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Effects of Experience, Knowledge and Signals on Willingness to Pay for a Public Good

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Abstract

This paper compares how increases in experience versus increases in knowledge about a public good affect willingness to pay (WTP) for its provision. This is challenging because while consumers are often certain about their previous experiences with a good, they may be uncertain about the accuracy of their knowledge. We therefore design and conduct a field experiment in which treated subjects receive a precise and objective signal regarding their knowledge about a public good before estimating their WTP for it. Using data for two different public goods, we show qualitative equivalence of the effect of knowledge and experience on valuation for a public good. Surprisingly, though, we find that the causal effect of objective signals about the accuracy of a subject's knowledge for a public good can dramatically affect their valuation for it: treatment causes an increase of $150-$200 in WTP for well-informed individuals. We find no such effect for less informed subjects. Our results imply that WTP estimates for public goods are not only a function of true information states of the respondents but *beliefs* about those information states.

Keywords: Information, Beliefs, Field Experiment, Valuation, Uncertainty, Choice Experiment

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1. Introduction

Familiarity with economic decisions can significantly influence how those economic decisions are made. For example, direct experience with a good can influence an economic agent's valuation for that good (Nelson 1970, Erdem and Keane 1996, Ackerberg 2003). Even in the absence of direct personal experience, additional information in the form of expert advice or objective information about a good or economic game can affect economic decision making (Schotter 2003, Eil and Rao 2011, Grossman and Owens 2012). In other words, not only does direct experience matter for economic decision making, but so do other measures of familiarity such as objective information.

While economic research shows that various measures of familiarity can affect important economic decisions, like willingness to pay (WTP) for a good, it is unclear exactly how similar or different these various measures of familiarity are. For example, it is an open question in the economics literature whether previous consumption experience with a good and a priori knowledge about a good affect a consumer's WTP in precisely the same way.[7] While it is intuitive that experience and knowledge could be substitutes for each other, they are intrinsically different: consumers know with reasonable certainty whether or not they have had previous experience with a good.[8] Conversely, consumers might be uncertain as to the accuracy of their knowledge about a good.

We test two hypotheses in this paper to address these unresolved issues in the context of public good valuation. The first hypothesis tests for differences between how increases in experience versus increases in knowledge influence WTP estimates for two different public goods. Specifically, we use two choice experiments to estimate the relationship between information and experience on the mean and

[7] By a priori knowledge, we mean knowing objective information about a good without having consumed it. For example, if a consumer has never driven a particular car, but knows its safety rating or horsepower to weight ratio we define that to be a priori knowledge.

[8] If consumers do not have full recall or display bounded rationality, this claim is not true. We abstract from this concern in the current paper.

variance of stated WTP for two different public goods: one that consumers can easily experience directly (beach quality) and one that consumers cannot experience directly (a deep-sea marine reserve for cold water corals).[9] When direct experience is not possible, we measure subjects' knowledge by giving them a quiz on objective information about a public good (e.g., cold water corals). These particular public goods provide and ideal forum for testing the comparative statics of how increases in a consumer's experience versus increases in knowledge influence willingness to pay estimates since deep-sea cold water corals cannot be directly experienced.[10] While previous research shows that previous experience and information provided to survey participants can influence WTP estimates, we are not aware of any research which evaluates how similar or dissimilar knowledge about a good versus experience with a good are in the context of stated preference measures of WTP. (List and Gallet 2001, Landry and List 2007; Munro and Hanley, 1999; Boyle et al., 1993, Whitehead et al., 1995, Cameron et al., 1997, Ferrini et al., 2007, Hanley et al., 2009, Czajkowski et. al. 2013).

The second hypothesis uses a purely experimental design embedded in a stated preference survey to test the causal effect of objective signals of subjects' knowledge about a public good on the level and certainty of their stated WTP. We embed a field experiment within a choice experiment designed to elicit WTP for a deep sea marine reserve intended to preserve cold water coral (CWC). The experiment is constructed as follows: at the beginning of the stated preference survey we provided basic information about CWCs. Next, all subjects take a short quiz that asks brief objective questions which probe their understanding of the public good. Subjects are randomly assigned to a treatment or control group. In the treatment group, subjects are informed of their test scores immediately after completing

[9] Simple models of Bayesian updating show that more experience with a good will cause consumers to be more certain about their valuation of goods (Czajkowski et. al. 2013).

