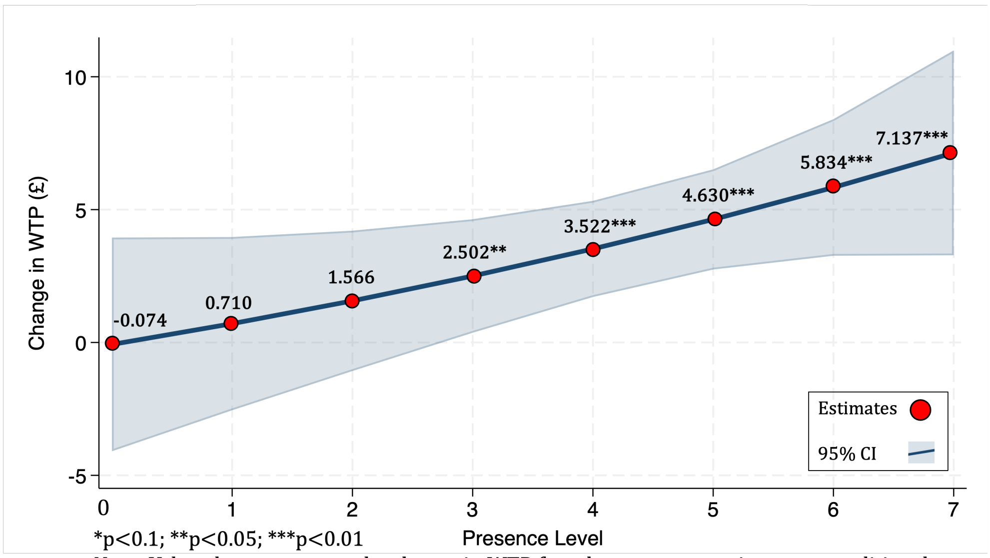
Figures 4 and 5 illustrate these relationships. At low realism levels, scope sensitivity was substantially reduced. Participants at the lowest realism level (2) showed only a modest, non-significant WTP increase of £1.38 (95% CI: [-1.05, 3.81], $p > 0.05$) for a larger conservation area and became significant at level 3. At the highest realism level (7), participants increased WTP by £8.02 (95% CI: [3.49, 12.55], $p < 0.01$). Across realism levels 2–7, the corresponding scope elasticities increased from 0.254 to 0.742.[16]

Figure 4: Marginal Plot of Realism on Scope Sensitivity




Note: No respondents selected '0 & 1' in the realism scale. Values here represent the change in WTP for a larger conservation area, conditional on different realism level. For instance, conditional on having the highest realism level (7), participant increases their WTP by £8.019 for a bigger conservation area.

Figure 5: Marginal Plot of Presence on Scope Sensitivity




Note: Values here represent the change in WTP for a larger conservation area, conditional on different presence level. For instance, conditional on having the highest presence level (7), participant increases their WTP by £7.137 for a bigger conservation area.

16. Calculation of the moderators' scope elasticities and marginal effects are provided in Section 7.6.5 in Supplementary Materials.

A similar pattern was observed for presence. At the lowest level (0), WTP differences were negligible at −£0.07 (95% CI [−4.32, 4.18], $p > 0.05$) and became significant from level 3. At the highest presence level (7), participants were willing to pay £7.14 more (95% CI [3.30, 10.98], $p < 0.01$), and across presence levels 0 to 7, scope elasticities ranged from 0.011 to 0.753. These findings suggest that VR's effectiveness depends on achieving high perceived realism and presence rather than on using VR technology alone.

While realism and presence are key theoretical constructs in VR valuation studies, practical factors such as physiological discomfort may also shape valuation responses. Following the preregistered analysis plan, a discomfort index was created by averaging the levels of disorientation, general discomfort, and nausea reported by participants.

Table 9: Within-VR Heterogeneity in Scope Sensitivity (Discomfort, Prior Experience)

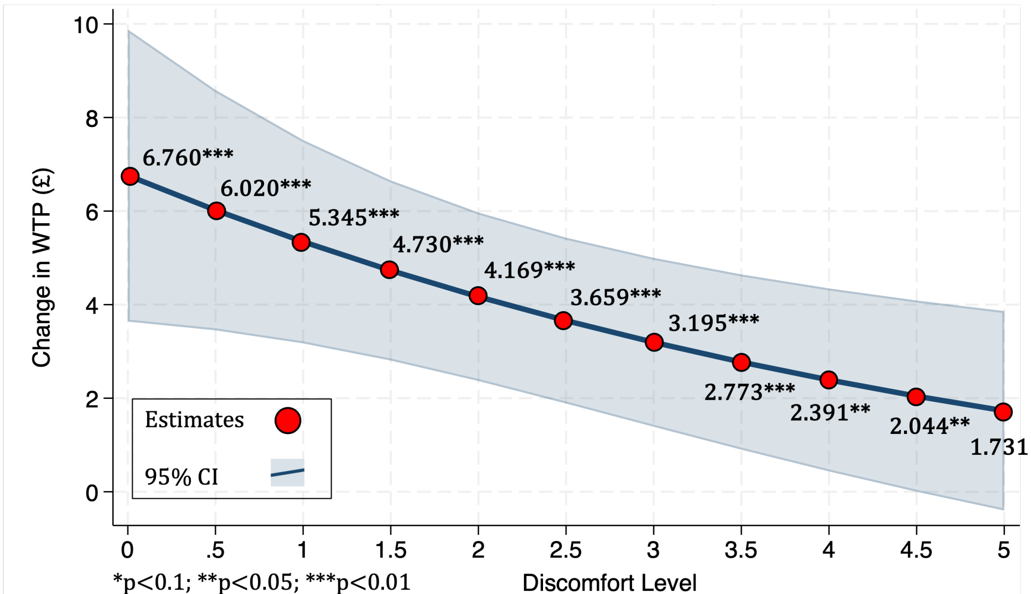
| | Population Level Average Marginal Effects | | | |
|---|---|---|---|---|
| Variables | Model A (Discomfort) | | Model B (Prior VR Experience) | |
| | AME | 95% CI | AME | 95% CI |
| $\text{Scope}_{ij}$ | 5.025*** | [3.110, 6.939] | 5.069*** | [3.083, 7.055] |
| | (0.977) | | (1.013) | |
| $\text{Donation}_i$ | -16.360*** | [-21.936, -10.783] | -16.541*** | [-22.312, -10.770] |
| | (2.845) | | (2.945) | |
| Environmental Concern | 0.412 | [-1.364, 2.187] | 0.648 | [-1.136, 2.431] |
| | (0.906) | | (0.910) | |
| Environmental Knowledge | 1.185 | [-0.673, 3.043] | 1.101 | [-0.813, 3.016] |
| | (0.948) | | (0.977) | |
| Environmental Behaviour | -0.670 | [-3.088, 1.748] | -0.711 | [-3.188, 1.767] |
| | (1.234) | | (1.264) | |
| Male | -0.242 | [-5.441, 4.958] | 0.382 | [-5.062, 5.827] |
| | (2.653) | | (2.778) | |
| Education | 1.856 | [-0.500, 4.212] | 2.536** | [0.163, 4.910] |
| | (1.202) | | (1.211) | |
| Log Income | 1.602* | [-0.106, 3.311] | 1.414 | [-0.328, 3.156] |
| | (0.872) | | (0.889) | |
| Discomfort | -1.284* | [-2.621, 0.053] | – | – |
| | (0.682) | | | |
| $\text{Scope}_{ij}$ × Discomfort | -1.006** | [-1.779, -0.233] | – | – |
| | (0.394) | | | |
| Prior VR Experience | – | – | -1.086 | [-5.389, 3.216] |
| | | | (2.195) | |
| $\text{Scope}_{ij}$ × Prior VR Experience | – | – | -0.509 | [-5.064, 4.046] |

(2.324)

Notes: **Dependent variable is unconditional WTP in £.** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Scope coefficient shows the average marginal effect of increasing conservation from 20% to 50% across all participants, not conditioned on specific moderator values. For discomfort, conditional AME of scope for those with lowest (0) and highest discomfort (5) are 6.760 ($p < 0.01$) and 1.731 ($p > 0.05$) respectively. For prior VR experience, conditional AME of scope for those with no and prior experience are 5.379 ($p < 0.01$) and 4.870 ($p < 0.01$) respectively. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Results are presented in Table 9, Model A. The analysis revealed that discomfort moderated scope sensitivity. A one-unit increase in discomfort was associated with a £1.01 reduction in WTP for a larger conservation area. Figure 6 illustrates this relationship. Participants experiencing no discomfort (0) were willing to pay £6.76 more (95% CI: [3.76, 9.76], $p < 0.01$) for a larger conservation area. However, this sensitivity systematically decrease with increasing discomfort, falling to £1.73 (95% CI: [-0.37, 3.83], $p > 0.05$) at maximum discomfort, corresponding to scope elasticities declining from 0.663 to 0.354. This suggests that discomfort progressively impeded participants' ability to value differences in conservation scale. Notably, prior VR experience did not moderate scope sensitivity, indicating the effects reflect fundamental characteristics of the medium rather than novelty effects.

Figure 6: Marginal Plot of Discomfort on Scope Sensitivity




Note: Values here represent the change in WTP for a larger conservation area, conditional on different discomfort level. For instance, conditional on having no discomfort (0), participants increases their WTP by £6.760 for a bigger conservation area.

# 5 Discussion and Conclusion

## 5.1 Equivalence of VR and Video

This study demonstrated that both formats achieve equivalent scope sensitivity for Amazon rainforest conservation programmes. Observed scope elasticities were 0.576 for video and 0.588 for VR, not a statistically significant difference ($p > 0.05$). Both fall within the empirically plausible range of 0.15–0.88 identified by Whitehead (2016), indicating that well-designed visual presentations can elicit valid scope sensitivity. Sensitivity also remained consistent across payment contexts, with comparable elasticities for real and hypothetical donations in VR (0.584 and 0.616, respectively) and video (0.528 and 0.639, respectively). This equivalence provides an important benchmark for understanding where immersive technologies add value in valuation contexts. Critically, both enhanced visual presentations successfully elicited scope-sensitive valuations for a remote ecosystem dominated by non-use values, demonstrating that visual technologies can overcome traditional scope insensitivity challenges for such goods.

For most stated preference applications, video is sufficient. High-quality video appears adequate for Amazon rainforest valuation and could extend to other ecosystems, offering substantial advantages in cost, accessibility, and ease of implementation. For researchers conducting multi-country studies, online surveys, or valuations with limited resources, video represents an effective approach capable of producing valid scope-sensitive valuations without VR's equipment costs, technical demands, or logistical constraints. VR remains valuable when research specifically investigates immersion's role in valuation contexts – such as testing whether VR mitigates known biases like hypothetical bias or distance decay – or when examining the psychological mechanisms of presence and engagement in immersive environments.

The equivalence between video and VR raises the fundamental question of why VR did not outperform video despite its higher presence, perceived survey realism, and emotional engagement. Several explanations merit consideration. First, effective visual communication of environmental scale may be sufficient for scope sensitivity, rendering VR's additional immersion unnecessary. The video condition, although less immersive, presented identical environmental content and spatial cues as VR, which appears sufficient for participants to meaningfully differentiate between protecting 20% and 50% of the Amazon. Once participants can clearly visualise scale differences, additional sensory immersion may not further enhance their ability to distinguish conservation areas. This suggests a task-specific threshold effect where video provides sufficient visual information for scope differentiation.

Second, medium familiarity may play a crucial role. Video is a familiar, passive format that promotes easy information processing for most participants. VR, as a relatively novel technology, requires active attention and navigation, imposing cognitive demands that may offset its advantages in presence and realism. This cognitive load could divert mental resources away from valuation tasks. Notably, prior VR experience did not moderate scope sensitivity, suggesting that the issue lies in fundamental processing demands rather than novelty effects.

Third, breaks in presence may influence how participants experience VR, suggesting that the effectiveness of immersive technology depends on multi-sensory coherence and realistic scenario design. When visual immersion suggests a rainforest environment, but other senses receive contradictory inputs – feeling room temperature instead of tropical heat, or hearing ambient room sounds – these sensory mismatches create cognitive dissonance that disrupts psychological immersion (Slater & Steed, 2000; Kim & Lee, 2022). The finding that low perceived survey realism significantly reduces scope sensitivity within VR supports this. VR creates expectations of multi-sensory coherence that, when unmet, may undermine participants' engagement with conservation scenarios. Video, by contrast, does not promise full immersion and therefore avoids creating expectations it cannot fulfill. These 'breaks in presence' effects may explain the equivalence between formats despite VR's higher immersion.

