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Willingness to Pay for Agricultural Soil Quality Protection and Improvement

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Abstract: Understanding and estimating the economic value that society places on agricultural soil quality protection and improvement can guide the development of policies aimed at mitigating pollution, promoting conservation, or incentivizing sustainable land management practices. We estimate the general public's willingness to pay (WTP) for agricultural soil quality protection and improvement in Spain (n = 1000) and the UK (n = 984) using data from a cross-sectional survey via Qualtrics panels in March–April 2021. We use a double-bound dichotomous choice contingent valuation approach to elicit the individuals' WTP. We investigate the effect of uncertainty on the success of policies aiming at achieving soil protection. In addition, to understand the heterogeneity in individuals' WTP for agricultural soil quality protection and improvement, we model individuals' WTP through individuals' awareness and attitudes toward agricultural soil quality protection and the environment; trust in institutions; risk and time preferences; pro-social behavior; and socio-demographics in Spain and the UK. We found that there is significant public support for agricultural soil quality protection and improvement in Spain and the UK. We also found that the support does not vary significantly under uncertainty of success of policies aiming at achieving soil protection. However, the individual's reasons for supporting agricultural soil quality protection and improvement are found to depend on the level of uncertainty and country. Hence, promoting public support for soil protection needs to be tailored according to the level of the general public's perceived uncertainty and geographic location.

Keywords: soil quality; willingness to pay; contingent valuation; sustainable land management; uncertainty; risk preferences; time preferences

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1. Introduction

The soil system provides different types of ecosystem services such as provisioning ecosystem services (e.g., a medium to provide food, natural water reservoir to provide clean water, habitat provision); regulating ecosystem services offering resilience to climate change and extreme weather events, droughts, and floods (e.g., climate regulation through carbon storage, nutrient cycling); and cultural services (e.g., supporting culture, traditions, and practices linked to agriculture and landscapes) [1]. Consequently, soil management is key to build up resilience to ensure sustainable agricultural systems and the environment through soil quality protection and improvement [2].

Currently about 60 to 70% of soils in the EU are in an unhealthy state [3]. The costs of soil degradation in the EU have been estimated in that they may exceed EUR 50 billion annually [3] based on a previous estimate of EUR 38 billion annually for 25 EU countries that did not include costs from biodiversity decline, sealing, or compaction [4]. For the UK, soil degradation has been estimated to cost GBP 1.2 billion annually [5]. The past European Union's (EU) Common Agricultural Policy (CAP) based on price support in combination with technological change led to agriculture intensification, specialization, and concentration of production with subsequent environmental impacts including

habitat loss and decline in wildlife and biodiversity [6–9] and possibly detrimental soil quality and yields (e.g., shorter rotations, traffic-induced soil compaction [10–12]).

The EU CAP has reacted to these environmental impacts and the constraints to agricultural support set up in the 1994 WTO's Uruguay Round Agreement in agriculture [13]. Thus, in 1998, voluntary set-aside was introduced to reduce crop overproduction and deliver environmental benefits, following the 1992 MacSharry reform that made set-aside compulsory and the CAP's Agenda 2000, which allowed Member States (MSs) to apply cross-compliance. Under Regulation (EEC) 2078/92, MSs were allowed to provide support to farmers for making environmental improvements to their land by changing farming practices [14]. The Fisher reform in 2003 meant that agricultural policies moved from price support to area-based payments and payments for the supply of environmental goods (e.g., agri-environmental schemes).

More specifically on soil, the EU has developed an EU soil strategy, which has medium- and long-term objectives by 2030 and 2050, respectively. The EU soil strategy's medium-term objectives include the following: (a) Combat desertification; restore degraded land and soil, including land affected by desertification, drought, and floods; and strive to achieve a land degradation-neutral world (Sustainable Development Goal 15.3). (b) Restore significant areas of degraded and carbon-rich ecosystems, including soils. (c) Achieve an EU net greenhouse gas removal of 310 million tonnes CO_2 equivalent per year for the land use, land use change, and forestry (LULUCF) sector. (d) Reach good ecological and chemical status in surface waters and good chemical and quantitative status in groundwater by 2027. (e) Reduce nutrient losses by at least 50%, the overall use and risk of chemical pesticides by 50%, and the use of more hazardous pesticides by 50% by 2030. (f) Significant progress has been made in the remediation of contaminated sites. As for the long-term objectives, these are (a) reach no net land taking; (b) soil pollution should be reduced to levels no longer considered harmful to human health and natural ecosystems and respect the boundaries our planet can cope with, thus creating a toxic-free environment; (c) achieve a climate-neutral Europe and, as the first step, aim to achieve land-based climate neutrality in the EU by 2035; (d) achieve for EU a climate-resilient society, fully adapted to the unavoidable impacts of climate change by 2050. Also, aiming for that by 2030, at least 75% of soils in each EU Member State are healthy, or show a significant improvement towards meeting accepted thresholds of indicators, to support ecosystem services [3]. Consequently, the EU has been incorporating specific policy measures to target agricultural soils at regional and national levels [15]. The CAP has set out soil protection policies via its soil thematic strategy, which includes a proposal for a Directive on soil monitoring and resilience (soil monitoring law) [16].

Regarding the UK, the 2016 Brexit vote and UK decision to leave the EU meant that the UK could decide on a new agricultural policy, which is currently under development with farm support in the UK changing. Agriculture Act 2020 provided a framework for the UK government to create its own agricultural policy. However, agriculture is a devolved policy area, which means that each administration (England, Scotland, Wales, and Northern Ireland) can shape their own agricultural policies. This offers opportunities to develop policies closer to stakeholders that consider particular environmental, socio-demographic, and geographical characteristics. It also faces challenges such as effective coordination whenever needed. To ensure an effective coordination, the UK government and the devolved administrations agreed to establish the UK agricultural support framework to learn from each other and coordinate policies when needed. Soil management and improved soil quality can be targeted through the environmental land management scheme (ELMS) and its sustainable farming incentive [17].

These policies in the EU and the UK require investment in soil quality protection and improvement. The funding allocated to the CAP for the 2021–2027 period is EUR 387 billion, which is split into the European agriculture guarantee fund (EAGF), EUR 291.1 billion, and the European agricultural fund for rural development (EAFRD), EUR 95.5 billion. The CAP strategic plans devote EUR 98 billion (EUR 14 billion per year) to deliver

specific environmental benefits for climate, water, soil, air, biodiversity, and animal welfare and to encourage practices that go beyond the conditionality [18]. However, there is no estimate of CAP spending on soil quality protection and improvement apart from an estimate of CAP financing for sustainable soils and manure management to be approximately EUR 85 billion over 2014–2020 (EUR 12 billion per year) [19], which seems an overestimate considering the CAP strategic plans' figure.

Regarding the UK budget, agriculture transition plan 2021–2024 states the spending plans across environmental and animal welfare outcomes, improving farm prosperity and direct payments, which amounts to an average of GBP 2.4 billion a year [17]. However, there are uncertainties on the effectiveness of policy measures and agricultural practices to be applied to protect and improve soil quality (e.g., uncertainties around the effectiveness of measures to improve soil carbon sequestration [20]). These uncertainties may play a role in the public's support for public policies that support soil quality.