[10] Importantly, our estimates for the effect of increases in experience or knowledge about the good are not causal. The first hypothesis in this paper is not to identify the causal of experience and the causal effect of knowledge. Rather, it is to test for the similarities or differences between how WTP for a public good are related to increases in consumers' experience versus increases in consumer knowledge. As shown in Czajkowski et. al. 2013, though, failing to control for the effects of different levels of experience in WTP results in a misspecified demand equation and can lead to biased WTP estimates if not properly controlled for.

the quiz.[11] In the control group, subjects are not informed of their test scores. This allows us to identify the causal effect of objective signals of a consumer's knowledge about a public good on the mean and precision of willingness to pay estimates.

With respect to the first hypothesis, we find that experience and knowledge influence the precision of willingness to pay estimates in the same way. Respondents with either more experience or more knowledge give significantly more precise willingness to pay estimates and are also both willing to pay more for changes in public good provision relative to the status quo. Even though this set of results is not causal it still has potentially important implications: subjects in many stated preference surveys have no reasonable opportunity to obtain direct experience with a public good (e.g., a deep-sea marine reserve for cold water corals) but may indeed have *a priori* knowledge. To compensate for this, the econometrician gives the subject objective information about the public good being studied. If additional information and additional experience operate on stated WTP in the same way, it raises interesting questions on the nature of the stated preference WTP estimate of the econometrician.[12]

We find a surprising result with respect to the second hypothesis: informing a subject of their test score when they are well-informed causes a significant increase in stated WTP of between $150 and $200 dollars for establishing a large marine protected area. We find, however, that giving well-informed subjects objective signals about their knowledge does not uniformly increases the certainty of WTP estimates. Rather, we find that the treatment effect varies over existence versus indirect use values of the public good. We find neither of these effects for individuals who are not well-informed.

Our experimental result is different from previous work which shows that objective signals about an economic agent's subjective beliefs about themselves (e.g., their attractiveness to the opposite sex)

[11] Treated subjects are not, though, told how their score relates to other individuals' scores.
[12] The revealed preference analog would be estimating demand for a good after the econometrician gives the consumer a free sample of the good.

affects economic decision making (Eil and Rao 2011) or that agents don't update negative signals in the same way as positive signals (Grossman and Owens 2012). We instead find that objective signals conveying positive information significantly affect stated willingness to pay estimates. In a stated preference context, the implication is that an external signal of the extent of people's knowledge about a public good can be expected to produce different effects on estimated willingness to pay depending on the level of knowledge.[13]

How different levels and sources of familiarity affect consumer WTP is particularly important in the context of public goods. Presenting information to agents is a unique feature of public good stated preference demand estimation that is fundamentally different from revealed preference demand estimation techniques. Revealed preference demand estimation uses market data and therefore takes an economic agent's a priori information set and experience level with the good as exogenous. If information about a good and experience with a good similarly affect willingness to pay for it, then providing information about a good in stated preference demand estimation could be non-trivial.[14] Similarly, if an economic agent's beliefs over the accuracy of their knowledge are important for economic decisions, it is vitally important to know how those beliefs affect stated preference WTP estimates. As a result, understanding how knowledge or information about a good proxies for experience with a good- in addition to understanding how a consumer's belief about the accuracy of their knowledge affect their preferences for a good- takes on added importance in stated preference demand estimation.

[13] If these results carry over to private goods, the implication for firms is to send well-informed consumers signals confirming that they are indeed well-informed before offering them the product. Similarly, it is optimal to not send uninformed consumers signals telling them that they are poorly informed.

[14] In many circumstances, however, a more informed WTP estimate may be the precise goal of the econometrician. For example, stated preference WTP estimates are often used to inform the design of a subsequent ballot initiative. It is reasonable to expect that voters acquire information before voting on binding initiatives implying that more informed WTP estimates are the desired outcome of a CV study.

The remainder of this paper is organized as follows: section two details the empirical strategy for testing our hypotheses and the experimental design for testing the second hypothesis. Section three discusses the public goods and surveys used to estimate demand for provision of them. Section four presents results and discussion about the results. Section five offers concluding remarks.