## 5.2 Exploratory Insights for VR Implementation

While video is recommended for most environmental valuation applications, researchers may still choose VR for specific purposes, such as investigating immersion mechanisms, testing VR-specific hypotheses about bias mitigation, or leveraging VR's novelty for participant engagement. Given VR's increasing adoption in environmental research, understanding the factors that influence its effectiveness remains practically valuable. For these purposes, exploratory analyses within the VR condition offer insights into moderators of scope sensitivity and inform practical implementation decisions. Emotional variations within VR were not significantly associated with donation amounts, nor did they moderate scope sensitivity, aligning with Martingano et al. (2023), who found 360° VR experiences did not yield greater donations than traditional media formats. The lack of a relationship between emotional engagement and scope sensitivity suggests that cognitive factors, such as spatial comprehension, may be more important than affective responses for distinguishing between conservation scales.

In contrast, perceived realism and presence significantly moderated scope sensitivity within VR. Higher realism is associated with stronger scope effects, while at low realism levels, sensory mismatches may create cognitive dissonance. Similarly, higher presence is associated with greater scope elasticity, extending past research identifying presence as a pathway for VR's influence on pro-environmental behaviour (Ahn, Bailenson & Park, 2014). Stronger feelings of 'being there' may have helped participants develop intuitive understanding of conservation scale differences. Conversely, participant discomfort significantly moderated scope sensitivity. VR-induced simulator sickness appears to divert cognitive resources from scope differentiation, aligning with findings that VR discomfort fundamentally alters valuation responses (Fang et al., 2020; Chang, Kim & Yoo, 2020). For researchers implementing VR, attention to presence, realism, and comfort may be important, though the causal nature of these relationships remains to be established.

## 5.3 Limitations and Future Directions

Several limitations of this study should be acknowledged. The predominantly student sample may limit generalisability (Hanel & Vione, 2016), with higher technological literacy potentially inflating VR acceptance. Policymakers applying findings to population-level valuation should replicate the study with demographically representative samples. Second, while the perceived survey realism measure likely reflects how realistic the forest environment appeared rather than whether participants perceived the payment scenario as consequential, the specific contributing factors cannot be isolated. Third, using two conservation levels suffices for scope sensitivity testing but limits characterising the full functional relationship between scope and WTP.

Future research should incorporate multiple conservation levels to better characterise non-linearities in the scope-WTP relationship and test whether video-based approaches generalise to other remote ecosystems where non-use values dominate. Future studies should also directly test the mechanisms identified in this study through experimental manipulations of presence and realism across formats, and disentangle why video achieves parity despite lower presence through process-tracing methods such as eye-tracking or think-aloud protocols to examine how participants form valuations. In conclusion, this study demonstrates that video technology is sufficient to generate scope-sensitive environmental valuations, achieving performance equivalent to VR at substantially lower cost and complexity. For most environmental valuation contexts, video represents the recommended approach due to its practical advantages while achieving equivalent validity. VR remains valuable for specific research contexts where immersion is theoretically central or implementation can be optimised.

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## 5.5 Pre-registration

This study was pre-registered at the Open Science Framework and is accessible via **https://osf.io/8fj3d**.

## 5.6 Data Availability

Data and replication code will be made publicly available upon completion of a companion study examining hypothetical bias (expected in 2026). In the interim, anonymised data are available from the corresponding author upon reasonable request to support replication and verification of the results reported in this paper.

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# 7 Supplementary Materials

## 7.1 Survey Instruments

The survey instrument provided below corresponds to participants assigned to the VR treatment with real monetary donation condition. Seven additional versions were created with the following systematic variations:

- **Medium treatment:** Video group participants viewed the same content on a screen rather than in VR during the valuation scenario section
- **Conservation framing:** The order of 20% vs. 50% conservation scenarios was counterbalanced across participants
- **Payment condition:** Hypothetical donation groups received identical questions but without actual monetary payment

All other survey elements (demographics, environmental attitudes, presence measures, and post-experience questions) remained identical across all versions.

### 7.1.1 Example Survey: VR Treatment, Real Donation Condition

**Consent Section**

Dear participant,

Thank you for your interest in this experiment about understanding the impact of visual experiences on individual preferences for rainforest conservation. Please read the following information carefully.

This study will investigate how different visual experiences influence individual economic preferences for environmental goods, such as rainforest conservation. We will ask you questions about your familiarity with rainforest conservation programmes, your participation in environmental programmes, and your attitudes towards such programmes.

**In this experiment, you may also have the opportunity to make a voluntary donation towards the World Wildlife Fund for Nature's (WWF) overall conservation efforts, which also contribute to their rainforest conservation programmes.**

Participation in the survey and donation is **voluntary**, and you may withdraw consent at any time during the experiment. There are no negative consequences for you if you decide not to take part in this experiment. You may select a "Prefer not to answer" option for any questions you are uncomfortable with.

Your participation will remain anonymous, and your personal information will not be shared or used in any reports or publications resulting from the study. Collected data will be aggregated and use to fulfill the requirements of a PhD and may be used for future academic publications. Before agreeing, please also read the below information.

By agreeing to take part in this survey, you confirm that:

(a) You are 18 years or older;
(b) You have read the above information and had the opportunity to ask questions;
(c) You agree to participate in the experiment voluntarily;
(d) You understand that your responses will be kept confidential and anonymous, and that your personal information will be kept securely and destroyed at the end of the study;
(e) You do not have any neurological or psychiatric conditions that may affect your participation in the visual experiences;
(f) You are currently not on medications that may produce adverse reactions upon exposure to visual experiences.

If you have any questions regarding this study please contact the researcher, [redacted] from Department of Geography and Environment on [redacted] If you have any concerns or complaints regarding the conduct of this research, please contact the LSE Research Governance Manager via [redacted]

The LSE Research Privacy Policy can be found here:
https://info.lse.ac.uk/staff/divisions/Secretarys-Division/Assets/Documents/Information-Records-Management/Privacy-Notice-for-Research-v1.2.pdf

Do you agree to participation given above conditions?

- ○ Yes, I have read the information above and agree to take part in this experiment.
- ○ No, I do not agree to participate in this experiment.

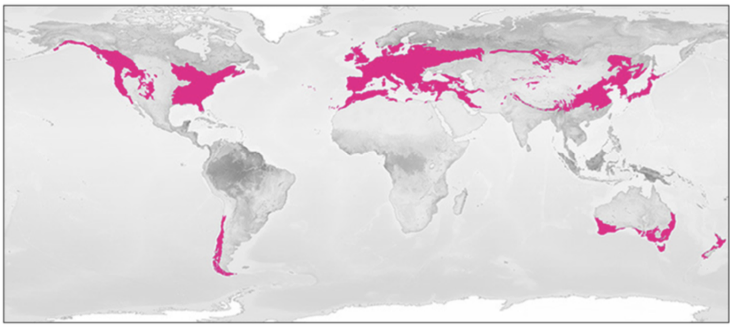
The researcher will now help you get set up for your session. This standardised setup process is part of our protocol for all participants. Don't hesitate to ask questions if you need clarification at any point.

**Attitudinal Section**

In this section, we will ask about your views and any previous experience that you may have regarding rainforest conservation, which is the focus of this survey.

How concerned are you about the current state of **temperate forests** worldwide? These forests are located in Eastern and Western United States, Chile, Argentina, Canada, Europe, China, Southern Australia and Japan (as shown below in pink).

**Location of temperate forests**



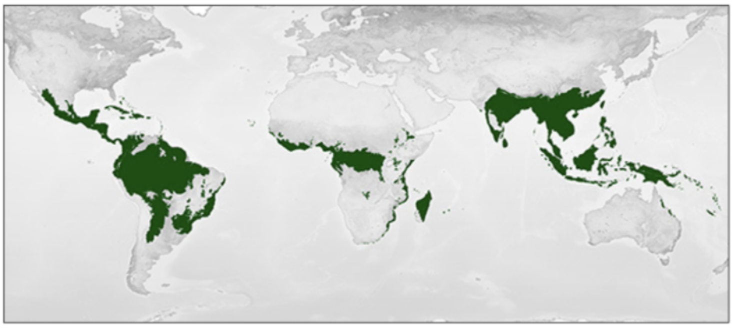
Source: NASA

**Temperate forests**

| | Not concern at all | | | | | Extremely concern | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Level of concern | | | | | | | | |

How concerned are you about the current state of **tropical rainforests** worldwide? These forests are located in South and Central America, Central Africa and South East Asia (as shown below).

**Location of tropical rainforests**



Source: NASA

**Tropical rainforests**

| | Not concern at all | | | | | Extremely concern | |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Level of concern | | | | | | | | |

Have you visited any **temperate forests** in the past year? This might have been during a vacation, a business trip, or a school excursion.

- ◯ Yes
- ◯ No

Have you visited **any tropical rainforests** in the past year? This might have been during a vacation, a business trip, or a school excursion.

- ◯ Yes
- ◯ No

**Knowledge Section**

Do you know about any projects or efforts, like campaigns or organisations, that are working to protect **forests**?

- ○ Yes
- ○ No
- ○ Not sure

What do you think are the main reasons **forests** are being destroyed? (Select all that apply)

- ☐ Building roads and cities
- ☐ Programmes that protect the forest (conservation)
- ☐ Farming
- ☐ Forest fires
- ☐ Cutting down trees for wood (logging)

What do you think are some important roles of **forests**? (Select all that apply)

- ☐ Producing oxygen
- ☐ Absorbing carbon
- ☐ Protecting wildlife
- ☐ Help to regulate the climate
- ☐ Producing plastic

What do you think are some common ways to protect **forests**? (Select all that apply)

- ☐ Eco-friendly tourism
- ☐ Creating protected areas
- ☐ Building roads and cities in forests
- ☐ Sustainable logging
- ☐ Teaching people about forests

What do you think are the types of wildlife commonly found in forests? (Select all that apply)

- ☐ Birds (e.g. eagles, owls)
- ☐ Penguins
- ☐ Insects
- ☐ Reptiles (e.g. snakes, lizards)
- ☐ Mammals (e.g. deer, monkeys)

**Behavioural Section**

How frequently do you come across environmental news through various media channels?

| | Never 0 | 1 | 2 | 3 | 4 | 5 | 6 | Everyday 7 |
|---|---|---|---|---|---|---|---|---|
| Level of frequency | | | | | | | | |

Within the past year, have you come across any news or information related to forests?

- ○ Yes
- ○ No
- ○ Not sure

Within the past year, have you encountered any news or information about the destruction or decline of forests?

- Yes
- No
- Not sure

Within the past year, have you participated in any activities or initiatives related to protecting the environment? (e.g. recycling, composting, turning off electrical appliances when not in use, or reducing plastic consumption)

- Yes
- No

Within the past year, have you contributed to any forest conservation programmes? (e.g. volunteering, donating, attending events or raising awareness)

- Yes
- No

Within the past year, have you done any activities in a forest? This could include activities like walking, trekking, hiking, or foraging.

- Yes
- No

Are you currently a member or donor of any environmental organisations, such as WWF, Greenpeace International, or Climate Action Network?

- Yes
- No

**Valuation Section**

## Instructions for VR Experiment with Meta-Quest 3

Next, you will use the Meta-Quest 3 VR headset to explore a 360-degree virtual experience of the Amazon rainforest. Before beginning, please carefully read the following details about the donation process.

### Donation Process Overview:

During this experiment, we will ask you **twice** about your willingness to donate to the World Wildlife Fund (WWF) for **two** different rainforest conservation programmes. While the programmes you'll see are part of the experiment, your donation will support WWF's overall conservation efforts. This includes crucial work like combating deforestation, protecting rainforests and rivers, and restoring habitats around the world.

### Important Information:

- **Voluntary Participation**:
  **Donations are entirely voluntary.** Your choice to donate or not will not affect your participation or payment. You will still receive full compensation for your time, regardless of your decision.
- **Random Selection of Donation**:
  You will be asked to indicate a donation amount for each of the two conservation programmes. Only one of these amounts will be randomly selected to determine the actual donation. For example, if you choose to donate £4 to the first programme and £5 to the second, either amount may be randomly chosen as the binding donation. **This means that you will be required to fulfill that donation amount.**
- **How Donations Work**:
  The donation amount will be randomly selected at the end of the survey, for which you will be directed to a link where you can complete the donation. This donation will be sent directly to WWF. In case you run into any difficulty with the payment process, a researcher will be available to assist you after the experiment.