This study contributes to the scarce literature on the general public's valuation of agricultural soil quality protection and improvement by (a) evaluating the public support for agriculture soil quality protection and improvement policies, and (b) gaining understanding on what motivates the general public's support for agricultural soil protection and improvement. In addition, it contributes to the literature that incorporates uncertainty into the economic valuation of agricultural policies by providing a monetary valuation of policies under relatively less and more certain scenarios. To the best of our knowledge, this is the first paper to provide an economic valuation of agricultural soil quality protection and improvement in the UK and Spain and one of the scarce papers estimating the soil's economic value and how general population values soil functions and their support for public policy action [21–24]. The previous literature on willingness to pay (WTP) for soil security has provided WTP estimates for Italian and Australian citizens, indicating that there is public support for these. The average public's WTP for soil security in the Veneto region in Italy and New South Wales in Australia was estimated to be EUR 244 and AUD 567, respectively, by using a choice experiment approach [21]. Other stated preference valuation studies of soils [20,25–28] provide useful information for setting specific agri-environmental schemes contributing to manage soil in a sustainable way. However, as pointed out by Bartowski et al. [29], they are narrow in terms of the soil-based ecosystem services covered (soil erosion, carbon sequestration). Regarding soil erosion, studies using stated preference methods have also addressed other types of erosion control. Specifically, one study examined public support for erosion control programs at a popular beach resort in Sicily, Italy [30].

The structure of this paper is as follows: Section 2 covers the material and methods of this study, Section 3 presents the results of this study, Section 4 discusses the results, and finally Section 5 is dedicated to the conclusions of this study.

2. Materials and Methods

2.1. Data Collection: Survey

A cross-sectional survey instrument was designed and administered to a panel using Qualtrics. Qualtrics distributed the survey to a panel, collecting a total of 882 and 910 valid responses from the UK and Spain, respectively, in March–April 2021, for which ethical approval was according to the procedures specified by Newcastle University Research Ethics Committee. Quota restrictions were imposed on age and gender. We divided survey participants into two groups per country: Group 1 UK (n = 449); Group 2 UK (n = 433); Group 1 Spain (n = 462); Group 2 Spain (n = 448).

Both groups in each country were presented with the same background information except that those in group 2 in each country had extra text in their background information, which introduced uncertainty and ambiguity on the environmental scheme presented to improve soil quality. This was based on the fact that it is difficult to see what farmers would decide to carry out (e.g., number and type of soil management practices

that will be conducted at each farm; the number, distribution, and location of farms that would join the environmental land management scheme to implement these soil improving measures) [2].

It is worth noting that we conducted pre-tests and piloted it to refine questions, identify potential issues, and ensure that the questionnaire is clear and understandable. During the data collection process, we initially used a sample of 100 responses to verify that the provided responses were reasonable and coherent. During the main data collection, we implemented real-time supervision and monitoring to oversee the data collected. Time taken to respond to the questionnaire was recorded. Since it was expected that panel data respondents typically respond quicker than non-panel data respondents since they are usually more familiar with the survey process, having participated in previous surveys, we used only responses from respondents who answered all questions of the questionnaire and took more than 4 min to respond. The median time to respond to all questions was 18 min.

2.2. Data Collection: Questionnaire

The survey questionnaire comprised a total of 10 sections including background information, WTP questions, protest views, soil quality attitudes, trust, risk attitudes, time preference, uncertainty, pro-social behavior, and socio-demographics. In addition, the questionnaire included attention check questions to ensure that respondents were focusing on the questions asked.

2.2.1. Background Information

We presented all participants with information about soil quality and its decline in many parts of the world: "Soil quality is in decline in many parts of the world. Agricultural practices and agriculture intensification (e.g., increase in the use of fertilizers per ha) are two of the main drivers of soil quality decline. However, the use of sustainable soil management practices by farmers can help improving soil fertility and soil structure, which can reduce the risk of flooding and erosion. Hence, farmers' uptake of sustainable soil management practices is seen as key to improve soil quality and the associated environmental benefits". We also explain to UK and Spanish respondents relevant EU and UK policies. For the UK respondents, we stated that "Under the Agriculture Act 2020 the UK government establishes that it may give financial assistance for environmental protection or improvement. This means that the government may pay farmers in order to achieve these purposes. These payments may be part of the new Environmental Land Management scheme, the cornerstone of the governments' new agricultural policy. Farmers may be paid for delivering the following public goods: clean air; clean and plentiful water; thriving plants and wildlife; protection from environmental hazards; beauty, heritage and engagement with the environment; reduction of and adaptation to climate change". To Spanish respondents, we stated that "The soil protection policy of the European Union (EU) is shaped through the EU Soil Thematic Strategy. This soil policy is provided using various instruments such as the common agricultural policy (CAP). The EU can give financial support to farmers for environmental protection or improvement. These payments would be based on farmers achieving environmental benefits: clean and plentiful water; thriving plants and wildlife; protection from environmental hazards; beauty, heritage and engagement with the environment; reduction of and adaptation to climate change". Then, we asked all respondents to focus specifically on one of the ways in which farmers may contribute to protect and improve the environment, protecting or improving quality of soil, and stated that "Soil is an essential ecosystem that delivers valuable services such as the provision of food, energy and raw materials, carbon sequestration, water purification, nutrient regulation, pest control, and support for biodiversity and recreation".

Then, we provided all respondents with a table (Table 1) with information on the ways in which agricultural soil improvement can be achieved by farmers and the related benefits to soil quality and the environment.

Table 1. Soil improving cropping system components and their environmental benefits.

Soil Improving Cropping System Component	Description
Cover crops, green manures, and intercropping	Help keep ground covered over winter when rain and winds can cause erosion; can reduce need for fertilizer and supply organic N if leguminous; create habitat for insects and therefore food for birds.
Crop rotation	Rotating crops with a diverse mix of crops as well as livestock can increase soil health infiltration through different root lengths by adding a range of nutrients, therefore reducing the need for chemical inputs, improving soil structure and reducing the need for chemical pest and weed control.
Fertilization/soil amendments	Adding compost, mulch, woodchips (fresh or composted), and animal manure reduces the need for chemical fertilizers.
Soil cultivation	Reducing or eliminating the amount of plowing or tillage of the soil can improve soil health by reducing organic matter decline, keeping soil microbiology intact, and reduce compaction through less machine passes across fields as well as reducing fuel use and related emissions.
Compact alleviation	Sub-soiling can be used to alleviate compaction (increasing infiltration and soil health), as well as using diverse cover crops (the roots of which can help aerate soil and improve structure), and reducing machinery passes across fields, e.g., reducing tillage.
Controlled drainage	Re-use of water on farms; ditches, etc., to allow run-off; afforestation to reduce waterlogging. Improves crop productivity and resource use efficiency; minimizes the risk of waterlogging.
Integrated landscape management	Mixed farming and rotations across farms; hedgerows and corridors for wildlife and beneficial predators; water harvesting, e.g., through dams and reservoirs. Improves biodiversity, pest management, and cropping system sustainability on a landscape-scale.

Participants in Group 2 were given the following extra information: "However, there is uncertainty on the overall impact/success of the *Environmental Land Management scheme (for UK respondents)/EU Soil Thematic Strategy (for Spanish respondents)* (i.e., level of provision of public goods) since this depends on: (1) the number, distribution and location of farms which would join the environmental land management scheme to implement these soil improving measures, (2) the number and type of soil management practices that will be conducted in each farm." This information introduces a lack of certainty about the scheme success/outcome to respondents as well as lack of clarity on how the environmental land management scheme will be implemented (i.e., ambiguity).