2. Empirical Strategy

2.1 Discrete choice modeling as a Stated Preference strategy

The most versatile methods in which consumers' preferences for public goods can be modelled and quantitatively described are based on their stated choices, i.e. choices which they make in a carefully designed, hypothetical situations.[15] Stated preference methods, and the discrete choice experiment (DCE) elicitation format in particular, are of paramount importance for researchers and policy-makers because they allow for modelling consumers' preferences for goods (or changes of their characteristics) which are not yet available in markets (Hanley, Shogren et al. 2013). They also allow for estimating welfare changes resulting from the provision of environmental public goods, public health or transport infrastructure improvements into a common, economic analysis framework.

In this paper we utilized a DCE method to derive contingent values consumers hold for two environmental goods. The main focus of our work was, however, to investigate the effects of their prior experience and knowledge about these goods, and comparing the pathways in which these two types of information can influence respondents' WTP. Utilizing the stated preference methods in this respect

[15] These situations can be described to respondents by the means of attributes of a good. The choice alternatives are then defined in terms of attribute levels – a respondent is asked to select an alternative which would provide him with the highest utility. As long as these choice situations are framed in such a way that they pose some characteristics of consequentiality (e.g., a survey is said to inform policy-makers so that they can design a new policy which would be most preferred by the public), respondents' choices are believed to reveal their underlying preferences Carson, R. T. and M. Czajkowski (2013).

provided a unique opportunity to include both users and non-users in the analysis, while controlling for their prior experience or knowledge levels.

2.2 Econometric approach

Modelling respondents' stated choices is based on the random utility theory (McFadden 1974). It assumes that the utility associated with any choice alternative can be divided into a sum of contributions that can be observed by a researcher, and a component that cannot, and hence is assumed random. Formalizing, let individual i choose among J alternatives, each characterized by a vector of observed attributes $\mathbf{x}_{ij}$. The utility associated with alternative j is then given by:

$$U_i\left(Alternative = j\right) = U_{ij} = \boldsymbol{\beta}'\mathbf{x}_{ij} + \varepsilon_{ij}\,, \tag{1}$$

where $\boldsymbol{\beta}$ is a parameter vector of marginal utilities of the attributes.

Assumptions with respect to the random term ε variance may be expressed by scaling the utility function in the following way:

$$U_{ij} = \sigma\boldsymbol{\beta}'\mathbf{x}_{ij} + \varepsilon_{ij}\,, \tag{2}$$

where the random component of the utility function is typically assumed to be independently and identically (iid) Extreme Value Type 1 distributed across individuals and alternatives, while 'scaling' the deterministic parameters of the utility function by σ introduces the proper amount of randomness in the respondents' observed choices.[16] Note that since the utility function is ordinal, arbitrary scaling of the model parameters does not alter the preference structure – the coefficients σ and $\boldsymbol{\beta}$ cannot *both*

[16] This randomness is necessary since it is otherwise impossible to explain why respondents who are identical with respect to all observable characteristics may make different choices.

be identified and are reported as a product which can only be interpreted relatively to the other model parameters.[17]

The focus of this paper makes it interesting to test how observed scale, σ, and WTP estimates change with respect to respondents' information (knowledge or experience) levels. The interpretation of some respondents having a higher scale parameter is that their choices are less random – there is less uncertainty associated with choosing each of the alternatives. In our econometric framework, this means that the ratio of the deterministic component of their utility function to the random component is higher. This can be introduced by making the scale parameter dependent on respondents' characteristics, which in our case will be related to their information levels. Since scale is strictly positive, it is possible to introduce scale-related covariates in the following way:

$$U_{ij} = \sigma \exp\left(\boldsymbol{\theta}'\mathbf{k}_i\right)\boldsymbol{\beta}'\mathbf{x}_{ij} + \varepsilon_{ij}\,. \tag{3}$$

As a result, the 'effective' scale is a function of $\mathbf{k}_i$: a vector of respondent-specific variables.