Please remember:

- Donations are **entirely voluntary**. There are **no penalties** if you choose not to donate.
- If you decide to donate, the final amount will be determined randomly, and **you will be required to fulfill that donation.**

You may now put on the Meta-Quest 3 VR headset.
**Please make sure to select Group 2 & 4 in the VR headset before beginning your experience.**

Please proceed with the remainder of the survey.

Please remember that the donation is **entirely voluntary**. However, if you choose to donate, you will be required to fulfil the amount, which will be randomly selected as described earlier.

**Research suggests that people sometimes overestimate their willingness to pay in such surveys. Please consider carefully how much you are truly willing to donate, even if only one amount will be binding, both donation amount should represent your true willingness to contribute. Keep in mind that this will reduce the amount of disposable income you have after the experiment.**

What is the maximum amount you are willing to donate, as a **one-time lump sum (in GBP £)**, to WWF for the **first** conservation programme? Please note that your real donation will support WWF's overall conservation efforts, including initiatives similar to the one described in the first programme.

**FIRST Programme**


**Conservation area: 20% of rainforest**
**(aerial view of Amazon rainforest)**

- 0
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 12
- 15
- 20
- 25
- 30
- More than 30; please specify below:

How sure are you of the choice you just made?

| | Not certain at all | | | | | | | | | Extremely certain | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Level of certainty | | | | | | | | | | | |

What are the reasons behind your choice? (Select all that apply)

- [ ] I think the problem of deforestation and forest degradation is urgent and important to mitigate it now
- [ ] Tropical rainforests should be protected for future generations
- [ ] I simply like that idea of tropical rainforests existing
- [ ] I will not really have to pay the amount
- [ ] Rainforests hold untapped potential as sources of new medicines and other unknown benefits which might be useful for us in the future
- [ ] Other reasons

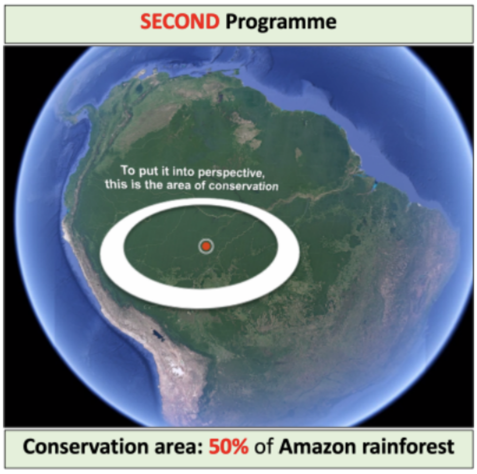
What are the reasons behind your choice? (Select all that apply)

- [ ] I did not understand the question
- [ ] I cannot afford to pay
- [ ] I do not believe in WWF in using my donation wisely
- [ ] I have other needs for which the money can be used for
- [ ] I am not particularly worried about tropical rainforests
- [ ] Other reasons

Please remember that the donation is **entirely voluntary**. However, if you choose to donate, you will be required to fulfil the amount, which will be randomly selected as described earlier.

**Research suggests that people sometimes overestimate their willingness to pay in such surveys. Please consider carefully how much you are truly willing to donate, even if only one amount will be binding, both donation amount should represent your true willingness to contribute. Keep in mind that this will reduce the amount of disposable income you have after the experiment.**

**Instead of the first conservation programme**, what is the maximum amount you are willing to donate, as a **one-time lump sum (in GBP £)**, to WWF for the **second** conservation programme? Please note that your real donation will support WWF's overall conservation efforts, including initiatives similar to the one described in the second programme.




- ○ 0
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 12
- ○ 15

- 20
- 25
- 30
- More than 30; please specify below:

How sure are you of the choice you just made?

| | Not certain at all | | | | | | | | | Extremely certain |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Level of certainty | | | | | | | | | | |

What are the reasons behind your choice? (Select all that apply)

- I think the problem of deforestation and forest degradation is urgent and important to mitigate it now
- Tropical rainforests should be protected for future generations
- I simply like that idea of tropical rainforests existing
- I will not really have to pay the amount
- Rainforests hold untapped potential as sources of new medicines and other unknown benefits which might be useful for us in the future
- Other reasons

What are the reasons behind your choice? (Select all that apply)

- I did not understand the question
- I cannot afford to pay
- I do not believe in WWF in using my donation wisely
- I have other needs for which the money can be used for
- I am not particularly worried about tropical rainforests
- Other reasons

The Intergovernmental Panel on Climate Change (IPCC) reports that over 420 million hectares of forest (around 13 times the size of England) were lost worldwide between 1990 and 2020 due to deforestation, with more than 90% of this loss occurring in tropical regions. How important is it to you that we prevent further deforestation?

| | Not important at all | | | | | | | Extremely important |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Level of importance | | | | | | | | |

**VR Debrief Questions**

Prior to today, have you had any experience with virtual reality/ virtual environment?

- Yes
- No

To what extent does your previous experience resemble what you just experienced?

| | Not at all | | | | | | | Extremely identical |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Level of resemblance | | | | | | | |

How would you rate your overall experience in the virtual environment?

| | Not at all 0 | 1 | 2 | 3 | 4 | 5 | 6 Extremely strong 7 |
|---|---|---|---|---|---|---|---|
| Feeling of 'being there' in the rainforest | | | | | | | |
| Feeling emotionally moved by the VR experience | | | | | | | |
| Feeling of disorientation | | | | | | | |
| Feeling of general discomfort | | | | | | | |
| Feeling of nausea | | | | | | | |

**Demographics Section**

We are reaching the end of the survey! Hang in there!

Which of the following best describes your gender?

- Man
- Woman
- Non-binary
- My gender is not listed
- Prefer not to say

Which age band do you fit in?

- Under 18
- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- 65 - 74
- 75 or older

What is your marital status?

- Married
- Widowed
- Divorced
- Separated
- Never married

Do you have children? Please only consider children to whom you are the legal guardian.

- Yes
- No

What is the highest level of formal education you have attained or currently pursuing?

- No formal education
- Some Primary
- Completed Primary School
- Some Secondary
- Completed Secondary School
- Vocational or similar
- Some University but no degree
- University Bachelors Degree
- Graduate or Professional Degree (MA, MSc, MBA, PhD, JD, MD, DDS)
- Prefer not to say

What is your current employment status?

- Employed - Full time
- Employed - Part time
- Homemaker
- Unemployed
- Retired
- Student
- Prefer not to say

Could you please indicate your monthly income after taxes? **Please note that the responses collected here will be strictly confidential and anonymous.**

- I have no income
- £1 - £200
- £201 - £500
- £501 - £700
- £701 - £1,000
- £1,001 - £1,200
- £1,201 - £1,400
- £1,401 - £1,600
- £1,601 - £1,900
- £1,901 - £2,300
- £2,301 - £3,400
- £3,401 - £4,500
- £4,501 - £7,000
- More than £7,001
- Prefer not to say

What is your monthly allowance from all sources (e.g. parents, part-time work, etc.)?

- Less than £100
- £100 - £200
- £201 - £300
- £301 - £400
- £401 - £500
- £501 - £600
- £601 - £700

- £701 - £800
- £801 - £900
- £901 - £1,000
- £1,001 - £1,100
- £1,101 - £1,200
- £1,201 - £1,300
- £1,301 - £1,400
- £1,401 - £1,500
- More than £1,500

Which of these ethnic groups do you most closely identify with?

- Asian or Asian British
- Black, Black British, Caribbean or African
- Mixed or multiple ethnic groups
- White
- Other ethnic group
- Prefer not to say

How do you find the overall survey?

| | Definitely no | | | | | | Definitely yes |
|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 7 |
| Is it realistic? | | | | | | | |
| Is the survey easy to understand? | | | | | | | |
| Is the survey too long? | | | | | | | |
| Is it interesting? | | | | | | | |
| After the initial VR experience, the format of the rest of the study matched my expectations. | | | | | | | |

**Donation Results**

Please enter your **LSE Sona ID** below to ensure you receive your Amazon vouchers.
The vouchers will sent via e-mail to you over the next few days upon completion of the survey.

You will now be presented with the random draw results of your indicated donation amount.

You have selected to donate £${q://QID28/ChoiceGroup/SelectedChoicesTextEntry} for the first programme, and £${q://QID86/ChoiceGroup/SelectedChoicesTextEntry} for the second programme.

Your random draw result for your final donation amount is: £${e://Field/Selected_WTP}

**Donation amount to be paid today**: £${e://Field/Donation_Amount}

**Your LSE Sona ID: ${q://QID115/ChoiceTextEntryValue}**
**Donation amount to be paid today: £${e://Field/Donation_Amount}**
**Please proceed to make your donation via this LINK or from the QR code below.**

An instruction sheet is provided next to the laptop on how to proceed with the donation. If you run into any issue, please approach the researcher located outside the room for assistance.

## 7.2 Standardised Script

The following script was strictly followed by the researcher throughout the data collection period. In the event that participants faced issues, such as not being able to see the VR environment clearly, the researcher performed the necessary troubleshooting while keeping verbal interactions to a minimum.

**Researcher:** Hello there, are you here for the Amazon rainforest study? Can I get your LSE SONA ID please?

*[Participant provides ID]*

**Researcher:** Thank you very much. Please follow me this way.

*[Participant sits down and settles in]*

**Researcher:** I would now like you to read through the consent form and I will be back with you shortly.

*[Participant agrees to consent form and proceeds to the first question which asks them to wait for the researcher to be back]*

**Researcher:** Now I'll help you get set up with the equipment. Everyone starts with the headset for the initial phase of the study.

*[Participant puts on VR headset]*

**Researcher:** Can you see clearly? Is everything comfortable? The experience will begin shortly.

*[Participant says okay or agrees]*

**Researcher:** You should be seeing Alhambra now. To select an item, press the right click button on the right controller. To reset, simply press and hold your right thumb on the Meta button for 3 seconds before releasing it. All I need you to do now is to explore the environment, swirl around the chair and look around. I will be back with you in 2 minutes.

*[After 2 minutes, researcher comes back and remove headset]*

**Researcher:** Okay for the remaining part of the experiment, you can follow the instructions from the iPad. You may or may not be required to put on the headset again, but if you do, I will come in and help you set up.

*[The below script applies to VR group only]*

*[Participant reaches the valuation scenario portion]*

**Researcher:** As mentioned, I'll now help you with the equipment for this part of the study.

*[Assist with VR headset]*

**Researcher:** Can you see clearly? Is everything comfortable? Good. The experience will begin shortly.

*[VR Amazon Rainforest experience starts]*

**Researcher:** You should now see the environment. To interact, use the right trigger button on the controller. If you need to reset your view, press and hold the home button for 3 seconds. Feel free to look around in all directions - you can turn in your chair to explore. The system will indicate when this section is complete, then you can remove the headset and continue with the survey.

## 7.3 Independent Variables and Indices

Prior to conducting the regression analysis, multiple preregistered indices for examining the primary hypotheses were used. The table below presents how these key measures were constructed, along with the other independent variables incorporated into the main regression model.

Table 10: Description of Independent Variables

| Variable | Description | N or Mean | % or S.D. |
|---|---|---|---|
| VR | Dummy variable = 1 if VR, = 0 if video | - | - |
| Scope | Dummy variable = 1 if 50% conservation area, = 0 if 20% conservation area | - | - |
| Donation | Dummy variable = 1 if real donation, = 0 if hypothetical | - | - |
| VR x Scope | Interaction term between VR and Scope | | |
| Environmental Concern | Mean score for the questions "concern for tropical rainforest" and "concern for temperate forest", rated on Likert scale of 1-7. | 5.02 | 1.25 |
| Environmental Behaviour | Sum of 'yes' responses to 5 questions about forest-related experiences including environmental news exposure, conservation participation, donations, forest activities, and environmental organisation membership. Range: 0-5 points. | 2.68 | 0.99 |
| Environmental Knowledge | Sum of correct answers to 5 environmental knowledge questions covering rainforest protection projects, causes of deforestation, forest functions, conservation methods, and forest wildlife. Range: 0-5 points. | 3.14 | 1.20 |
| Male | Dummy variable = 1 if male, = 0 if female | 77 | 31.3% |
| Educ | Ordinal variable for education level: 1 = No degree, 2 = Bachelors degree, 3 = Graduate/ Professional Degree | 2.48 | 0.68 |
| Logincome | Natural log of total monthly income or allowance using midpoint values of income categories | 6.48 | 1.18 |

## 7.4 Two-Part Model of WTP (Probit and GLM Estimates)

The first-stage probit estimates the likelihood of a positive WTP (participation decision), while the second-stage GLM models the conditional WTP amount (payment decision).