2.2.2. Willingness to Pay (WTP) Questions

After the background information was presented, we moved to the WTP questions, providing the following explanation to respondents: "Next you will be asked about your willingness to pay for a policy that aims at improving the soil quality. Under this policy, the government may grant financial assistance to farmers for the protection or improvement of the environment. Payments would be given to farmers who carry out agricultural practices indicated in Table 1. This information you provide may be useful for government to establish the agri-environmental payments farmers receive in the future associated with soil quality protection and improvement". We use a double-bounded dichotomous choice contingent valuation approach. Respondents were asked to answer "yes" or "no" to the following question: "Would you be willing to pay an additional £X in your taxes each month for the next 10 years to protect and improve agricultural soil quality?", which was followed up by another question, which depended on the answer given to the first question (e.g., "You said you would not be willing to pay £5. Would you be willing to pay £1

each month for the next 10 years?"; "You said you would be willing to pay £15. Would you be willing to pay £20 each month for the next 10 years?" (See Section 2.4 for more detail).

2.2.3. Protest Answers

When respondents answered "no" twice to the WTP question, they were asked about the reasons for their answer. Table 2 shows a list of possible reasons for respondents answering "no" twice to the WTP question. Respondents were asked to select as many statements as applied as follows: "You answered that you are not prepared to pay for the proposed policy. Could you state the reason for your answer? Click as many as they apply". Responses driven by the respondent's economic constraints or failures to derive utility from protecting and improving soil quality are considered as "true zeros" (i.e., statements 1, 3, 7, and 8 are considered "true zeros"). Regarding the "other, please state" option, there were a variety of reasons including "true" and "non-true" zeros. For instance, most respondents expressed dissatisfaction with the scenario presented (e.g., "They all seem to be things the farmers are already doing or should be doing and I fail to see why they need paying to look after the farm properly—also what is it that they feel needs cash another"; "I have never known a poor farmer. Sell one of the Range Rovers and use that money"; "Farmers and government are well funded already. They don't need more taxes from already taxed people I think"). These were not considered to be a true zero due to the participant, whereas some respondents expressed economic constraints (e.g., "I am retired and I do not have any spare income"), which were considered to be "true zeros". For the UK survey, we removed a total of 87 protest responses out of 882 (9.9%) whereas from the Spanish survey, we removed a total of 88 protest responses out of 910 (9.7%), leaving a sample size for the UK of n = 882 and a sample size of n = 910 for Spain.

Table 2. Protest view statements.

	Statement
1	I cannot pay. I do not have enough income
2	I will need to have more information about this policy
3	I am skeptical the money will go to farmers
4	I am already paying tax and I think the government has to use that money to support farmers
5	It is unfair for me to pay
6	I object to the way the question is asked
7	The money collected will not make a difference
8	My employment is temporary, uncertain; therefore, my commitment cannot be long term
9	Other, please state

2.2.4. Views on Sustainable Agricultural Practice Benefits

We collected respondents' views on how important the benefits related to the implementation of sustainable practices are for them. A set of 10 benefits were stated (Table 3). To reduce data complexity, we applied a Principal Component Analysis (PCA) to the 10 statements. The PCA produced a single component, named "SAP benefits" (with strong internal consistency—alpha ranging between 0.90 and 0.93; Keiser–Meyer–Olkin (KMO) ranging between 0.92 and 0.94), which was used as an explanatory variable of the individual's WTP for agricultural soil quality protection and improvement.

Table 3. Benefits associated with the implementation of sustainable agricultural practices.

	Statement
1	Creating habitat for insects and therefore food for birds

2	Improving soil health and structure
3	Reducing the need for chemical pest and weed control
4	Reducing fuel use and related emissions
5	Improving water use efficiency
6	Minimizing risks of salinization and desertification
7	Improving crop productivity
8	Minimizing the risk of waterlogging
9	Improving biodiversity
10	Improving cropping system sustainability

2.2.5. Views on How Concerned Participants Are about Soil Quality Decline

We asked participants a question with four possible answers on how serious the issue of declining soil quality was for them. We asked "How serious is the issue of declining soil quality to you?" and the possible answers were "not at all serious", "not very serious", "fairly serious", and "extremely serious". This allowed us to classify participants into relatively concerned about soil quality decline (those who answered "fairly serious" or "extremely serious") and relatively unconcerned about soil quality decline (those who answered "not at all serious" or "not very serious"). The variable "Soil quality concern" takes a value of 1 if they are relatively concerned, and 0 otherwise, given the responses given to the question above.

2.2.6. Trust

Regarding trust, UK and Spanish participants were asked to evaluate how much trust they put in the UK/Spanish parliament; UK/Spanish government; UK/Spanish political parties; UK/Spanish politicians; Defra Department for environment and rural affairs (for UK respondents only); Spanish Ministry for Agriculture, Fisheries and Food (for Spanish respondents only); government to monitor farmers' agricultural practices; farmers to carry out sustainable agricultural practices; and agri-environmental schemes to be successful in improving soil quality. Respondents evaluated their level of trust in these using a 5-point Likert scale (none at all, a little, a moderate amount, a lot, a great deal). We conducted a PCA to identify trust dimensions and how these may affect the public's WTP. Two components were obtained, "Trust in governance" and "Trust in agriculture stewardship", which showed strong internal consistency (alpha ranging between 0.87 and 0.92; KMO ranging between 0.87 and 0.91), which were used as explanatory variables in the WTP model. We expect that the more trust respondents have in these, the more likely they are to be willing to pay for the soil quality improvement scheme.

2.2.7. Risk Attitudes

We used an experimental approach to measure risk-taking behavior following Holt and Laury's ten paired lottery choice decisions [31] (Table 4). Each of the lotteries was presented individually to respondents and consecutively (from the top lottery to the bottom lottery shown in Table 4). Respondents should cross over to option B when the probability of the payoff outcome increases enough as they "move down the table" [31]. The switching point is used as an estimate for the relative risk aversion (i.e., we use a 10-point risk aversion scale based on the switching point from option A to option B) [31]. The expected payoff (these were not provided to respondents) indicates that a risk-neutral individual would switch from option A to option B at the fifth question; an extreme-risk-averse individual would switch at the tenth question; and an extreme-risk lover would switch at the first question.

Table 4. Benefits.

Option A	Option B	Expected Payoff Difference

10% chance winning GBP/EUR 2.00 and 90% winning GBP/EUR 1.60	10% chance winning GBP/EUR 3.85 and 90% winning GBP/EUR 0.10	GBP/EUR 1.17
20% chance winning GBP/EUR 2.00 and 80% winning GBP/EUR 1.60	20% chance winning GBP/EUR 3.85 and 80% winning GBP/EUR 0.10	GBP/EUR 0.83
30% chance winning GBP/EUR 2.00 and 70% winning GBP/EUR/1.60	30% chance winning GBP/EUR/EUR 3.85 and 70% winning GBP/EUR 0.10	GBP/EUR 0.50
40% chance winning GBP/EUR 2.00 and 60% winning GBP/EUR 1.60	40% chance winning GBP/EUR 3.85 and 60% winning GBP/EUR 0.10	GBP/EUR 0.16
50% chance winning GBP/EUR 2.00 and 50% winning GBP/EUR 1.60	50% chance winning GBP/EUR 3.85 and 50% winning GBP/EUR 0.10	−GBP/EUR 0.18
60% chance winning GBP/EUR 2.00 and 40% winning GBP/EUR 1.60	60% chance winning GBP/EUR 3.85 and 40% winning GBP/EUR 0.10	−GBP/EUR 0.51
70% chance winning GBP/EUR 2.00 and 30% winning GBP/EUR 1.60	70% chance winning GBP/EUR 3.85 and 30% winning GBP/EUR 0.10	−GBP/EUR 0.85
80% chance winning GBP/EUR 2.00 and 20% winning GBP/EUR 1.60	80% chance winning GBP/EUR 3.85 and 20% winning GBP/EUR 0.10	−GBP/EUR 1.18
90% chance winning GBP/EUR 2.00 and 10% winning GBP/EUR 1.60	90% chance winning GBP/EUR 3.85 and 10% winning GBP/EUR 0.10	−GBP/EUR 1.52
100% chance winning GBP/EUR 2.00 and 0% winning GBP/EUR 1.60	100% chance winning GBP/EUR 3.85 and 0% winning GBP/EUR 0.10	−GBP/EUR 1.85

Associated with the implementation of sustainable agricultural practices.