The above specification leads to the Heteroskedastic Multinomial Logit (H-MNL) model, with the following closed-form expression of the probability of choosing alternative j from a set of J available alternatives:

$$P\left(j \mid J\right) = \frac{\exp\left(\sigma \exp\left(\boldsymbol{\theta}'\mathbf{k}_i\right)\boldsymbol{\beta}'\mathbf{x}_{ij}\right)}{\sum_{k=1}^{J}\exp\left(\sigma \exp\left(\boldsymbol{\theta}'\mathbf{k}_i\right)\boldsymbol{\beta}'\mathbf{x}_{ik}\right)}\,. \tag{4}$$

We choose this model because it is it allows us to simply and transparently highlight the effect of respondents' prior information (knowledge or experience) and the effect of signals about knowledge on

[17] The ratio of the coefficient of a characteristic-related attribute to the coefficient of a monetary attribute becomes a marginal rate of substitution, i.e. in this case the implicit price (WTP) for the particular characteristic. Note that in this case the scale parameter cancels out.

scale and WTP estimates. A similar specification, which allows for an systematic investigation of differences in scale between respondents, choice tasks or alternatives was earlier used by Dellaert et al. (1999) and Swait and Adamowicz (2001).

The goal of this paper is to test two hypotheses. First, we test for how more familiarity with the public good- either experience or knowledge- are related to WTP and scale estimates for increased provision of the good. To test for increases in WTP, we include our measures of familiarity as a covariate in the vector **x** and test for the sign of the coefficient for WTP for increased provision of the public good. To test for increases in scale we include our measures of familiarity as a covariate in the vector **k** and test for the sign and significance of the estimated coefficient. Because familiarity measures are not exogenous at the participant level, these estimates are not causal. They still do, however, inform the econometrician if increases in either familiarity measure affect provision in the same way.

Second, we test for the causal effect for how objective signals of a survey participant's knowledge about a public good affects their WTP and scale estimates. We test for the signal's effect on WTP and scale estimates in the exact same way as above. The difference here is that participants only received a signal or not (e.g., there were not multiple signals). Further, whether a participant received a signal or not was randomly assigned, meaning that our estimates for this variable are causal. The details of our experimental design are detailed in the next section.

3. Case studies and experimental design

Two case studies were used to generate the data. These were (a) a study on visitor's preferences for water quality and beach quality improvements at coastal beaches and (b) a study on the preferences of a sample of the general public in Norway for the protection of recently-discovered cold water corals in deep sea areas off the coast of Norway. We provide some brief information on both studies in which we briefly describe our simple experimental design used in the CWC study to test for the effect of objective signals of one's knowledge on WTP and scale estimates.

These two public goods were chosen because they represent two public goods defined by two different types of a priori information sets. Coastal water and beach quality are public goods which economic agents can experience directly. As a result, economic agents can learn about their preferences for water and beach quality directly through experience. Cold water corals, on the other hand, are very difficult to experience directly as they are found at great depths, generally below 200m. Economic agents can only learn about their preferences for cold water corals through knowledge acquisition channels like reading about them and seeing pictures. This distinction provides an ideal opportunity to compare how similarly or dissimilarly increases in experience versus increases in knowledge affect scale and WTP estimates.

3.1 Coastal water and beach quality study

A choice experiment was designed to measure the preferences of beach visitors in the Northern Ireland for changes in the environmental quality of beaches and coastal waters. Such changes are likely to occur due to the implementation of the European Commission's Revised Bathing Waters Directive. This will significantly raise the required standards of designated bathing waters in terms of a range of pathogens, with consequent reductions in health risks for people swimming or surfing etc., and will also result in changes in marine biodiversity and beach litter (due to enhancements in sewage treatment which will become necessary). Since beach users were sampled, a measure of experience with the good in question was available, namely the number of visits to the beach on which they were sampled (or other beaches in Northern Ireland) in the past 12 months.[18] No measure was obtained of their ex ante knowledge about coastal water quality or the risks of swimming.