Table 11: Regression Coefficients - Model 1

| | | | 95% Normal-based CI | |
|---|---|---|---|---|
| Variables | Probit | GLM | Probit | GLM |
| Intercept | -1.854** | 0.762 | [-3.294,-0.414] | [-0.121,1.646] |
| | (0.735) | (0.451) | | |
| $\text{Scope}_{ij}$ | 0.213*** | 0.459*** | [0.059,0.367] | [0.350,0.568] |
| | (0.079) | (0.056) | | |
| $\text{VR}_i$ | 0.189 | 0.111 | [-0.193,0.572] | [-0.112,0.334] |
| | (0.195) | (0.114) | | |
| $\text{Donation}_i$ | -1.143*** | -1.297*** | [-1.608,-0.678] | [-1.546,-1.049] |
| | (0.237) | (0.127) | | |
| Environmental Concern | 0.164** | 0.049 | [0.008,0.321] | [-0.069,0.168] |
| | (0.080) | (0.060) | | |
| Environmental Knowledge | 0.175* | 0.057 | [-0.008,0.358] | [-0.057,0.171] |
| | (0.093) | (0.058) | | |
| Environmental Behaviour | 0.081 | -0.005 | [-0.131,0.294] | [-0.171,0.161] |
| | (0.108) | (0.085) | | |
| Male | -0.318 | -0.028 | [-0.742,0.107] | [-0.353,0.298] |
| | (0.217) | (0.166) | | |
| Education | 0.038 | 0.197** | [-0.238,0.315] | [0.038,0.356] |
| | (0.141) | (0.081) | | |
| Log Income | 0.219*** | 0.133** | [0.061,0.377] | [0.016,0.251] |
| | (0.081) | (0.060) | | |
| Observations | 462 | | — | |
| AIC | 2734.664 | | — | |
| BIC | 2817.375 | | — | |
| Wald chi2(9) | 37.67 | | — | |
| Prob > chi2 | 0.000 | | — | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); second stage models WTP amount in £ (conditional on WTP > 0).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. N = 492 - 30 = 462, with 30 having prefer not to report their income level. For interpretation, scope coefficient (0.213) indicates that higher conservation scope increases the probability of positive WTP. For GLM stage, scope coefficient (0.459) shows that higher conservation scope increases WTP amounts among participants willing to pay.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 12: Regression Coefficients - Model 2

| | | | 95% Normal-based CI | |
|---|---|---|---|---|
| Variables | Probit | GLM | Probit | GLM |
| Intercept | -1.845** | 0.766 | [-3.286,-0.405] | [-0.127,1.660] |
| | (0.735) | (0.456) | | |
| $\text{Scope}_{ij}$ | 0.194** | 0.451*** | [0.011,0.376] | [0.299,0.602] |
| | (0.093) | (0.077) | | |
| $\text{VR}_i$ | 0.172 | 0.103 | [-0.229,0.572] | [-0.135,0.341] |
| | (0.204) | (0.121) | | |
| $\text{VR}_i \times \text{Scope}_{ij}$ | 0.037 | 0.016 | [-0.264,0.339] | [-0.194,0.226] |
| | (0.154) | (0.107) | | |
| $\text{Donation}_i$ | -1.143*** | -1.297*** | [-1.609,-0.677] | [-1.546,-1.049] |
| | (0.238) | (0.127) | | |
| Environmental Concern | 0.164** | 0.049 | [0.008,0.321] | [-0.069,0.168] |
| | (0.080) | (0.060) | | |
| Environmental Knowledge | 0.175* | 0.057 | [-0.008,0.358] | [-0.057,0.171] |
| | (0.093) | (0.058) | | |
| Environmental Behaviour | 0.081 | -0.005 | [-0.131,0.294] | [-0.171,0.161] |
| | (0.108) | (0.085) | | |
| Male | -0.318 | -0.027 | [-0.743,0.107] | [-0.353,0.298] |
| | (0.217) | (0.166) | | |
| Education | 0.038 | 0.197** | [-0.238,0.315] | [0.038,0.356] |
| | (0.141) | (0.081) | | |
| Log Income | 0.219*** | 0.133** | [0.061,0.377] | [0.016,0.251] |
| | (0.081) | (0.060) | | |
| Observations | 462 | | — | |
| AIC | 2738.64 | | — | |
| BIC | 2829.623 | | — | |
| Wald chi2(10) | 37.71 | | — | |
| Prob > chi2 | 0.000 | | — | |

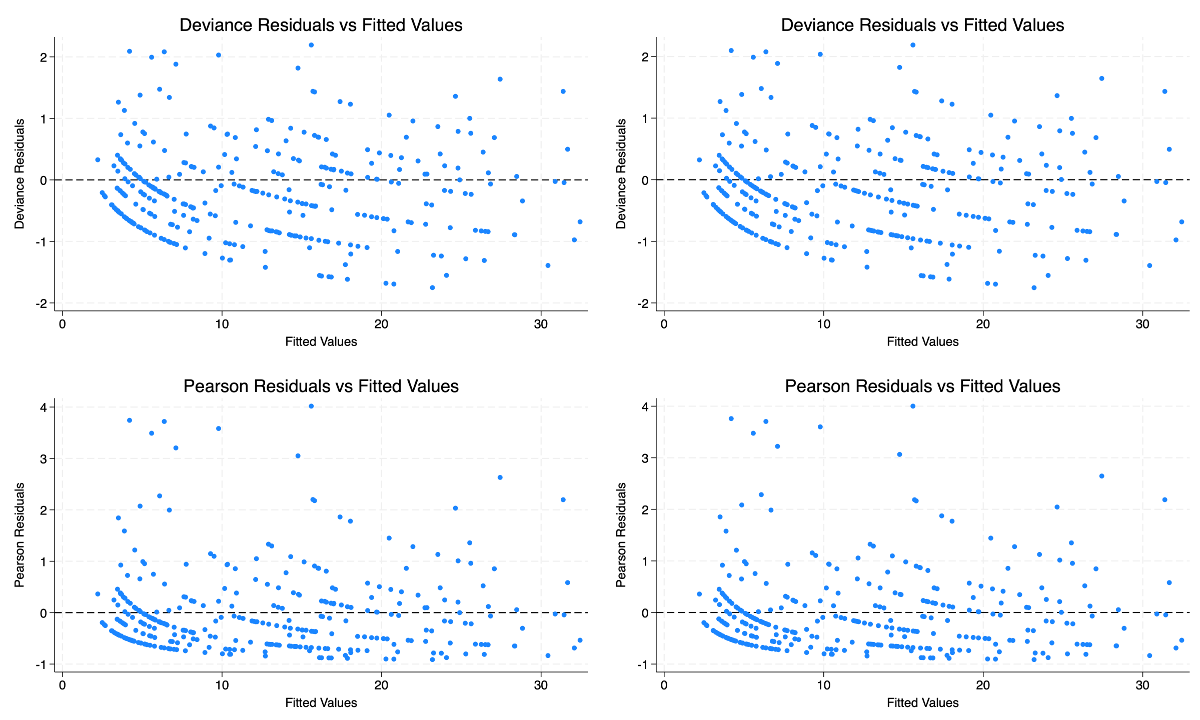
Notes: **Dependent variables: First stage models whether WTP > 0 (binary); second stage models WTP amount in £ (conditional on WTP > 0).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. N is 492 - 30 = 462, with 30 having prefer not to report their income level. For interpretation, scope coefficient (0.194) indicates that higher conservation scope increases the probability of positive WTP. For GLM stage, scope coefficient (0.451) shows that higher conservation scope increases WTP amounts among participants willing to pay.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

## 7.5 Robustness Checks

Several diagnostic tests and alternative specifications were employed to validate the results. First, the independence assumption required for the two-part model was assessed by examining correlations between the first- and second-part residuals. The correlation coefficients of 0.029 ($p = 0.589$) and 0.029 ($p = 0.591$) for Model 1 and 2 used in the main hypotheses indicate that there is no significant relationship between participation and amount decisions, supporting the use of a two-part model. Subsequently, the link tests assessed the functional form adequacy for both model components. In Model 1, the squared linear predictor terms were non-significant for both the probit first part ($p = 0.280$) and Gamma GLM second part ($p = 0.848$), indicating no evidence of misspecification. Parallel results were also found in Model 2 where the predictor terms were both non-significant, with $p = 0.276$ for probit model and $p = 0.858$ for Gamma GLM. Additionally, residual diagnostics for the Gamma GLM showed appropriate centering around zero with no severe violations of model assumptions.

Figure 7: Residual Diagnostics - Model 1 (left) and Model 2 (right)




Alternative specifications were tested to ensure the robustness of the results. The first-part estimates remained stable when using logit instead of probit, with marginal effects having minimal differences across all covariates for both Model 1 and 2. For the second part, Gamma GLM was compared against Gaussian GLM and OLS on log-transformed WTP. Main findings remained stable across all specifications, with consistent signs and significance levels for key variables.

Table 13: Robustness Check - Probit vs Logit (Regression Coefficients)

| Variables | Model 1 | | | |
|---|---|---|---|---|
| | Probit | | Logit | |
| | Coefficient | 95% CI | Coefficient | 95% CI |
| Intercept | -1.854** | [-3.294, -0.414] | -3.195*** | [-5.608, -0.782] |
| | (0.735) | | (1.231) | |
| $\text{Scope}_{ij}$ | 0.213*** | [0.059, 0.367] | 0.368*** | [0.100, 0.636] |
| | (0.079) | | (0.137) | |
| $\text{VR}_i$ | 0.189 | [-0.193, 0.572] | 0.363 | [-0.300, 1.026] |
| | (0.195) | | (0.338) | |
| $\text{Donation}_{ij}$ | -1.143*** | [-1.608, -0.678] | -2.009*** | [-2.847, -1.172] |
| | (0.237) | | (0.427) | |
| Environmental Concern | 0.164** | [0.008, 0.321] | 0.269** | [0.002, 0.536] |
| | (0.080) | | (0.136) | |
| Environmental Knowledge | 0.175* | [-0.008, 0.358] | 0.314** | [0.002, 0.627] |
| | (0.093) | | (0.160) | |
| Environmental Behaviour | 0.081 | [-0.131, 0.294] | 0.135 | [-0.245, 0.514] |
| | (0.108) | | (0.193) | |
| Male | -0.318 | [-0.742, 0.107] | -0.531 | [-1.293, 0.232] |
| | (0.217) | | (0.389) | |
| Education | 0.038 | [-0.238, 0.315] | 0.061 | [-0.428, 0.549] |
| | (0.141) | | (0.249) | |
| Log Income | 0.219*** | [0.061, 0.377] | 0.386*** | [0.110, 0.661] |
| | (0.081) | | (0.141) | |
| Observations | 462 | | 462 | |
| AIC/BIC | 452.144/493.500 | | 451.422/492.777 | |

Notes: **Dependent variable is whether WTP > 0 (binary).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 14: Robustness Check - Probit vs Logit (Average Marginal Effects)

| Variables | Model 1 | | | |
|---|---|---|---|---|
| | Probit | | Logit | |
| | Coefficient | 95% CI | Coefficient | 95% CI |
| $\text{Scope}_{ij}$ | 0.056*** | [0.018, 0.094] | 0.056*** | [0.018, 0.094] |
| | (0.019) | | (0.019) | |
| $\text{VR}_i$ | 0.050 | [-0.044, 0.144] | 0.055 | [-0.039, 0.149] |
| | (0.048) | | (0.048) | |
| $\text{Donation}_i$ | -0.301*** | [-0.395, -0.208] | -0.307*** | [-0.402, -0.211] |
| | (0.048) | | (0.049) | |
| Environmental Concern | 0.043** | [0.006, 0.081] | 0.041** | [0.004, 0.078] |
| | (0.019) | | (0.019) | |
| Environmental Knowledge | 0.046** | [0.003, 0.090] | 0.048** | [0.005, 0.091] |
| | (0.022) | | (0.022) | |
| Environmental Behaviour | 0.021 | [-0.033, 0.076] | 0.021 | [-0.035, 0.076] |
| | (0.028) | | (0.028) | |
| Male | -0.084 | [-0.195, 0.028] | -0.081 | [-0.196, 0.034] |
| | (0.057) | | (0.059) | |
| Education | 0.010 | [-0.060, 0.080] | 0.009 | [-0.061, 0.080] |
| | (0.036) | | (0.036) | |
| Log Income | 0.058*** | [0.019, 0.096] | 0.059*** | [0.021, 0.097] |
| | (0.020) | | (0.019) | |