The variable "Risk averse" takes the values at which the respondent has switched. If the respondent switches to B and comes back to A in the next question, the first switch is not considered a definite switch.

2.2.8. Time Preferences

To capture individuals' time preferences or patience, we use an approach previously used in the literature [32,33] where survey participants are given two choices from which they are asked to select one of them: either GBP/EUR 3400 this month or GBP/EUR 3800 next month. Respondents were divided into relatively patient and relatively impatient according to the choice they made. The variable "Time Preference" takes a value of 1 if the respondent is patient and 0 if they are impatient. The relationship between time preference and willingness to pay has been previously analyzed using experiments [34]. Findings indicated consumers' WTP for fuel economy improvements to be higher if payments for improvements are made more disperse through time [34]. The association between risk and time preferences and farmers' preferences for agroforestry attributes has also been investigated and it has been recommended to be included when studying the adoption of agricultural innovations [35]. We incorporate individuals' time preferences to investigate their direct association with individuals' willingness to pay.

2.2.9. Ambiguity Tolerance

As defined by McLain, ambiguity aversion theory states that decision makers prefer a known risk to an ambiguous risk [36]. In our study, there is no certainty about the level of success of the policy (i.e., granting farmers financial assistance to carry out agricultural practices in Table 1) in achieving its objective. To measure individuals' ambiguity tolerance, we used a 13-item measure of ambiguity tolerance (MSTAT-II) proposed by McLain using a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree) [37]. Table 5 shows the 13 items used. We do not have any strong prior expectation on the relationship between ambiguity tolerance and individuals' WTP for granting farmers financial assistance to carry out agricultural practices. Individuals who have a relatively high tolerance to ambiguity are more comfortable with uncertainty and more likely to be willing to pay for soil quality protection and improvement than those with relatively low tolerance to ambiguity. On the other hand, individuals with high ambiguity tolerance may be less willing to pay for soil quality protection and improvement than those with relatively low tolerance to ambiguity since the latter would like to reduce the ambiguity/uncertainty. To reduce data complexity and classify participants by their relative ambiguity tolerance level, we applied a cluster analysis. Two clusters are obtained. The variable "Ambiguity Tolerant" takes a value of 1 if the respondent is ambiguity-tolerant and 0 otherwise. We expect for ambiguity-tolerant respondents to be willing to pay more than ambiguity-intolerant respondents in general, but more in particular under an ambiguous situation such as the one presented to respondents in group 2. Ambiguity tolerance has been found to play a role in explaining organic wine purchase behaviors [38]

Table 5. MSTAT-II's 13 items to measure ambiguity tolerance.

	Statement
1	I don't tolerate ambiguous situations well
2	I would rather avoid solving a problem that must be viewed from several different perspectives
3	I try to avoid situations that are ambiguous
4	I prefer familiar situations to new ones
5	Problems that cannot be considered from just one point of view are a little threatening
6	I avoid situations that are too complicated for me to easily understand
7	I am tolerant of ambiguous situations
8	I enjoy tackling problems that are complex enough to be ambiguous
9	I try to avoid problems that don't seem to have only one "best" solution
10	I generally prefer novelty over familiarity
11	I dislike ambiguous situations
12	I find it hard to make a choice when the outcome is uncertain
13	I prefer a situation in which there is some ambiguity

2.2.10. Pro-Social Behavior

We measure pro-social individual behavior by using a set of 27 statements (Table 6) on social responsibility, empathy, moral reasoning, and self-report altruism (past helpfulness and interpersonal generosity) that participants evaluate using a 7-point Likert scale, following Rapert et al. (2021) [39]. A cluster analysis is conducted, resulting in 3 groups of respondents. The variable "pro-social behavior" takes value 1 for those with relatively high pro-social behavior; 2 for those with medium pro-social behavior; and 3 for those with relatively low pro-social behavior.

Table 6. Pro-social behavior statements.

	Statement
1	I would feel less bothered about leaving litter in a dirty park than in a clean one
2	Depending on what a person has done, there may be an excuse for taking advantage of them
3	With the pressure of grades and the widespread cheating in school nowadays, the individual who cheats occasionally is not really as much at fault
4	It doesn't make much sense to be very concerned about how we act when we are sick and feeling miserable
5	If I broke a machine through mishandling, I would feel less guilty if it was already damaged before I used it
6	When you have a job to do, it is impossible to look out for everyone's best interest
7	When I see someone being taken advantage of, I feel kind of protective towards them
8	Other people's misfortunes usually disturb me a great deal
9	When I see someone being treated unfairly, I usually feel pity for them
10	I am often quite touched by things that I see happen
11	I often have tender, concerned feelings for people less fortunate than me
12	I often feel very sorry for other people when they are having problems
13	I would describe myself as a pretty soft-hearted person
14	My decisions are usually based on my concern for other people
15	I choose a course of action that maximizes the help other people receive
16	My decisions are usually based on concern for the welfare of others
17	I choose alternatives that minimize the negative consequences to other people
18	I have helped carry a stranger's belongings (e.g., books, packages, groceries, etc.)
19	I have let a neighbor whom I didn't know too well borrow an item of some value (e.g., tools, a dish, etc.)
20	I have, before being asked, voluntarily looked after a neighbor's pet or children without being paid for it
21	I have offered to help a handicapped or elderly stranger (e.g., to cross a street, to lift something, etc.)
22	When one of my loved ones needs my attention, I really try to slow down and give them the time and help they need
23	I am known by family and friends as someone who makes time to pay attention to others' problems
24	I'm the kind of person who is willing to go the "extra mile" to help take care of my friends, relatives, and acquaintances
25	When friends or family members experience something upsetting or discouraging, I make a special point of being kind to them
26	It makes me very happy to give to other people in ways that meet their needs
27	I make it a point to let my friends and family know how much I love and appreciate them

2.2.11. Socio-Demographics

We also collected respondents' information on their age, gender, highest level of education completed (primary school, secondary school, college qualification (e.g., Diploma), University degree (e.g., BA, BSc, Master's, PhD, PGCE), and level of income. Regarding the level of income, we asked respondents to indicate their approximate annual

household income before taxes by selecting 1 out of 11 income value ranges from less than GBP/EUR 10,000 to GBP/EUR 100,000 or more.

2.3. Conceptualization of the Analysis

Figure 1 illustrates the model variables and how the process was followed to obtain them. We use a set of constructs including views on the benefits associated with sustainable agricultural practices; views on soil quality decline; individuals' ambiguity tolerance, pro-social behavior, and time and risk preferences; and their trust in governance and agriculture stewardship to investigate the heterogeneity in the WTP for soil quality protection and improvement through payments to farmers to carry out sustainable agricultural practices. Figure 1 also shows how the constructs have been derived or what information is contained (e.g., socio-demographics). This is applied to both groups of UK and Spanish respondents (those to whom extra background information was provided on uncertainty and ambiguity on the environmental scheme presented to improve soil quality and those to whom this information was not presented).