[18] As noted in the introduction, this measure of experience is endogenously chosen by survey participants. In all likelihood people who choose to go to the beach probably like it more. Testing if this particular measure of

Following a series of focus groups with beach users the attributes chosen for the Choice Experiment described three aspects of coastal water and beach quality: benthic health, human health risks, and beach debris. We now describe each in more detail. For *Benthic Health, m*easures taken as part of complying with the revised directive will impact upon the 'health of the seas' through improvements at the benthic level. However, the concept of benthic health is not likely to be understandable to most members of the public, and so was related here to probable outcomes on vertebrate populations (birds, fish and marine mammal species). The levels selected for this attribute were:

- No Improvement to the current situation (reference level), meaning no changes to the numbers or chance of seeing fish, birds and mammals.
- A small improvement in benthic health (BH_1). This will mean that endangered species will be less likely to disappear from the seas around Northern Ireland, although respondents were told that it is unlikely that they would see any more fish, birds or mammals on an average visit to the beach.
- A large improvement in benthic health (BH_2) which will mean that there will be many more fish, birds and mammals with "…an increased chance of you seeing them on your average visit to the beach."

Health Risks was included an attribute since fecal coliform and fecal streptococci bacteria concentrations are expected to be reduced under the new directive standards. The levels of fecal coliforms under current and future states were then related to the risk of a stomach upset or an ear infection, based upon dose response relationships. Attribute levels selected were:

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experience and (endogenously) learned knowledge have a similar effect on preferences for public goods is the first goal of this paper.

- 10% Risk (reference level) – No Change to the current risk of a stomach upset or ear infection from bathing in the sea (the average current risk level in bathing waters);
- 5% Risk (HR_1) – Good Water Quality achieved with a somewhat reduced risk of stomach upsets and ear infections, although risks still exist in particular for vulnerable groups such as children.
- Very Little Risk (HR_2) – Excellent Water Quality achieved with a larger reduction in the risk of stomach upsets and ear infections.

The third attribute was *Debris Management.* Management actions likely to be required to achieve the targets of the directive will impact upon the amount of litter (such as cans, bottles, cotton buds, plastic bags, sanitary products) found on beaches and in coastal waters. Three levels were selected:

- No Change (reference level) – current levels of debris will remain.
- Prevention (DM_1) – more filtration of storm water, more regular cleaning of filters and better policing of fly tipping.
- Collection and Prevention (DM_2) – debris collected from beaches more regularly in addition to filtration and policing.

Finally, the per visit cost to an individual of visiting a beach with a given set characteristics (the costs of travel to the site) was used as the cost attribute (*FEE*). Six levels of additional cost were selected: 0, £0.6, £1.6, £3, £6, and £9.

The design of the experiment was generated using efficient design principles. With three blocks, this meant that each individual responded to 8 choice cards. In each choice card, respondents were asked to choose the option they preferred from three choices. A sample choice card is included as Figure 1. 558 respondents were surveyed on-site at a range of beaches around the Northern Irish coast in autumn

2011.[19] In this study, the indicator of respondents' familiarity with the good "coastal water quality" was the reported number of days spent at the beach each year. The number of days spent at the beach per year is a good proxy for experience here, as beach quality is visually observable. It is also in the interest of beach goers to find out about water quality measures for health reasons before they enter the sea to go swimming or surfing. Information of the latter is displayed on-site at designated beaches as a result of current EU legislation.

3.2 Cold Water Corals survey

A large number of cold-water coral sites have recently been discovered off the coast of Norway.[20] They represent high biodiversity ecosystems, but are threatened by a number of pressures including deep-water fishing, mineral extraction and pipeline laying. Deep-water fishing using trawls is a particularly important cause of degradation. Since growth rates are slow, cold water corals (CWC) have very long recovery times once damaged, and can therefore be regarded as a non-renewable resource within a time frame relevant for humans. Although CWC reefs are protected from bottom trawling and other types of destructive activity, the Norwegian government is considering extensions of this protection. This means extending the size of protected areas from just the reef to a larger area encompassing the reef and its surroundings.

A choice experiment was designed to collect information about peoples' valuation for such extended protection and the results will be given as input to the decision-making process. Based on focus groups and scientific inputs, four attributes were used in the design. These were 1) the total size of area to be

[19] While on site surveys suffer from the well-known property that they over-sample frequent users of the resource, it is less of a concern for us in this study as we are not concerned so much with a representative level of WTP rather than comparative statics of WTP within the sampled population.