Notes: **Dependent variable is whether WTP > 0 (binary).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Average marginal effects show the change in probability for a one-unit change in each variable.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 15: Robustness Check - Gamma, Gaussian and OLS (Regression Coefficients)

| Variables | Model 1 | | | | | |
|---|---|---|---|---|---|---|
| | Model A (Gamma GLM) | | Model B (Gaussian GLM) | | Model C (OLS log(WTP)) | |
| | Coefficient | 95% CI | Coefficient | 95% CI | Coefficient | 95% CI |
| Intercept | 0.762 | [-0.121, 1.646] | 0.394 | [-1.706, 2.493] | 0.608 | [-0.273, 1.489] |
| | (0.451) | | (1.071) | | (0.450) | |
| $\text{Scope}_{ij}$ | 0.459*** | [0.350, 0.568] | 0.533*** | [0.364, 0.703] | 0.400*** | [0.301, 0.500] |
| | (0.056) | | (0.087) | | (0.051) | |
| $\text{VR}_i$ | 0.111 | [-0.112, 0.334] | 0.188 | [-0.147, 0.523] | 0.020 | [-0.188, 0.227] |
| | (0.114) | | (0.171) | | (0.106) | |
| $\text{Donation}_i$ | -1.297*** | [-1.546, -1.049] | -1.368*** | [-1.676, -1.059] | -1.188*** | [-1.405, -0.971] |
| | (0.127) | | (0.157) | | (0.111) | |
| Environmental Concern | 0.049 | [-0.069, 0.168] | 0.003 | [-0.177, 0.183] | 0.025 | [-0.077, 0.126] |
| | (0.060) | | (0.092) | | (0.052) | |
| Environmental Knowledge | 0.057 | [-0.057, 0.171] | -0.019 | [-0.209, 0.171] | 0.066 | [-0.045, 0.177] |
| | (0.058) | | (0.097) | | (0.057) | |
| Environmental Behaviour | -0.005 | [-0.171, 0.161] | 0.174 | [-0.155, 0.503] | 0.037 | [-0.116, 0.189] |
| | (0.085) | | (0.168) | | (0.078) | |
| Male | -0.028 | [-0.353, 0.298] | -0.402 | [-0.922, 0.117] | -0.174 | [-0.460, 0.111] |
| | (0.166) | | (0.265) | | (0.146) | |
| Education | 0.197** | [0.038, 0.356] | 0.192* | [-0.032, 0.416] | 0.144* | [-0.001, 0.290] |
| | (0.081) | | (0.114) | | (0.074) | |
| Log Income | 0.133** | [0.016, 0.251] | 0.187 | [-0.092, 0.465] | 0.143** | [0.033, 0.252] |
| | (0.060) | | (0.142) | | (0.056) | |
| Observations | 462 | | 462 | | 341 | |

Notes: **Dependent variables: Models A and B: WTP amount in £ (conditional on WTP > 0). Model C: ln(WTP) (conditional on WTP > 0).** All models estimate second-stage effects only, conditional on positive WTP. Model A uses Gamma GLM; Model B uses Gaussian GLM; Model C uses OLS. Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Sample size smaller in Model C due to exclusion of zero WTP observations for log transformation. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 16: Robustness Check - Gamma, Gaussian and OLS (Average Marginal Effect)

| Variables | Model 1 - Population-level AME | | | | | |
|---|---|---|---|---|---|---|
| | Model A (Gamma GLM) | | Model B (Gaussian GLM) | | Model C (OLS log(WTP)) | |
| | AME | 95% CI | AME | 95% CI | AME | 95% CI |
| $\text{Scope}_{ij}$ | 4.693*** | [3.332, 6.055] | 5.193*** | [3.407, 6.979] | 4.067*** | [2.838, 5.296] |
| | (0.695) | | (0.911) | | (0.627) | |
| $\text{VR}_i$ | 1.431 | [-0.777, 3.640] | 2.053 | [-1.161, 5.267] | 0.586 | [-1.512, 2.684] |
| | (1.127) | | (1.640) | | (1.070) | |
| $\text{Donation}_i$ | -14.427*** | [-18.009, -10.846] | -14.489*** | [-18.278, -10.699] | -13.168*** | [-16.568, -9.767] |
| | (1.827) | | (1.933) | | (1.735) | |
| Environmental Concern | 0.809 | [-0.323, 1.940] | 0.350 | [-1.368, 2.068] | 0.576 | [-0.404, 1.557] |
| | (0.577) | | (0.877) | | (0.500) | |
| Environmental Knowledge | 0.903 | [-0.217, 2.024] | 0.173 | [-1.600, 1.945] | 0.973* | [-0.122, 2.068] |
| | (0.572) | | (0.904) | | (0.559) | |
| Environmental Behaviour | 0.129 | [-1.524, 1.782] | 1.717 | [-1.316, 4.750] | 0.505 | [-0.996, 2.006] |
| | (0.843) | | (1.548) | | (0.766) | |
| Male | -0.939 | [-4.215, 2.336] | -4.224* | [-8.957, 0.510] | -2.256 | [-5.090, 0.578] |
| | (1.671) | | (2.415) | | (1.446) | |
| Education | 1.895** | [0.247, 3.544] | 1.793* | [-0.243, 3.829] | 1.383* | [-0.154, 2.921] |
| | (0.841) | | (1.039) | | (0.785) | |
| Log Income | 1.703*** | [0.552, 2.854] | 2.100* | [-0.382, 4.583] | 1.757*** | [0.656, 2.857] |
| | (0.587) | | (1.267) | | (0.561) | |

Notes: **Dependent variable: Unconditional WTP in £ for all models.** Models A and B use two-part models with Gamma and Gaussian GLMs (second stage) respectively. Model C uses two-part lognormal specification (probit first stage; OLS on ln(WTP) second stage). All models report population-level average marginal effects combining participation and amount decisions. Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 17: Robustness Check - Probit vs Logit (Regression Coefficients)

| Variables | Model 2 | | | |
|---|---|---|---|---|
| | Probit | | Logit | |
| | Coefficient | 95% CI | Coefficient | 95% CI |
| Intercept | -1.845** | [-3.286, -0.405] | -3.180** | [-5.595, -0.765] |
| | (0.735) | | (1.232) | |
| $\text{Scope}_{ij}$ | 0.194** | [0.011, 0.376] | 0.334** | [0.012, 0.655] |
| | (0.093) | | (0.164) | |
| $\text{VR}_i$ | 0.172 | [-0.229, 0.572] | 0.330 | [-0.364, 1.025] |
| | (0.204) | | (0.354) | |
| $\text{Donation}_i$ | -1.143*** | [-1.609, -0.677] | -2.009*** | [-2.848, -1.171] |
| | (0.238) | | (0.428) | |
| $\text{VR}_i \times \text{Scope}_{ij}$ | 0.037 | [-0.264, 0.339] | 0.070 | [-0.456, 0.596] |
| | (0.154) | | (0.268) | |
| Environmental Concern | 0.164** | [0.008, 0.321] | 0.269** | [0.002, 0.536] |
| | (0.080) | | (0.136) | |
| Environmental Knowledge | 0.175* | [-0.008, 0.358] | 0.314** | [0.001, 0.627] |
| | (0.093) | | (0.160) | |
| Environmental Behaviour | 0.081 | [-0.131, 0.294] | 0.135 | [-0.245, 0.514] |
| | (0.108) | | (0.194) | |
| Male | -0.318 | [-0.743, 0.107] | -0.531 | [-1.294, 0.233] |
| | (0.217) | | (0.389) | |
| Education | 0.038 | [-0.238, 0.315] | 0.060 | [-0.429, 0.549] |
| | (0.141) | | (0.250) | |
| Log Income | 0.219*** | [0.061, 0.377] | 0.386*** | [0.110, 0.662] |
| | (0.081) | | (0.141) | |
| Observations | 462 | | 462 | |
| AIC/BIC | 454.126/499.617 | | 453.400/498.891 | |

Notes: **Dependent variable is whether WTP > 0 (binary).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 18: Robustness Check - Probit vs Logit (Average Marginal Effects)

| Variables | Model 2 | | | |
|---|---|---|---|---|
| | Probit | | Logit | |
| | AME | 95% CI | AME | 95% CI |
| $\text{Scope}_{ij}$ | 0.056*** | [0.018, 0.094] | 0.056*** | [0.018, 0.094] |
| | (0.019) | | (0.019) | |
| $\text{VR}_i$ | 0.050 | [-0.044, 0.144] | 0.056 | [-0.039, 0.150] |
| | (0.048) | | (0.048) | |
| $\text{Donation}_i$ | -0.301*** | [-0.395, -0.208] | -0.307*** | [-0.402, -0.211] |
| | (0.048) | | (0.049) | |
| $\text{VR}_i \times \text{Scope}_{ij}$ | 0.002 | [-0.075, 0.079] | 0.002 | [-0.076, 0.079] |
| | (0.039) | | (0.039) | |
| Environmental Concern | 0.043** | [0.006, 0.081] | 0.041** | [0.004, 0.078] |
| | (0.019) | | (0.019) | |
| Environmental Knowledge | 0.046** | [0.003, 0.090] | 0.048** | [0.005, 0.091] |
| | (0.022) | | (0.022) | |
| Environmental Behaviour | 0.021 | [-0.033, 0.075] | 0.021 | [-0.035, 0.076] |
| | (0.028) | | (0.028) | |
| Male | -0.084 | [-0.195, 0.028] | -0.081 | [-0.196, 0.034] |
| | (0.057) | | (0.059) | |
| Education | 0.010 | [-0.060, 0.080] | 0.009 | [-0.061, 0.080] |
| | (0.036) | | (0.036) | |
| Log Income | 0.058*** | [0.019, 0.096] | 0.059*** | [0.021, 0.097] |
| | (0.020) | | (0.019) | |

Notes: **Dependent variable is whether WTP > 0 (binary).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Average marginal effects show the change in probability for a one-unit change in each variable.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 19: Robustness Check - Gamma, Gaussian and OLS (Regression Coefficients)

| Variables | Model 2 | | | | | |
|---|---|---|---|---|---|---|
| | Model A (Gamma GLM) | | Model B (Gaussian GLM) | | Model C (OLS log(WTP)) | |
| | Coefficient | 95% CI | Coefficient | 95% CI | Coefficient | 95% CI |
| Intercept | 0.766 | [-0.127, 1.660] | 0.412 | [-1.686, 2.511] | 0.592 | [-0.293, 1.476] |
| | (0.456) | | (1.071) | | (0.451) | |
| $\text{Scope}_{ij}$ | 0.451*** | [0.299, 0.602] | 0.508*** | [0.264, 0.751] | 0.432*** | [0.284, 0.579] |
| | (0.077) | | (0.124) | | (0.075) | |
| $\text{VR}_i$ | 0.103 | [-0.135, 0.341] | 0.156 | [-0.181, 0.493] | 0.049 | [-0.174, 0.273] |
| | (0.121) | | (0.172) | | (0.114) | |
| $\text{Donation}_{ij}$ | -1.297*** | [-1.546, -1.049] | -1.367*** | [-1.676, -1.058] | -1.188*** | [-1.405, -0.972] |
| | (0.127) | | (0.158) | | (0.111) | |
| $\text{VR}_i \times \text{Scope}_{ij}$ | 0.016 | [-0.194, 0.226] | 0.043 | [-0.302, 0.388] | -0.057 | [-0.250, 0.136] |
| | (0.107) | | (0.176) | | (0.099) | |
| Environmental Concern | 0.049 | [-0.069, 0.168] | 0.002 | [-0.179, 0.184] | 0.025 | [-0.076, 0.126] |
| | (0.060) | | (0.093) | | (0.052) | |
| Environmental Knowledge | 0.057 | [-0.057, 0.171] | -0.019 | [-0.210, 0.171] | 0.066 | [-0.045, 0.177] |
| | (0.058) | | (0.097) | | (0.057) | |
| Environmental Behaviour | -0.005 | [-0.171, 0.161] | 0.174 | [-0.154, 0.503] | 0.036 | [-0.117, 0.189] |
| | (0.085) | | (0.168) | | (0.078) | |
| Male | -0.027 | [-0.353, 0.298] | -0.404 | [-0.930, 0.122] | -0.174 | [-0.460, 0.111] |
| | (0.166) | | (0.268) | | (0.146) | |
| Education | 0.197** | [0.038, 0.356] | 0.192* | [-0.034, 0.418] | 0.145* | [-0.001, 0.290] |
| | (0.081) | | (0.115) | | (0.074) | |
| Log Income | 0.133** | [0.016, 0.251] | 0.187 | [-0.093, 0.467] | 0.142** | [0.033, 0.252] |
| | (0.060) | | (0.143) | | (0.056) | |
| Observations | 462 | | 462 | | 343 | |