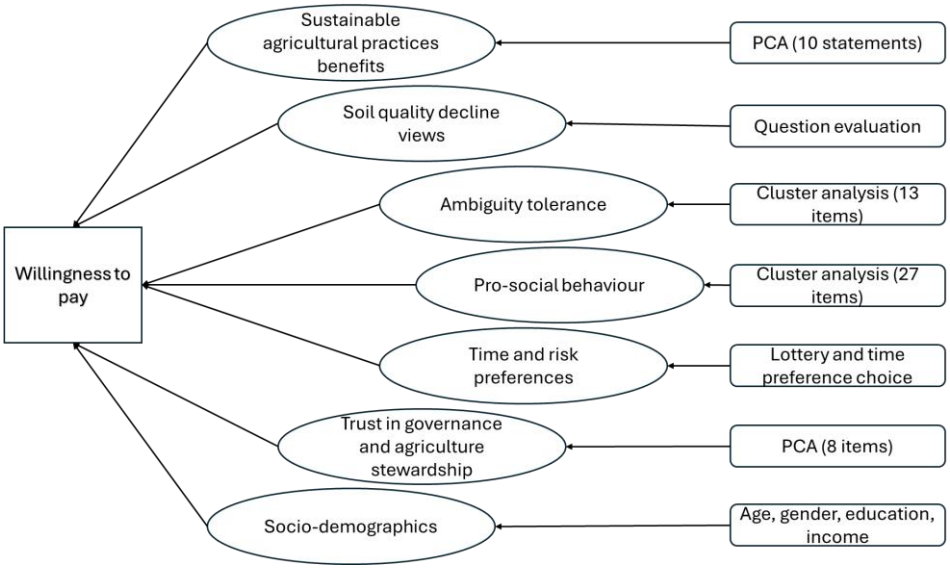

Figure 1. Conceptual framework.

2.4. Data Analysis: Double-Bounded Dichotomous Choice Contingent Valuation

We use a double-bounded dichotomous choice contingent valuation approach to elicit the general public's WTP for soil quality improvement through the implementation of policies aiming at farmers to uptake sustainable agricultural practices. The payment vehicle is a monthly tax to be paid in the next 10 years. All participants were first asked whether they would be "willing to pay an additional £/€X in their taxes each month for the next 10 years to protect and improve agricultural soil quality". The initial bids were GBP/EUR 5, GBP/EUR 15, GBP/EUR 25, GBP/EUR 35, and GBP/EUR 45. These were randomly distributed so that each respondent had the same probability to be shown any of these bids. If the respondent answered "yes" ("no") to the initial question, then the respondent was asked whether they would be willing to pay a higher (lower) amount. The corresponding higher (and lower) amounts were +GBP/EUR 5 (−GBP/EUR 5) with respect to the original bid. This is GBP/EUR 10, GBP/EUR 20, GBP/EUR 30, GBP/EUR 40, and GBP/EUR 50 for the "yeses" and GBP/EUR 1, GBP/EUR 10, GBP/EUR 20, GBP/EUR 30, and GBP/EUR 40 for the "noes".

2.5. Data Analysis: Model Estimation

Random Utility Model (RUM) provides the theoretical basis for the double-bound contingent valuation method used. Under RUM, individuals choose alternatives that maximize their utility. We use an interval regression to estimate the WTP model. Our model specification is

$$WTP_i = f(x_i; \beta) + \epsilon_i$$

where $f(x_i; \beta) = \alpha + \beta x_i + \varepsilon_i$; WTP_i is the WTP (latent variable) of respondent i for a policy program to protect and improve agricultural soil quality; x_i is a vector of explanatory variables including respondents' views on the benefits of sustainable agricultural practices (SAP_benefits), soil quality decline views (soil quality concern), respondents' ambiguity tolerance (ambiguity tolerance), pro-social behavior (pro-social behavior), time preference, risk preference, trust in governance, trust in agriculture stewardship, age, gender, and education level and income; β is a vector of coefficients associated with the explanatory variables to be estimated; and ϵ is the normally distributed error term. The probability of the respondent's WTP for a policy program to protect and improve agricultural soil quality is $Pr\{WTP_i \subseteq (B_i^L, B_i^U)\} = \phi(Z_i^L) - \phi(Z_i^U)$, where B_i^L and B_i^U are the respondent's WTP lower and upper bounds; Z_i is the standard normal random variable, and ϕ represents the standard normal cumulative distribution function (cdf) with $Z_i^L = \frac{B_i^L - \alpha + \beta x_i + \epsilon_i}{\sigma}$ and $Z_i^L = \frac{B_i^U - \alpha + \beta x_i + \epsilon_i}{\sigma}$.

We estimate 4 models: (1) UK respondents—no uncertain and ambiguous background information presented; (2) UK respondents—uncertain and ambiguous background information presented; (3) Spanish respondents—no uncertain and ambiguous background information presented; (4) Spanish respondents—uncertain and ambiguous background information presented.

3. Results

This section is structured as follows: Section 3.1 reports the descriptive statistics and Section 3.2 reports the results obtained from the interval regression estimation of the WTP models for UK and Spain (control and treatment).

3.1. Descriptive Statistics

The sample descriptive statistics of the variables used in the statistical models is presented in Table 7. No major differences exist between control and treatment groups for the UK and Spanish respondents. Regarding differences between countries, Spanish respondents are on average relatively more concerned about soil quality, less risk-averse, and more impatient and have less trust in governance but more trust in stewardship than UK respondents.

Table 7. Sample descriptive statistics.

	UK—Control (n = 449)	UK—Treatment (n = 433)	ESP—Control (n = 462)	ESP—Treatment (n = 448)
Variable	**Mean (Std Dev)**	**Mean (Std Dev)**	**Mean (Std Dev)**	**Mean (Std Dev)**
SAP benefits	7.993 (1.530)	8.031 (1.654)	8.404 (1.381)	8.375 (1.375)
Soil quality concern	0.744 (0.437)	0.736 (0.442)	0.907 (0.291)	0.920 (0.272)
Ambiguity tolerance	0.492 (0.500)	0.416 (0.493)	0.444 (0.497)	0.426 (0.495)
Pro-social behavior—high	0.565 (0.497)	0.515 (0.500)	0.584 (0.493)	0.581 (0.494)
Pro-social behavior—low	0.437 (0.497)	0.485 (0.500)	0.419 (0.493)	0.420 (0.494)

Risk aversion	6.933 (2.305)	6.952 (2.370)	6.394 (2.487)	6.469 (2.383)
Time preference	0.759 (0.428)	0.733 (0.443)	0.571 (0.495)	0.583 (0.494)
Trust in governance	2.874 (2.030)	3.145 (2.313)	2.524 (2.010)	2.641 (2.199)
Trust in stewardship	4.606 (1.830)	4.962 (1.873)	5.124 (1.859)	5.452 (2.030)
Age	46.909 (15.816)	45.951 (15.642)	42.982 (13.619)	42.728 (13.317)
Gender	0.508 (0.500)	0.494 (0.501)	0.487 (0.500)	0.520 (0.500)
Education level—primary/secondary/professional	0.256 (0.437)	0.296 (0.457)	0.297 (0.457)	0.261 (0.440)
Education level—college	0.254 (0.436)	0.233 (0.423)	0.271 (0.445)	0.277 (0.448)
Education level—university/postgraduate degree	0.490 (0.500)	0.471 (0.500)	0.433 (0.496)	0.462 (0.499)
Income	37,895 (23,262)	40,471 (26,185)	29,437 (20,535)	29,218 (20,482)

Regarding the representativeness of the sample, the age, gender, and income level statistics align closely with those reported by the UK Office for National Statistics (ONS) and the Spanish Instituto Nacional de Estadística (INS). The educational categories used in this study are not directly comparable to those used by the ONS or the INS. However, some comparisons are still possible.