[20] Cold-water corals are slow-growing organisms, growing less than 25mm annually (UNEP, 2007). They are generally found at depths between 100 – 2000 meters, with the deepest reef recorded at 3000m (Fossa et al. 2002). They are found world-wide and can form large reefs and mounds. The largest cold water coral reef known today is Røstrevet, outside the coast of Northern Norway. It is 35 km long and 3 km wide.

protected, 2) whether future protected areas would be located in areas important for commercial activities (fisheries and/ or the oil/ gas industry), 3) how important the CWC was as nursery and habitat for fish, and 4) costs. The size of protected area attribute consisted of 3 levels:

- No increase in protected area, but keep the current 2,445 km^2 of protected area (reference level only used in the BAU alternative)
- A moderate increase to 5,000 km^2 ($SIZE_5$)
- A large increase to 10,000 km^2 ($SIZE_{10}$)

With regard to *commercially-important areas*, respondents were told protected area status could in some areas involve either prohibiting or limiting commercial activities such as fishing or oil and gas exploration. Other areas, however, are not attractive for such activities. The levels this attribute took were thus:

- Attractive for fisheries (FISH)
- Attractive for oil and gas industry (OIL/GAS)
- Attractive to both fisheries and the oil/ gas industry
- Attractive to neither fisheries and the oil/ gas industry

For *important to fish*, respondents were told that the amount of fish can vary from one reef to another, thus one can assume that some coral reefs may either be an important habitat for fish (*HAB*) or may not. As of today, among the protected reef areas there are some which are very important as habitat for fish and some that are not so important. Finally, respondents were told that whether the Norwegian authorities would increase the amount of protected CWC areas depends on support in the population. The willingness to pay in the form of increased taxes per household to secure larger areas of CWC protection is therefore used as a signal to the authorities. The tax would be ear-marked with all revenues going to a CWC fund (*FEE*). Five non-discretionary amounts were used: 0, 100, 400, 800 and 1000 NOK ($0, $17, $67, $131, and $165) per year.

Choice cards were then designed based on these four attributes, using two options which increased CWC protection at a cost, and one no increase, no cost alternative. Figure 2 gives an example. The choice tasks were designed using a Bayesian efficient design procedure based on the pilot data. After an introduction to CWC and the management issue to be considered to make the respondents familiar with the topic, each respondent were given the survey which included 12 choice cards. Data were collected from a large stratified sample of randomly-chosen Norwegian households using a face-to-face interview format. In all, 397 responses were used.

3.2.1 Knowledge Score and Experimental Design

Unlike in the beach quality study, an objective measure of experience was not feasible in the CWC study, since there is no recreational use of these ecosystems in Norway due to the depths at which they are found. There is thus no relevant measure of experience for familiarity with CWCs. Instead, we exploit that characteristic of CWCs to test for how different levels of a priori knowledge of survey participants about the CWC affect WTP and scale estimates. To test the first hypothesis in this paper we will evaluate if increases in experience in the beach quality study and increases in a priori knowledge in the CWC study have the same estimated sign for WTP and scale estimates.

To test for how knowledge about CWCs affect WTP and scale estimates, we developed a novel technique to create a score which informs the econometrician about the level of familiarity each participant has for CWCs. After the presentation of basic info about CWC, the participants were asked to fill in the survey. In filling in the survey, each respondent was first asked to complete a short 8-question multiple choice quiz on cold-water corals (see Table 5). Each question had 4 possible answers of which only one was correct. We take a participant's score (0-8) and use it as a measure of their knowledge of CWCs. This score takes the place of the experience variable in the water quality survey above.

We integrated a field experiment into the CWC survey to test the second hypothesis in this paper: to identify the causal effect of an objective signal of a participants knowledge about a public good- CWC in this case- on WTP and scale estimates. Respondents were randomly allocated into two groups. Group 1 were told how well they had performed in the quiz (number of correct answers) before they started the choice experiment. Group 2 were not told their score. Group 1, then, is the treatment group and group 2 is the control group. Because assignment into groups was random, the interpretation of the estimated coefficient on the binary "treatment" variable is causal.