Notes: **Dependent variables: Models A and B: WTP amount in £ (conditional on WTP > 0). Model C: ln(WTP) (conditional on WTP > 0).** All models estimate second-stage effects only, conditional on positive WTP. Model A uses Gamma GLM; Model B uses Gaussian GLM; Model C uses OLS. Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Sample size smaller in Model C due to exclusion of zero WTP observations for log transformation. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 20: Robustness Check - Gamma, Gaussian and OLS (Average Marginal Effects)

| | Model 2 - Population-level AME | | | | | |
|---|---|---|---|---|---|---|
| Variables | Model A (Gamma GLM) | | Model B (Gaussian GLM) | | Model C (OLS log(WTP)) | |
| | AME | 95% CI | AME | 95% CI | AME | 95% CI |
| $\text{Scope}_{ij}$ | 4.610*** | [3.298, 5.921] | 5.058*** | [3.415, 6.701] | 4.313*** | [2.781, 5.845] |
| | (0.669) | | (0.838) | | (0.781) | |
| $\text{VR}_i$ | 1.450 | [-0.776, 3.676] | 2.006 | [-1.013, 5.025] | 0.816 | [-1.415, 3.047] |
| | (1.136) | | (1.540) | | (1.138) | |
| $\text{Donation}_{ij}$ | -14.428*** | [-18.008, -10.848] | -14.486*** | [-18.273, -10.698] | -13.181*** | [-16.584, -9.777] |
| | (1.827) | | (1.933) | | (1.737) | |
| $\text{VR}_i \times \text{Scope}_{ij}$ | 0.866 | [-1.651, 3.382] | 1.370 | [-2.759, 4.992] | -0.436 | [-2.181, 1.309] |
| | (1.284) | | (1.968) | | (0.890) | |
| Environmental Concern | 0.809 | [-0.322, 1.940] | 0.345 | [-1.388, 2.078] | 0.580 | [-0.403, 1.563] |
| | (0.577) | | (0.884) | | (0.501) | |
| Environmental Knowledge | 0.903 | [-0.218, 2.024] | 0.172 | [-1.596, 1.941] | 0.974* | [-0.122, 2.069] |
| | (0.572) | | (0.902) | | (0.559) | |
| Environmental Behaviour | 0.129 | [-1.526, 1.785] | 1.719 | [-1.310, 4.749] | 0.504 | [-0.999, 2.006] |
| | (0.845) | | (1.546) | | (0.767) | |
| Male | -0.938 | [-4.215, 2.340] | -4.236* | [-9.012, 0.539] | -2.256 | [-5.091, 0.579] |
| | (1.672) | | (2.436) | | (1.447) | |
| Education | 1.895** | [0.246, 3.544] | 1.796* | [-0.251, 3.842] | 1.387* | [-0.153, 2.927] |
| | (0.841) | | (1.044) | | (0.785) | |
| Log Income | 1.702*** | [0.550, 2.855] | 2.104* | [-0.387, 4.595] | 1.756*** | [0.655, 2.858] |
| | (0.588) | | (1.271) | | (0.562) | |

Notes: **Dependent variable: Unconditional WTP in £ for all models.** Models A and B use two-part models with Gamma and Gaussian GLMs (second stage) respectively. Model C uses two-part lognormal specification (probit first stage; OLS on ln(WTP) second stage). All models report population-level average marginal effects combining participation and amount decisions. Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

To assess potential impacts of response quality, the analysis evaluated whether results were sensitive to the exclusion of speedsters and outliers. Robustness checks including speedsters and outliers in both Model 1 and Model 2 confirmed the main findings. Scope maintained its positive and statistically significant effect, demonstrating the stability of the key result despite reduced significance in some control variables.

Table 21: Average Marginal Effects - Model 1

| | First Stage (Probit) | | Population Level | |
|---|---|---|---|---|
| Variables | AME | 95% CI | AME | 95% CI |
| $\text{Scope}_{ij}$ | 0.047** | [0.010, 0.084] | 4.591*** | [3.003, 6.179] |
| | (0.019) | | (0.810) | |
| $\text{VR}_i$ | 0.023 | [-0.078, 0.124] | 2.509 | [-0.822, 5.840] |
| | (0.051) | | (1.699) | |
| $\text{Donation}_i$ | -0.115** | [-0.215, -0.015] | 0.948 | [-2.272, 4.168] |
| | (0.051) | | (1.643) | |
| Environmental Concern | 0.045** | [0.003, 0.087] | 0.308 | [-1.154, 1.770] |
| | (0.021) | | (0.746) | |
| Environmental Knowledge | 0.051** | [0.008, 0.094] | 0.524 | [-0.943, 1.991] |
| | (0.022) | | (0.748) | |
| Environmental Behaviour | -0.011 | [-0.070, 0.048] | -0.102 | [-2.328, 2.123] |
| | (0.030) | | (1.135) | |
| Male | -0.021 | [-0.142, 0.100] | -1.240 | [-5.300, 2.820] |
| | (0.062) | | (2.071) | |
| Education | -0.026 | [-0.100, 0.047] | -0.272 | [-2.614, 2.070] |
| | (0.037) | | (1.195) | |
| Log Income | 0.033 | [-0.010, 0.077] | 1.150 | [-0.526, 2.826] |
| | (0.022) | | (0.855) | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); population-level models unconditional WTP in £**. Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. First stage shows marginal effects on donation probability. Population-level marginal effects combine both the participation decision (first stage) and donation amount conditional on participation (second stage).

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 22: Average Marginal Effects - Model 2

| | First Stage (Probit) | | Population Level | |
|---|---|---|---|---|
| Variables | AME | 95% CI | AME | 95% CI |
| $\text{Scope}_{ij}$ | 0.047** | [0.010, 0.084] | 4.502*** | [2.918, 6.086] |
| | (0.019) | | (0.808) | |
| $\text{VR}_i$ | 0.023 | [-0.078, 0.124] | 2.463 | [-0.803, 5.729] |
| | (0.052) | | (1.666) | |
| $\text{Donation}_i$ | -0.115** | [-0.215, -0.015] | 0.941 | [-2.267, 4.149] |
| | (0.051) | | (1.637) | |
| $\text{VR}_i \times \text{Scope}_{ij}$ | 0.016 | [-0.053, 0.089] | 2.314 | [-1.939, 6.837] |
| | (0.037) | | (2.276) | |
| Environmental Concern | 0.045** | [0.003, 0.087] | 0.315 | [-1.139, 1.768] |
| | (0.021) | | (0.742) | |
| Environmental Knowledge | 0.051** | [0.008, 0.094] | 0.521 | [-0.947, 1.989] |
| | (0.022) | | (0.749) | |
| Environmental Behaviour | -0.011 | [-0.069, 0.048] | -0.100 | [-2.326, 2.125] |
| | (0.030) | | (1.135) | |
| Male | -0.021 | [-0.142, 0.100] | -1.229 | [-5.281, 2.824] |
| | (0.062) | | (2.068) | |
| Education | -0.026 | [-0.100, 0.047] | -0.267 | [-2.608, 2.074] |
| | (0.037) | | (1.194) | |
| Log Income | 0.033 | [-0.010, 0.077] | 1.152 | [-0.524, 2.828] |
| | (0.022) | | (0.855) | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); population-level models unconditional WTP in £.** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. First stage shows marginal effects on donation probability. Population-level marginal effects combine both the participation decision (first stage) and donation amount conditional on participation (second stage).

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Interval regressions were also conducted for hypothetical donations only, following standard practice for payment card elicitation (Cameron & Huppert, 1989; OECD, 2018; Sajise et al., 2021). For these analyses, WTP responses were treated as intervals rather than as point estimates. The lower bound was set as the selected payment card value, while the upper bound was the next higher value on the card. For example, if a participant selected £0, this was coded as the interval [£0, £2]; if they selected £20, it was coded as [£20, £25]. For the highest payment card value of £30, the upper bound was set to £35. Responses above £30, where participants manually entered values, were treated as point estimates since these represent precise WTP amounts rather than interval selections.

The interval regression results for both Model 1 and Model 2 showed no meaningful differences from the main analysis, confirming the robustness of the main findings to different assumptions about payment card response interpretation.

Table 23: Interval Regression Results - Model 1 and Model 2

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| Variables | Coefficient | 95% CI | Coefficient | 95% CI |
| Intercept | -17.649* | [-37.284, 1.986] | -17.401* | [-37.287, 2.486] |
| | (10.018) | | (10.146) | |
| $\text{Scope}_{ij}$ | 8.633*** | [6.104, 11.163] | 8.137*** | [4.551, 11.723] |
| | (1.291) | | (1.830) | |
| $\text{VR}_i$ | 3.055 | [-1.952, 8.063] | 2.603 | [-1.556, 6.761] |
| | (2.555) | | (2.122) | |
| $\text{VR}_i \times \text{Scope}_{ij}$ | – | – | 0.906 | [-4.219, 6.030] |
| | | | (2.615) | |
| Environmental Concern | 1.319 | [-1.068, 3.706] | 1.319 | [-1.068, 3.706] |
| | (1.218) | | (1.218) | |
| Environmental Knowledge | 0.997 | [-1.627, 3.621] | 0.997 | [-1.627, 3.621] |
| | (1.339) | | (1.339) | |
| Environmental Behaviour | 1.224 | [-2.760, 5.207] | 1.224 | [-2.760, 5.207] |
| | (2.033) | | (2.033) | |
| Male | -6.321* | [-12.805, 0.164] | -6.320* | [-12.804, 0.164] |
| | (3.308) | | (3.308) | |
| Education | 2.711* | [-0.237, 5.659] | 2.711* | [-0.237, 5.659] |
| | (1.504) | | (1.504) | |
| Log Income | 1.746 | [-1.261, 4.752] | 1.746 | [-1.261, 4.752] |
| | (1.534) | | (1.534) | |

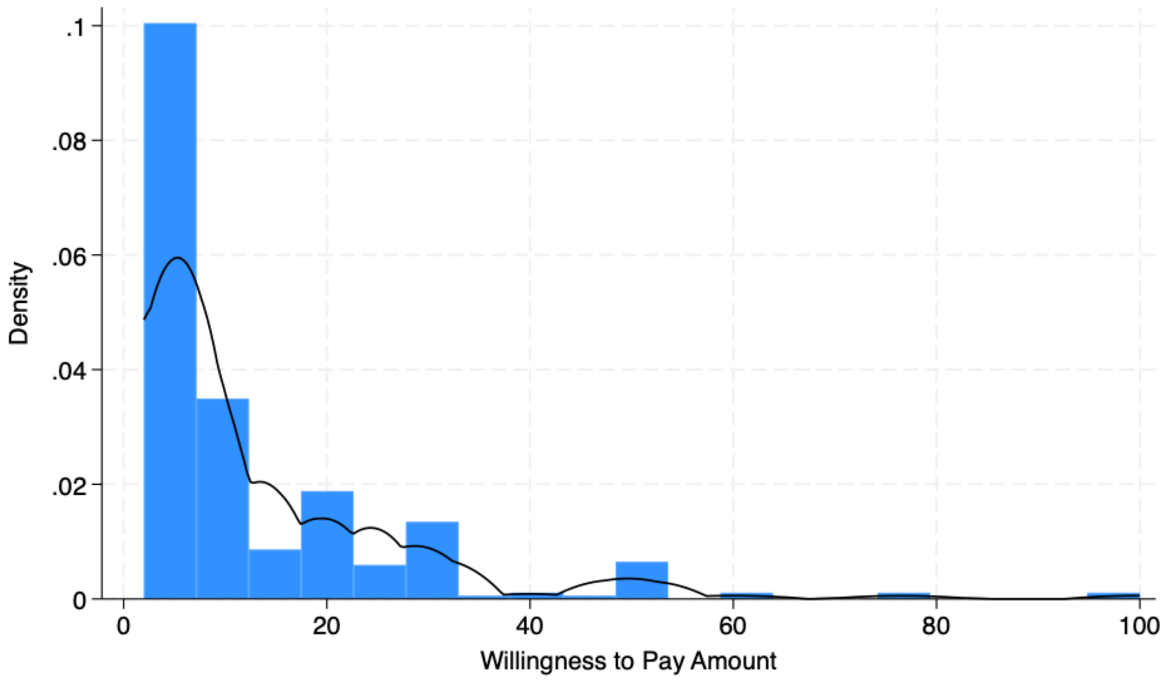
Notes: **Dependent variable is the interval-bounded WTP in £, specified as lower and upper bounds for interval regression.** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

### 7.5.1 Robustness Check - Violation of Normality Assumption

The Shapiro-Wilk test strongly rejects normality for positive WTP values (W = 0.703, $p < 0.001$), and visual inspection reveals substantial right skewness.