The UK government Office for National Statistics (ONS) reports that median gross annual earnings for full-time employees were GBP 34,963 in April 2023, which is similar to our sample median of GBP 35,000 [40]. In the year mid-2022, the median age of the UK population was 40.7 years, which is below the median sample age of 46.9 and 45.9 years (control and treatment) for the UK [41].

For education, the ONS provides information on the highest level of education for England and Wales. On the education level, the ONS indicates that 18.2% of the population in England and Wales in 2021 had no qualifications; 23.0% have achieved level 1/level 2 education [42]. Our sample does not have respondents with no qualifications; 27.8% of respondents have completed primary and secondary education; and 23.9% of respondents have a college degree, a group that can be comparable in some cases to an ONS apprenticeship and level 3 classifications, 5.3% and 16.9%, respectively (22.2%). Level 4 or above is comparable with our classification of a University/Post-graduate degree. The ONS statistic of level 4 is 33.8% whereas the sample includes University/Post-graduate degrees at 48.3%, indicating that our sample may be overrepresenting a higher-educated population in the UK.

The Spanish Instituto Nacional de Estadística (National Statistical Institute) reports that the mean gross annual earnings were GBP 26,949 in 2022, which is similar to our sample median of GBP 29,437 and GBP 29,218 for the control and treatment groups, respectively [43]. The level of education of the Spanish population in 2021 was 36.1% primary education, 23.2% secondary education, and post-secondary as non-superior (e.g., Bachelor's) and superior education (e.g., university degree, PhD) at 40.7% [44]. This compares to our sample as follows: primary and secondary education, and professional, of 56.8% and 53.8 (for control and treatment groups, respectively, which is similar to 36.1% + 23.2% = 59.3%); and 43.3% and 46.2% of respondents achieving superior education. The average age of the Spanish population in 2022 was 44.06 years [45], which is comparable to the sample average, which is 43.0 and 42.7 years (control and treatment samples).

Hence, while our sample adequately reflects the demographics of both the UK and Spanish populations in terms of age, gender, and income levels, it underrepresents people with no qualifications and overrepresents people with higher education in the UK.

Therefore, while the demographics match closely, some caution should be exercised in generalizing our findings to the entire UK and Spanish populations. However, although it may not be possible to claim that the sample is fully representative of the entire UK and Spanish populations, it still provides valuable insights into the views and attitudes associated with willingness to pay for soil protection and improvement that, while not universally applicable, may still be indicative of broader views and attitudes within the population as well as a reasonable approximation to the average willingness to pay for soil protection and improving, contributing to the body of knowledge in this area and informing future policy.

3.2. Willingness to Pay: Control and Treatment Models

3.2.1. UK—Willingness to Pay for Agricultural Soil Quality Improvement

Table 8 presents the results of the WTP models for the UK control and treatment models. Results for the control group show that individuals who appreciate the benefits of sustainable agricultural practices (SAPs) are willing to pay more for soil quality protection and improvement than those who do not appreciate the benefits of SAP. Likewise, those respondents who are concerned about soil quality are more willing to pay for soil quality protection and improvement than those who are relatively less concerned. We found that the more tolerant to ambiguity the individual is, the less they are willing to pay for soil quality protection and improvement. Also, pro-social behavior was not found to be associated with WTP for soil quality improvement. Risk and time preferences were not found to be associated with the WTP for soil quality protection and improvement for the control group. Age was found to be associated with individuals' WTP for soil quality protection and improvement. Thus, relatively older respondents were willing to pay less than younger respondents. Likewise, women were found to be willing to pay less than male respondents. Education was not found to be associated with individuals' WTP for soil quality protection and improvement.

Table 8. WTP interval regressions (UK).

	UK—Control		**UK—Treatment**	
Variable	**Coeff. (Std Dev)**	***p*-Value**	**Coeff. (Std Dev)**	***p*-Value**
Constant	12.686 (6.006)	0.035 **	6.836 (6.735)	0.310
SAP benefits	1.485 (0.545)	0.006 ***	1.570 (0.577)	0.007 ***
Soil quality concern	6.698 (1.778)	0.000 ***	3.524 (2.089)	0.092 *
Ambiguity tolerance	−3.331 (1.415)	0.019 **	−2.631 (1.609)	0.102
Pro-social behavior—high	2.436 (1.565)	0.120	0.067 (1.725)	0.699
Risk aversion	−0.284 (0.316)	0.320	−0.660 (0.348)	0.058 *
Time preference	−2.021 (1.566)	0.197	−4.615 (1.850)	0.013 **
Trust in governance	0.397 (0.399)	0.320	0.462 (0.466)	0.322
Trust in stewardship	0.147 (0.472)	0.755	0.794 (0.588)	0.177
Age	−0.149 (0.046)	0.001 ***	−0.102 (0.055)	0.064 *
Gender	−2.076 (1.489)	0.046 **	−0.641 (1.651)	0.698
Education level—college	0.691 (1.943)	0.722	1.834 (2.194)	0.403
Education level—university/post-graduate degree	1.718 (1.759)	0.329	2.557 (1.938)	0.187
Income	9.3×10^{-5} (3.2×10^{-5})	0.004 ***	7.3×10^{-5} (3.4×10^{-5})	0.030 **
n	449		433	
Log-likelihood	−631.628		−682.096	

LR chi2	85.85	68.72

Note: * indicates statistical significance at 10%; ** indicates statistical significance at 5%; *** indicates statistical significance at 1%.

The results for the treatment group (i.e., these respondents were shown information that introduced uncertainty and ambiguity on the environmental scheme presented to improve soil quality) are similar to the control group for SAP benefits, soil quality concern, pro-social behavior, trust in governance and stewardship, age, and income. However, the results from the treatment group also present some key differences with respect to the results obtained from the control sample. Although the coefficient associated with soil quality concern is statistically significant (p-value < 0.10), as it is for the control group, the relationship between this and the individual's WTP is weaker. The association between ambiguity tolerance and WTP association is less evident in the treatment group than in the control group (p-value = 0.019 in the control group; p-value = 0.102 in the treatment group). Individuals' risk aversion and time preference were found to be associated with the WTP. Thus, individuals who are relatively more risk-averse in the treatment group are willing to pay less than individuals who are relatively less risk-averse (p-value < 0.10). Also, relatively more patient individuals are less willing to pay for soil quality protection and improvement than relatively less patient individuals (p-value < 0.05). The gender difference in WTP is not present in the treatment group.

It is worth noting that although the estimated coefficients for the control and treatment pro-social behavior are not statistically significant (p-value > 0.10), there is a significant difference between them, suggesting that introducing uncertainty and ambiguity in the message may have influenced individuals' tendency to support the policy program.