4. Results

In what follows we present the results from estimating the H-MNL model described in the section 2.2 using the data collected from the two case studies. The goal of this section is twofold. First, we would like to test whether increases in experience with a public good has the same effect on willingness to pay and scale as increases in knowledge about a public good. Second, we would like to test whether objective signals of respondent's a-priori knowledge about a public good cause changes in their willingness to pay for that public good. Attribute levels of choice alternatives for each study were coded in the way described in section 3. We present results in the following order: 1) effects of more experience/knowledge on scale, 2) effects of more experience/knowledge on WTP, 3) effects of signals of knowledge on scale and 4) effects of signals of knowledge on WTP.[21]

4.1 Familiarity and Scale

[21] A model which simultaneously includes respondent-specific characteristics as interactions of choice attributes and covariates of scale cannot be identified. For this reason we estimate the effects of familiarity on scale and the effects of familiarity on WTP separately. This specification allows us to investigate if respondent preferences, and so WTPs, vary with each kind of familiarity in the same way.

In this section, we define our familiarity measures (experience in the beach study and knowledge in the CWC study) in the following way: for beach quality study we used the binary variable *EXP* which represents respondents who made more beach trips in the last 12 months than the mean number of beach trips for our sample. In the cold water corals study we used a similar, knowledge-related binary variable (*KNL*) which is based on respondent's score on the marine issues knowledge test.[22] These variables were included as covariates of scale as explained by equation 3 – to investigate if respondents with more familiarity (measured as experience or knowledge) are more certain, on average, about their choices (Table 1).

Table 1 shows the results from using each measure of familiarity as a covariate of scale. The coefficients of interest in table 1 are on *EXP* and *KNL.* In both studies, respondents with higher familiarity levels had a higher scale coefficient, i.e. the magnitude of the deterministic component of their utility functions relative to the random component. Put another way, more experience or knowledge about the good contributes to respondents being more precise, or less random, in their stated choices about the public good. As shown in Czajkowski et. al. (2013), this result is consistent with respondents using Bayesian updating to refine their preferences.

This result has important implications for estimating demand for public goods whose values include existence values, like CWC. It implies that additional information acts to shape preferences in the same way that additional experience shapes preferences for private goods or public goods with values mainly due to non-rivalrous direct uses (e.g., going to the beach). This provides evidence that learning about preferences for existence values may occur in similar ways to learning about direct or indirect use values.

[22] We also estimated the model using other thresholds and measures. All qualitative results are similar throughout the paper. We principally chose to focus on above and below the mean measures to more closely follow the work of Eil and Rao (2011) and Grossman and Owens (2012).

4.2 Familiarity and WTP

We also estimate the model in which the familiarity-related variables are interacted with the choice attributes. It is important to note, before proceeding, that these estimates are not causal. They are only presented to see if familiarity obtained via direct experience or knowledge is similarly or dissimilarly correlated with WTP estimates. Any causality for experience or knowledge on WTP estimates can in no way be inferred in this section.

Table 2 shows WTP estimates for the beach quality study on the left hand side and estimates for the CWC study on the right hand side. In addition to the coefficients associated with each choice attribute (main effects), we also provide interactions of each attribute-specific coefficient with the binary indicator of familiarity level (*EXP* or *KNL*, respectively). Finally, the labels 'low experience / knowledge' represent respondents below the mean level of experience/knowledge in the sample, while 'high experience / knowledge' refers to respondents above the mean. We maintain this binary distinction for high and low knowledge or high and low experience for WTP estimates throughout the paper in order to try to make these two different measures of familiarity more commensurate since it is unclear exactly how one additional experience with a good relates to one additional piece of knowledge about a good. It does preserve, though, the ability to determine if increases in experience and knowledge affect WTP in the same direction.[23]

The results in Table 2 indicate that agents with above mean level of experience in the beach quality study were more likely to choose the status quo alternative than agents below that mean; on the other hand, they were more sensitive to health risks associated with water quality changes, and had significantly lower marginal utility associated with costs. This makes the more experienced group willing to pay more for all improvements described in the study, including the status quo. Overall, the more

[23] As noted above, all qualitative results are robust to other specifications and we are motivated to use this approach by Eil and Rao (2011) and Grossman and Owens (2012).

experienced group's total WTP for a maximum improvement scenario was 26.46 GBP ($47.63) versus 12.82 GBP ($23.08) for the less experienced group. We take this as evidence that agents with more experience had stronger preferences for increased management of beach quality.