Figure 8: Distribution of positive WTP values with kernel density overlay



## 7.6 Exploratory Analyses Modelling Results

### 7.6.1 Within-VR Heterogeneity (Real and Hypothetical Donation)

The first-stage probit estimates the likelihood of a positive WTP (participation decision), while the second-stage GLM models the conditional WTP amount (payment decision).

Table 24: Regression Coefficients – Real and Hypothetical Donation

| | | | 95% Normal-based CI | |
|---|---|---|---|---|
| Variables | Probit | GLM | Probit | GLM |
| Intercept | -2.434** | 1.316* | [-4.260,-0.608] | [-0.091,2.723] |
| | (0.932) | (0.718) | | |
| Scope$_{ij}$ | 0.288 | 0.495*** | [-0.206,0.782] | [0.316,0.674] |
| | (0.252) | (0.091) | | |
| Donation$_i$ | -1.022** | -1.345*** | [-1.799,-0.246] | [-1.707,-0.982] |
| | (0.396) | (0.185) | | |
| Scope$_{ij}$ $\times$ Donation$_i$ | -0.090 | -0.084 | [-0.664,0.484] | [-0.400,0.232] |
| | (0.293) | (0.161) | | |
| Environmental Concern | 0.179 | 0.019 | [-0.049,0.408] | [-0.156,0.194] |
| | (0.117) | (0.089) | | |
| Environmental Knowledge | 0.164 | 0.073 | [-0.104,0.433] | [-0.111,0.258] |
| | (0.137) | (0.094) | | |
| Environmental Behaviour | -0.049 | -0.049 | [-0.356,0.258] | [-0.273,0.174] |
| | (0.157) | (0.114) | | |
| Male | -0.150 | 0.067 | [-0.854,0.554] | [-0.433,0.566] |
| | (0.359) | (0.255) | | |
| Education | 0.169 | 0.199* | [-0.204,0.542] | [-0.019,0.418] |
| | (0.191) | (0.112) | | |
| Log Income | 0.319*** | 0.097 | [0.100,0.538] | [-0.079,0.272] |
| | (0.112) | (0.089) | | |
| Observations | 246 | | — | |
| AIC | 1510.39 | | — | |
| BIC | 1580.50 | | — | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); second stage models WTP amount in £ (conditional on WTP > 0).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. For interpretation, donation coefficient (-1.022) indicates that real donation decreases the probability of positive WTP. For GLM stage, donation coefficient (-1.345) shows that real donation reduces WTP amounts among participants willing to pay.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

### 7.6.2 Within-Video Heterogeneity (Real and Hypothetical Donation)

Table 25: Population-level Average Marginal Effect

| Variables | Population level AME | 95% CI |
|---|---|---|
| $\text{Scope}_{ij}$ | 4.412*** | [2.470, 6.353] |
| | (0.991) | |
| $\text{Donation}_i$ | -12.057*** | [-15.844, -8.271] |
| | (1.932) | |
| $\text{Scope}_{ij} \times \text{Donation}_i$ | -6.332*** | [-10.794, -3.044] |
| | (1.955) | |
| Environmental Concern | 0.782 | [-0.444, 2.009] |
| | (0.626) | |
| Environmental Knowledge | 0.908 | [-0.377, 2.194] |
| | (0.656) | |
| Environmental Behaviour | 1.387 | [-0.528, 3.302] |
| | (0.977) | |
| Male | -2.928 | [-6.337, 0.482] |
| | (1.739) | |
| Education | 0.789 | [-1.474, 3.052] |
| | (1.155) | |
| Log Income | 1.901** | [0.439, 3.362] |
| | (0.746) | |

Notes: **Dependent variable is unconditional WTP in £.** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Population-level marginal effects combine both the participation decision (first stage) and donation amount conditional on participation (second stage). The conditional AME of Scope for real and hypothetical donation are 1.363 ($p < 0.01$) and 7.695 ($p < 0.01$) respectively.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

### 7.6.3 Combined Model for Realism, Emotion & Presence

Table 26: Population-level Average Marginal Effect

| Variables | AME | 95% CI |
|---|---|---|
| $\text{Scope}_{ij}$ | 5.045*** | [3.059, 7.031] |
| | (1.013) | |
| $\text{Donation}_i$ | -16.236*** | [-21.962, -10.509] |
| | (2.922) | |
| $\text{Realism}_i$ | 1.424 | [-0.501, 3.348] |
| | (0.982) | |
| $\text{Emotion}_i$ | 0.889 | [-0.901, 2.680] |
| | (0.914) | |
| $\text{Presence}_i$ | -0.893 | [-3.301, 1.516] |
| | (1.229) | |
| $\text{Scope}_{ij} \times \text{Realism}_i$ | 0.915 | [-0.629, 2.459] |
| | (0.788) | |
| $\text{Scope}_{ij} \times \text{Emotion}_i$ | -0.742 | [-3.141, 1.658] |
| | (1.224) | |
| $\text{Scope}_{ij} \times \text{Presence}_i$ | 2.274 | [-1.200, 5.749] |
| | (1.773) | |
| Environmental Concern | 0.058 | [-1.681, 1.797] |
| | (0.887) | |
| Environmental Knowledge | 1.202 | [-0.742, 3.145] |
| | (0.992) | |
| Environmental Behaviour | -0.759 | [-3.138, 1.621] |
| | (1.214) | |
| Male | 1.468 | [-4.126, 7.063] |
| | (2.854) | |
| Education | 2.353* | [-0.210, 4.916] |
| | (1.308) | |
| Log Income | 1.368 | [-0.419, 3.155] |
| | (0.912) | |

Notes: **Dependent variable is unconditional WTP in £.** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Scope coefficient shows unconditional marginal effects. For emotion, conditional AME of scope for those with lowest and highest emotion are 7.131 ($p > 0.05$) and 1.939 ($p > 0.05$) respectively. For realism, conditional AME of scope for those with lowest and highest realism are 2.546 ($p > 0.05$) and 7.121 ($p < 0.01$) respectively. For presence, conditional AME of scope for those with lowest and highest presence are -9.202 ($p > 0.05$) and 6.718 ($p < 0.05$) respectively.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

### 7.6.4 Two-Part Model of WTP - Emotion, Presence, Realism & Discomfort

The first-stage probit estimates the likelihood of a positive WTP (participation decision), while the second-stage GLM models the conditional WTP amount (payment decision).

Table 27: Regression Coefficients – Emotion

| | | | 95% Normal-based CI | |
|---|---|---|---|---|
| Variables | Probit | GLM | Probit | GLM |
| Intercept | -2.343** | 1.105 | [-4.293,-0.393] | [-0.318,2.528] |
| | (0.995) | (0.726) | | |
| Scope$_{ij}$ | 0.305 | 0.353 | [-0.460,1.069] | [-0.108,0.814] |
| | (0.390) | (0.235) | | |
| Donation$_i$ | -1.041*** | -1.398*** | [-1.826,-0.255] | [-1.778,-1.018] |
| | (0.401) | (0.194) | | |
| Emotion | -0.025 | 0.082 | [-0.249,0.198] | [-0.039,0.203] |
| | (0.114) | (0.062) | | |
| Scope$_{ij}$ $\times$ Emotion | -0.015 | 0.022 | [-0.154,0.125] | [-0.074,0.118] |
| | (0.071) | (0.049) | | |
| Environmental Concern | 0.192 | 0.004 | [-0.042,0.425] | [-0.165,0.174] |
| | (0.119) | (0.086) | | |
| Environmental Knowledge | 0.161 | 0.076 | [-0.116,0.438] | [-0.107,0.259] |
| | (0.141) | (0.093) | | |
| Environmental Behaviour | -0.055 | -0.060 | [-0.368,0.259] | [-0.284,0.163] |
| | (0.160) | (0.114) | | |
| Male | -0.163 | 0.172 | [-0.902,0.576] | [-0.352,0.696] |
| | (0.377) | (0.268) | | |
| Education | 0.168 | 0.187 | [-0.226,0.563] | [-0.047,0.422] |
| | (0.201) | (0.120) | | |
| Log Income | 0.321*** | 0.086 | [0.091,0.551] | [-0.090,0.262] |
| | (0.117) | (0.090) | | |
| Observations | 246 | | — | |
| AIC | 1511.03 | | — | |
| BIC | 1588.14 | | — | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); second stage models WTP amount in £ (conditional on WTP > 0).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. For intepretation, donation coefficient (-1.041) indicates that real donation decreases the probability of someone being willing to pay. For GLM stage, donation coefficient (-1.398) shows that real donation decreases WTP amounts among participants willing to pay.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 28: Regression Coefficients – Presence

| | | | 95% Normal-based CI | |
|---|---|---|---|---|
| Variables | Probit | GLM | Probit | GLM |
| Intercept | -2.260** | 1.411** | [-4.335,-0.184] | [0.002,2.820] |
| | (1.059) | (0.719) | | |
| $\text{Scope}_{ij}$ | 0.420 | -0.075 | [-0.759,1.598] | [-0.543,0.392] |
| | (0.601) | (0.239) | | |
| $\text{Donation}_i$ | -1.033*** | -1.378*** | [-1.811,-0.256] | [-1.750,-1.006] |
| | (0.397) | (0.190) | | |
| Presence | -0.038 | 0.006 | [-0.277,0.200] | [-0.136,0.149] |
| | (0.122) | (0.073) | | |
| $\text{Scope}_{ij} \times$ Presence | -0.035 | 0.100** | [-0.233,0.163] | [0.008,0.193] |
| | (0.101) | (0.047) | | |
| Environmental Concern | 0.186 | 0.020 | [-0.049,0.420] | [-0.157,0.196] |
| | (0.120) | (0.090) | | |
| Environmental Knowledge | 0.168 | 0.057 | [-0.120,0.455] | [-0.129,0.243] |
| | (0.147) | (0.095) | | |
| Environmental Behaviour | -0.061 | -0.041 | [-0.376,0.254] | [-0.261,0.179] |
| | (0.161) | (0.112) | | |
| Male | -0.165 | 0.138 | [-0.910,0.579] | [-0.388,0.665] |
| | (0.380) | (0.269) | | |
| Education | 0.165 | 0.191 | [-0.223,0.552] | [-0.038,0.419] |
| | (0.198) | (0.117) | | |
| Log Income | 0.325*** | 0.083 | [0.097,0.552] | [-0.098,0.263] |
| | (0.116) | (0.092) | | |
| Observations | 246 | | — | |
| AIC | 1511.03 | | — | |
| BIC | 1588.14 | | — | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); second stage models WTP amount in £ (conditional on WTP > 0).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. For interpretation, donation coefficient (-1.033) indicates that real donation decreases the probability of someone being willing to pay. For GLM stage, donation coefficient (-1.378) shows that real donation decreases WTP amounts among participants willing to pay.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 29: Regression Coefficients – Realism