3.2.2. Spain—Willingness to Pay for Agricultural Soil Quality Improvement

Table 9 shows the results of the WTP models for the Spain control and treatment models. Results for the control group show that, similarly to the UK control model, individuals who appreciate the benefits of sustainable agricultural practices (SAPs) and are concerned about soil quality are willing to pay more for soil quality protection and improvement than those who do not appreciate the benefits of SAP or are not concerned about soil quality. Unlike for the UK case, we found that for the Spain case, the tolerant ambiguity is not associated with individuals' WTP for soil quality protection and improvement, but individuals who have a relatively high pro-social behavior are willing to pay more than individuals with a relatively low pro-social behavior. Spanish respondents who have trust in governance are willing to pay higher amounts than those who place no trust in governance, something that was not found in the UK case. Risk and time preferences were not found to be associated with the WTP for soil quality protection and improvement for the control group, as in the UK case. Age was found to be associated with individuals' WTP for soil quality protection and improvement whereas gender was not found to be associated with WTP more or less for quality improvement. No differences in WTP were found across education and income levels. This result suggests that the impact of the overrepresentation of higher-educated respondents in the sample is likely limited in terms of influencing the specific findings related to willingness to pay.

Table 9. WTP interval regressions (Spain).

	Spain—Control		**Spain—Treatment**	
Variable	**Coeff. (Std Dev)**	***p*-Value**	**Coeff. (Std Dev)**	***p*-Value**
Constant	9.887 (6.429)	0.124	−2.034 (6.899)	0.768
SAP benefits	1.483 (0.695)	0.033 **	1.898 (0.714)	0.008 ***
Soil quality concern	5.432 (3.054)	0.075 *	3.571 (3.180)	0.261
Ambiguity tolerance	0.340 (1.657)	0.837	2.096 (1.639)	0.201

Pro-social behavior—high	4.287 (1.779)	0.016 **	1.732 (1.815)	0.340
Risk aversion	0.185 (0.327)	0.572	−0.023 (0.346)	0.947
Time preference	−0.376 (1.637)	0.818	−0.661 (1.654)	0.689
Trust in governance	1.075 (0.446)	0.016 **	0.958 (0.414)	0.021 **
Trust in stewardship	0.569 (0.485)	0.209	0.617 (0.451)	0.182
Age	−0.235 (0.063)	0.000 ***	−0.084 (0.063)	0.182
Gender	−2.124 (1.691)	0.217	−0.617 (1.708)	0.720
Education level—college	−0.628 (2.151)	0.770	−0.474 (2.218)	0.831
Education level—university/postgraduate degree	−0.080 (2.019)	0.968	2.083 (2.004)	0.299
Income	5.5×10^{-5} (4.4×10^{-5})	0.182	10×10^{-5} (4.3×10^{-5})	0.013 **
n	462		433	
Log-likelihood	−619.963		−586.911	
LR chi2	50.47		46.97	

Note: * indicates statistical significance at 10%; ** indicates statistical significance at 5%; *** indicates statistical significance at 1%.

For Spanish respondents who were shown information that introduced uncertainty and ambiguity on the environmental scheme presented to improve soil quality, the treatment group, the model shows similar results to the control group regarding SAP benefits, ambiguity tolerance, risk aversion, time preference, and trust in governance and stewardship. However, as in the UK case, the results from the treatment group also present some key differences with respect to the results obtained from the control sample. For these groups of respondents who were presented with a relatively more uncertain and ambiguous message about the impact/success of the schemes aiming to protect and improve soil quality, the only factors associated with their WTP were their appreciation for the benefits associated with sustainable agricultural practices, their level of trust in governance, and their level of income.

The estimated sample average and median WTP for UK and Spanish respondents in control and treatment groups is shown in Table 10.

Table 10. Average and median monthly and annual WTP by country and respondents' group.

Country and Group	Monthly Average WTP	Monthly Median WTP	Annual Average WTP	Annual Median WTP
UK—control (GBP)	18.33	18.59	220	223
UK—treatment (GBP)	20.26	19.72	243	237
Spain—control (EUR)	24.37	24.40	292	293
Spain—treatment (EUR)	23.82	23.89	286	287

Figure 2 shows the willingness to pay distribution for control and treatment groups for UK and Spanish respondents. Although the control and treatment monthly average willingness to pay results for the UK and Spain that appear are opposite, the willingness to pay distribution indicates that such differences are not significant at the willingness to pay distributional level.

As pointed out, we found significant heterogeneity in individuals' WTP for soil quality protection and improvement. Tables 11 and 12 show the average WTP for control and treatment groups and the difference between them under 18 different combination levels for SAP benefits, soil quality concern, pro-social behavior, and trust in governance.

Table 11. UK average WTP for control and treatment groups under 18 combination levels.

SAP Benefits	Soil Quality Concern	Pro-Social Behavior	Trust in Governance	Average WTP Control	Average WTP Treatment	Diff. (%)
5	5	Low	5	41.84	31.45	−10.39 (−24.83)
5	5	High	5	44.27	31.38	−12.88 (−29.10)
1	1	Low	1	7.52	9.38	1.86 (24.73)
1	1	Low	10	11.09	13.70	2.61 (23.53)
1	1	High	1	9.96	9.44	−0.52 (−5.22)
1	1	High	10	13.53	13.77	0.24 (1.77)
1	10	Low	1	67.80	40.82	−26.98 (−39.79)
1	10	Low	10	71.37	45.15	−26.22 (−36.74)
1	10	High	1	70.24	40.89	−29.35 (−41.79)
1	10	High	10	73.81	45.22	−28.59 (−38.73)
10	1	Low	1	20.88	23.12	2.24 (10.73)
10	1	Low	10	24.45	27.45	3.00 (12.27)
10	1	High	1	23.32	23.19	−0.13 (−0.56)
10	1	High	10	26.89	27.51	0.62 (2.31)
10	10	Low	1	81.16	54.57	−26.59 (−32.76)
10	10	Low	10	84.73	58.90	−25.83 (−30.49)
10	10	High	1	83.60	54.64	−28.96 (−34.64)
10	10	High	10	87.17	58.96	−28.21 (−32.36)

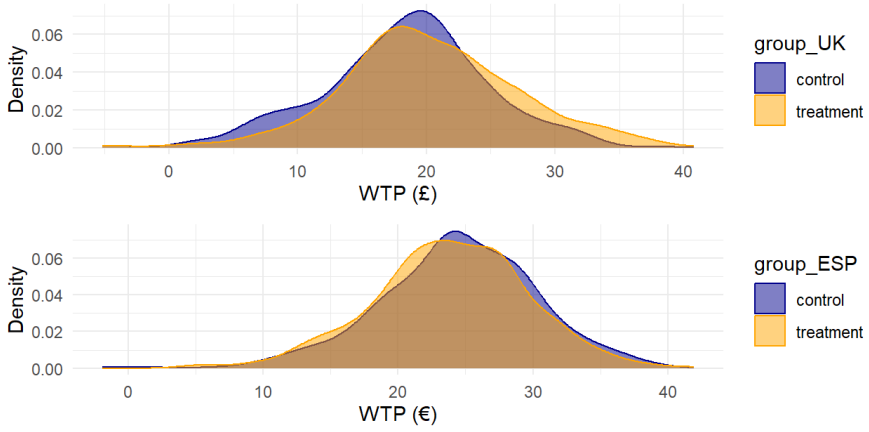

Figure 2. Willingness to pay distribution for control and treatment groups (UK and Spain).

Table 12. Spain average WTP for control and treatment groups under 18 combination levels.