| | | | 95% Normal-based CI | |
|---|---|---|---|---|
| Variables | Probit | GLM | Probit | GLM |
| Intercept | -1.890* | 1.160 | [-3.867,0.086] | [-0.326,2.645] |
| | (1.008) | (0.758) | | |
| Scope$_{ij}$ | -0.244 | 0.097 | [-1.167,0.680] | [-0.460,0.655] |
| | (0.471) | (0.285) | | |
| Donation$_i$ | -1.054** | -1.357*** | [-1.854,-0.253] | [-1.723,-0.992] |
| | (0.408) | (0.186) | | |
| Realism | -0.121 | 0.112 | [-0.375,0.134] | [-0.026,0.249] |
| | (0.130) | (0.070) | | |
| Scope$_{ij}$ $\times$ Realism | 0.092 | 0.066 | [-0.085,0.268] | [-0.049,0.180] |
| | (0.090) | (0.058) | | |
| Environmental Concern | 0.200* | -0.017 | [-0.031,0.432] | [-0.187,0.152] |
| | (0.118) | (0.087) | | |
| Environmental Knowledge | 0.154 | 0.063 | [-0.116,0.424] | [-0.112,0.238] |
| | (0.138) | (0.089) | | |
| Environmental Behaviour | -0.052 | -0.044 | [-0.362,0.258] | [-0.254,0.166] |
| | (0.158) | (0.107) | | |
| Male | -0.190 | 0.189 | [-0.925,0.545] | [-0.334,0.712] |
| | (0.375) | (0.267) | | |
| Education | 0.174 | 0.191* | [-0.216,0.564] | [-0.034,0.416] |
| | (0.199) | (0.115) | | |
| Log Income | 0.325*** | 0.061 | [0.096,0.553] | [-0.120,0.241] |
| | (0.117) | (0.092) | | |
| Observations | 246 | | — | |
| AIC | 1507.91 | | — | |
| BIC | 1585.03 | | — | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); second stage models WTP amount in £ (conditional on WTP > 0).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. For interpretation, donation coefficient (-1.054) indicates that real donation decreases the probability of someone being willing to pay. For GLM stage, donation coefficient (-1.357) shows that real donation decreases WTP amounts among participants willing to pay.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 30: Regression Coefficients – Discomfort

| Variables | Probit | GLM | 95% Normal-based CI Probit | 95% Normal-based CI GLM |
|---|---|---|---|---|
| Intercept | -2.371** | 1.671** | [-4.262,-0.479] | [0.151,3.190] |
| | (0.965) | (0.775) | | |
| $\text{Scope}_{ij}$ | 0.208 | 0.542*** | [-0.090,0.505] | [0.338,0.746] |
| | (0.152) | (0.104) | | |
| $\text{Donation}_{i}$ | -1.066*** | -1.404*** | [-1.852,-0.281] | [-1.762,-1.045] |
| | (0.401) | (0.183) | | |
| Discomfort | -0.026 | -0.083 | [-0.247,0.195] | [-0.207,0.042] |
| | (0.113) | (0.063) | | |
| $\text{Scope}_{ij} \times$ Discomfort | 0.018 | -0.067* | [-0.132,0.168] | [-0.144,0.010] |
| | (0.076) | (0.039) | | |
| Environmental Concern | 0.179 | 0.004 | [-0.053,0.412] | [-0.171,0.178] |
| | (0.119) | (0.089) | | |
| Environmental Knowledge | 0.166 | 0.083 | [-0.106,0.437] | [-0.096,0.263] |
| | (0.139) | (0.092) | | |
| Environmental Behaviour | -0.051 | -0.056 | [-0.367,0.265] | [-0.280,0.168] |
| | (0.161) | (0.114) | | |
| Male | -0.147 | 0.006 | [-0.869,0.575] | [-0.478,0.491] |
| | (0.369) | (0.247) | | |
| Education | 0.169 | 0.149 | [-0.209,0.547] | [-0.077,0.375] |
| | (0.193) | (0.115) | | |
| Log Income | 0.319*** | 0.093 | [0.096,0.542] | [-0.078,0.264] |
| | (0.114) | (0.087) | | |
| Observations | 246 | | — | |
| AIC | 1510.33 | | — | |
| BIC | 1587.45 | | — | |

Notes: **Dependent variables: First stage models whether WTP > 0 (binary); second stage models WTP amount in £ (conditional on WTP > 0).** Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. For interpretation, donation coefficient (-1.066) indicates that real donation decreases the probability of someone being willing to pay. For GLM stage, donation coefficient (-1.404) shows that real donation decreases WTP amounts among participants willing to pay.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

### 7.6.5 Marginal Effects Results – Presence, Realism & Discomfort

Table 31: Marginal Effect of Larger Scope on WTP – Realism and Presence

| | | | 95% Normal-based CI | |
|---|---|---|---|---|
| Rating | Realism | Presence | Realism | Presence |
| 0 | — | -0.074 | — | [-4.094,3.947] |
| | | (2.051) | | |
| 1 | — | 0.710 | — | [-2.550,3.969] |
| | | (1.663) | | |
| 2 | 1.380 | 1.566 | [-1.038,3.799] | [-1.073,4.206] |
| | (1.234) | (1.347) | | |
| 3 | 2.167** | 2.502** | [0.175,4.159] | [0.367,4.637] |
| | (1.016) | (1.089) | | |
| 4 | 3.171*** | 3.522*** | [1.543,4.799] | [1.712,5.331] |
| | (0.831) | (0.923) | | |
| 5 | 4.440*** | 4.630*** | [2.696,6.184] | [2.746,6.515] |
| | (0.890) | (0.962) | | |
| 6 | 6.033*** | 5.834*** | [3.249,8.816] | [3.264,8.404] |
| | (1.420) | (1.311) | | |
| 7 | 8.019*** | 7.137*** | [3.298,12.740] | [3.282,10.992] |
| | (2.409) | (1.967) | | |

Notes: Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. No individual selected 0 & 1 for realism rating. For interpretation, conditional on the highest realism and presence level, participants are willing to pay £8.019 and £7.137 more for a larger conservation area, respectively.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 32: Marginal Effect of Larger Scope on WTP – Discomfort

| Average Score | Discomfort | 95% Normal-based CI |
|---|---|---|
| 0 | 6.760*** | [3.638,9.882] |
| | (1.593) | |
| 0.5 | 6.020*** | [3.451,8.589] |
| | (1.311) | |
| 1 | 5.345*** | [3.171,7.519] |
| | (1.109) | |
| 1.5 | 4.730*** | [2.805,6.655] |
| | (0.982) | |
| 2 | 4.169*** | [2.368,5.970] |
| | (0.919) | |
| 2.5 | 3.659*** | [1.886,5.431] |
| | (0.904) | |
| 3 | 3.195*** | [1.389,5.000] |
| | (0.921) | |
| 3.5 | 2.773*** | [0.901,4.646] |
| | (0.955) | |
| 4 | 2.391** | [0.435,4.347] |
| | (0.998) | |
| 4.5 | 2.044** | [0.000,4.088] |
| | (1.043) | |
| 5 | 1.731 | [-0.401,3.863] |
| | (1.088) | |

Notes: Clustered bootstrapped standard errors in parentheses (2,000 replications) with normal-based confidence intervals. Discomfort is the average of three variables: nausea, disorientation and general discomfort, taking on values from 0 to 5. For interpretation, conditional on the lowest discomfort level, participants are willing to pay £6.760 more for a larger conservation area.

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

### 7.6.6 Predicted WTP & Elasticity – Presence, Realism & Discomfort

The following tables presents the predicted WTP and calculations for arc scope elasticity.

Table 33: Predicted WTP & Elasticity by Scope and Rating - Realism & Presence

| Variables | Predicted Values | | | |
|---|---|---|---|---|
| | Realism | | Presence | |
| | Estimate | Elasticity | Estimate | Elasticity |
| Scope 20% + Rating 0 | – | – | 7.613** | -0.011 |
| | | | (3.394) | |
| Scope 50% + Rating 0 | – | | 7.539** | |
| | | | (3.255) | |
| Scope 20% + Rating 1 | – | – | 7.602*** | 0.104 |
| | | | (2.723) | |
| Scope 50% + Rating 1 | – | | 8.312*** | |
| | | | (2.880) | |
| Scope 20% + Rating 2 | 5.651*** | 0.254 | 7.590*** | 0.218 |
| | (1.466) | | (2.132) | |
| Scope 50% + Rating 2 | 7.031*** | | 9.156*** | |
| | (1.833) | | (2.482) | |
| Scope 20% + Rating 3 | 6.187*** | 0.348 | 7.574*** | 0.331 |
| | (1.177) | | (1.621) | |
| Scope 50% + Rating 3 | 8.354*** | | 10.077*** | |
| | (1.593) | | (2.070) | |
| Scope 20% + Rating 4 | 6.754*** | 0.444 | 7.557*** | 0.441 |
| | (0.943) | | (1.214) | |
| Scope 50% + Rating 4 | 9.925*** | | 11.078*** | |
| | (1.374) | | (1.694) | |
| Scope 20% + Rating 5 | 7.349*** | 0.541 | 7.536*** | 0.548 |
| | (0.911) | | (0.989) | |
| Scope 50% + Rating 5 | 11.789*** | | 12.167*** | |
| | (1.395) | | (1.510) | |
| Scope 20% + Rating 6 | 7.967*** | 0.641 | 7.513*** | 0.653 |
| | (1.221) | | (1.047) | |
| Scope 50% + Rating 6 | 14.000*** | | 13.347*** | |
| | (1.964) | | (1.780) | |
| Scope 20% + Rating 7 | 8.604*** | 0.742 | 7.487*** | 0.753 |
| | (1.825) | | (1.357) | |
| Scope 50% + Rating 7 | 16.623*** | | 14.624*** | |
| | (3.151) | | (2.577) | |

Notes: Bootstrapped standard errors in parentheses (2,000 replications). Both realism and presence are measured from 0-7 scale. Scope elasticity is calculated using the formula: $(\Delta\mathrm{WTP}/\Delta Q) \times (\overline{Q}/\overline{\mathrm{WTP}})$, where $\Delta Q = 0.3$ and $\overline{Q} = 0.35$

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table 34: Predicted WTP & Elasticity by Scope and Rating - Discomfort

| | Discomfort | |
|---|---|---|
| Variables | Estimate | Elasticity |
| Scope 20% + Rating 0.5 | 8.511*** | |
| | (1.403) | 0.663 |
| Scope 50% + Rating 0.5 | 15.272*** | |
| | (2.350) | |
| Scope 20% + Rating 1.0 | 8.143*** | |
| | (1.168) | 0.630 |
| Scope 50% + Rating 1.0 | 14.163*** | |
| | (1.933) | |
| Scope 20% + Rating 1.5 | 7.790*** | |
| | (0.995) | 0.596 |
| Scope 50% + Rating 1.5 | 13.135*** | |
| | (1.643) | |
| Scope 20% + Rating 2.0 | 7.452*** | |
| | (0.893) | 0.562 |
| Scope 50% + Rating 2.0 | 12.182*** | |
| | (1.477) | |
| Scope 20% + Rating 2.5 | 7.128*** | |
| | (0.865) | 0.528 |
| Scope 50% + Rating 2.5 | 11.297*** | |
| | (1.422) | |
| Scope 20% + Rating 3.0 | 6.819*** | |
| | (0.901) | 0.493 |
| Scope 50% + Rating 3.0 | 10.477*** | |
| | (1.449) | |
| Scope 20% + Rating 3.5 | 6.522*** | |
| | (0.981) | 0.459 |
| Scope 50% + Rating 3.5 | 9.717*** | |
| | (1.525) | |
| Scope 20% + Rating 4.0 | 6.238*** | |
| | (1.088) | 0.424 |
| Scope 50% + Rating 4.0 | 9.011*** | |
| | (1.625) | |
| Scope 20% + Rating 4.5 | 5.966*** | |
| | (1.208) | 0.390 |
| Scope 50% + Rating 4.5 | 8.357*** | |
| | (1.733) | |
| Scope 20% + Rating 5.0 | 5.706*** | |
| | (1.333) | 0.354 |
| Scope 50% + Rating 5.0 | 7.750*** | |
| | (1.837) | |

Notes: Bootstrapped standard errors in parentheses (2,000 replications). Discomfort is the average of three variables: nausea, disorientation and general discomfort, taking on values from 0 to 5. Scope elasticity is calculated using the formula: $(\Delta\mathrm{WTP}/\Delta Q) \times (\overline{Q}/\overline{\mathrm{WTP}})$, where $\Delta Q = 0.3$ and $\overline{Q} = 0.35$
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$