SAP Benefits	Soil Quality Concern	Pro-Social Behavior	Trust in Governance	Average WTP Control	Average WTP Treatment	Diff. (%)
5	5	Low	5	41.93	33.22	−6.98 (−20.77)
5	5	High	5	45.57	34.95	−12.35 (−23.30)
1	1	Low	1	9.60	7.51	−2.09 (21.77)
1	1	Low	10	19.50	16.13	−3.37 (−17.28)
1	1	High	1	13.23	9.25	−3.98 (−30.08)
1	1	High	10	23.15	17.86	−5.29 (−22.85)
1	10	Low	1	58.59	39.65	−18.94 (−32.33)
1	10	Low	10	68.50	48.27	−20.23 (−29.53)
1	10	High	1	62.23	41.39	−20.84 (−33.49)
1	10	High	10	72.14	50.01	−22.13 (−30.68)
10	1	Low	1	23.45	24.60	1.15 (4.90)
10	1	Low	10	33.36	33.22	−0.14 (−0.42)
10	1	High	1	27.09	26.33	−0.76 (−2.81)
10	1	High	10	37.00	34.95	−2.05 (−5.54)
10	10	Low	1	72.44	56.74	−15.70 (−21.67)
10	10	Low	10	82.35	65.36	−16.99 (−20.63)
10	10	High	1	76.08	58.47	−17.61 (−23.15)
10	10	High	10	85.99	67.09	−18.90 (−21.98)

4. Discussion

We have found that there is significant public support for governments to provide financial assistance to farmers to improve soil quality through the use of sustainable agricultural practices. Our individuals' average and median WTP estimates are in line with recent research on the WTP estimates for soil security in Italy (EUR 244) and Australia (AUD 567) [21]. These estimates were obtained using an annual tax to be paid in the next 5 years as vehicle payment. Our vehicle payment was a monthly tax for the next 10 years. We estimated that the median annual WTP for agricultural soil quality protection and improvement is GBP 223 and EUR 293 (GBP 248 at GBP 1 = GBP 0.85 28 June 2024 exchange rate) for the UK and Spain, respectively. The estimates obtained once there was the introduction of uncertainty and ambiguity are GBP 237 and EUR 287 (GBP 243 at GBP 1 = GBP 0.85 28 June 2024 exchange rate) for the UK and Spain, respectively. These estimates allow us to provide an estimate of the capital value of programs supporting farmers financially to conduct sustainable agricultural practices to aim for agricultural soil quality improvement. For the UK, the annual capital value estimate is GBP 15.1–GBP 16.0 billion, whereas the annual capital value of the program for Spain is EUR 13.9–14.2 billion (using median WTP estimates with and without uncertainty and ambiguity and UK population data [42,46]). These are significantly higher than the annual GBP 2.4 billion and EUR 14 billion the UK and EU annual budgets allocated to UK agriculture transition plan 2021–2024 and the EU budget to deliver specific environmental benefits for climate, water, soil,

air, biodiversity, and animal welfare and to encourage practices that go beyond the conditionality.

We found that providing information about the uncertainty on the overall impact/success of the ELMS scheme/EU Soil Thematic Strategy (i.e., level of provision of public goods) alters the average and median WTP as well as the reasons that individuals have for being (or not) willing to pay for soil quality protection and improvement. We found that introducing information to respondents on the level of uncertainty of the program has an impact on their average WTP, with a 10.5% and 6.3% higher result in the average respondents' mean and median WTP for UK treatment respondents than UK control respondents and a 2.3% and 2.1% fall in the average respondents' mean and median WTP for Spanish treatment respondents compared to Spanish control respondents. These opposite results on the effect of introducing uncertainty can be explained by the significant heterogeneity in what motivates respondents' WTP for soil quality protection and improvement between the two countries. When uncertainty is introduced, the base willingness to pay falls (constant coefficient falls from 12.686 to 6.836), but this is offset by the role of UK respondents' positive views on sustainable agricultural practices, risk aversion, and time preferences, which become more relevant in their willingness to pay whereas concern for soil quality, ambiguity tolerance, and socio-demographics become less relevant. When estimating the individuals' willingness to pay, it is UK respondents' positive views on sustainable agricultural practices, the lesser influence of gender, and the higher influence of the level of trust in stewardship that push the willingness to pay estimate up from the UK control willingness to pay estimate. On the other hand, for Spanish respondents, when uncertainty is introduced, the base willingness to pay falls heavily (constant coefficient falls from 9.887 to −2.034). This is not fully offset by factors accounted for in the model, resulting in the willingness to pay estimates being slightly down compared to the control group. For Spanish respondents, what explains individuals' WTP moves away from aspects associated with individuals' level of concern for soil quality, their level of pro-social behavior, and their age towards individuals' appreciation of SAP benefits and their level of income.

We found that the more tolerant to ambiguity, the less individuals are willing to pay for soil quality protection and improvement. This may indicate that the less ambiguity-tolerant an individual is, the more the individual is keen to remove such ambiguity and therefore would be willing to pay for it.

Under uncertainty, relatively more risk-averse individuals in the UK are less willing to pay than less risk-averse individuals (i.e., relatively more risk-averse individuals value less a program aiming at protecting and improving soil quality when they are informed about the uncertainty of the success of the policy). This effect was not found for Spanish respondents. Results indicating a negative relationship between risk aversion and willingness to pay have been reported in different studies (e.g., for improved agricultural technologies [47]; energy-efficient insulation and ventilation systems in rental apartments [48]; insurance contracts [49]; and functional food [50]).

Regarding potential limitations of this study, it is worth mentioning that, although widely used, there have been contentious discussions regarding the multiple discrete choice (DCm) approach reliability [51]; its internal consistency [52] ; and hypothetical bias [53-55]. The DCm approach may suffer from hypothetical bias, i.e., a deviation from real market evidence, if the study was conducted in hypothetical situations with no consumption consequences for the participants [56]. However, on the other hand, [57] suggested double dichotomous choice as an efficient approach to obtaining contingent valuation estimates. Carson et al. (2003) [58] indicated that a careful contingent valuation survey design and development could reduce the concern of biased estimates of DCm, especially when a large-scale survey was employed rather than a small-size experiment. The above literature highlights the still inconclusive justification of using DCm for measuring WTP, and motivates the present study.

This study has developed a conceptual framework that can be altered to answer other types of questions compared to the ones presented here. We recommend that future valuation research incorporates elements of uncertainty and ambiguity into the analysis.

5. Conclusions

There is significant public support for agricultural soil quality protection and improvement in both Spain and the UK. Individuals' reasons for supporting and being willing to pay for a soil protection program change with increased uncertainty and ambiguity about the program's impact and results. These reasons may also vary across countries. These findings align with previous literature, which highlights significant spatial variation in responses to policy and biodiversity impacts. [7].

Results suggest that as the general public, being supportive of public policies, becomes more aware of the level of uncertainty around the success of achieving policy objectives, they can remain supportive of those public policies but their reasons for supporting them may change. Hence, under an increased public awareness on the level of uncertainty about a policy/program outcomes, actions to try to gain/keep public support should differ from actions taken to gain/keep support where public awareness on the level of uncertainty is low. It is also important to acknowledge that since the individual's reasons to support a public policy may change once the individual becomes more aware of the uncertainty around achieving the policy objectives and that these may vary across geographical locations, any action to gain/keep public support needs to be tailored to the relevant geographical area (e.g., country, region). For instance, for the case of promoting public support for soil protection, illustrating the benefits of SAP is important to gain/keep support in both countries studied, regardless of the level of policy outcome uncertainty. However, using other approaches such as promoting public support for soil protection through messages focusing on soil quality concerns may be less effective, when the public is aware of the uncertainty around the success of soil protection objectives, especially in Spain. Similarly, messages promoting pro-social behavior to gain/keep policy support for agricultural soil quality protection and improvement are less likely to be effective when the public is aware of the uncertainty of the success of these policies.

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