Similarly, in the CWC study, participants who scored above the mean (seven or eight correct answers) were willing to pay significantly more for larger CWC reserves. They were also more sensitive to whether the sites would be in conflict with oil and gas operations. Respondents with higher knowledge had significantly lower marginal utility associated with costs (in absolute terms), and therefore were willing to pay significantly more for individual attributes as well as the best overall improvement scenario (1,109 vs. 3,121 NOK or $188 vs. $530).

In both the beach quality and CWC surveys, then, agents with more familiarity with the public good by either measure where willing to pay more for it. As with the results for scale, this is evidence that if survey respondents enter the survey with additional knowledge they have similar qualitative preferences as respondents who enter the survey with additional experience. There is one important caveat for interpretation though: because the results are not causal, our results do not imply that providing more information about a public good will necessarily affect stated willingness to pay estimates. The most we can say is that respondents' endogenous decisions to acquire information about a public good whose value is largely existence value (e.g., CWC) is related to their willingness to pay for that good in similar ways to respondents' endogenous decisions to have more experience with a public good whose main value is an non-rivalrous use value (e.g., going to the beach).

In sum, then, we find that both additional experience and additional knowledge significantly increase scale (reduce the randomness of choice) in these two studies. Further, we find that additional experience and additional knowledge affect WTP estimates in similar ways across the two goods, although a direct comparison is not possible. We take this as evidence that increases in familiarity with a public good – either through increased knowledge or increased experience- affect demand estimates for the public good in the same qualitative manner.

4.3 Objective signals and scale

We next test whether objective signals about an agent's knowledge about a public good cause differences in her scale and stated WTP for the public good. This is made possible by the experimental treatment we incorporated in the cold water corals study: half of respondents were in a treatment group and were told their test scores, while the other half were in a control group and not told their test scores. Because assignment into the treatment group was random, all treatment effects in this section are causal.[24]

To test for the effect of objective signals on scale, we estimate the H-MNL model using score and treatment-related covariates. Again, we parse the subjects into two groups: those that score above the mean on the quiz (*KNL*) and those that score below the mean (baseline). In addition, we interact it with a dummy variable (*Treatment*) which takes the value one if a respondent was told his or her score. All these 3 covariates enter the scale coefficient, so that equation (3) now takes the following form:

$$U_{ij} = \sigma \exp\left(\theta_1 KNL + \theta_2 Treatment + \theta_3 KNL \cdot Treatment\right)\boldsymbol{\beta}'\mathbf{x}_{ij} + \varepsilon_{ij} \ . \qquad (5)$$

This specification allows the influence of the signal to vary across the subjects as a function of their score. This specification, motivated by the findings in Grossman and Owens (2012) and Eil and Rao (2011), allows for the possibility of asymmetric effects of treatment on high and low scorers.

The effects of being in the treatment on choice uncertainty are illustrated with the results presented in Table 3. The baseline is low knowledge and in the control group. The binary variable *KNL* indicates

[24] A table showing scores and demographic characteristics by treatment status is available from the authors upon request. We find no significant differences in observables by treatment status.

whether a subject is in the high scoring group. For those in a treatment group, the shift in their scale is reflected by (*Treatment*). Finally, for those who both had a high knowledge score and were in a control group an additional interaction is introduced (*KNL* Treatment*). This specification allows us to test the following hypotheses:

(i) higher knowledge score changes the scale parameter $(\theta_1 = 0)$

(ii) being told ones quiz score changes the scale parameter $(\theta_2 = 0)$

(iii) being told ones quiz score changes the scale parameter differently for respondents with higher knowledge $(\theta_3 = 0)$

A significant coefficient on θ_2 indicates that receiving any test score systematically affects the scale. A positive and significant coefficient implies being in the treatment group significantly increases the relative importance of the deterministic portion of the random utility model. In other words, consumers' valuation for the good become less random. A significant coefficient on θ_3 indicates that the marginal effect for a subject receiving an objective signal about the accuracy of their knowledge and being in the high knowledge group systematically affects the scale parameter. A positive and significant coefficient implies that well-informed subjects receiving a signal that they are indeed well-informed causes them to have significantly less dispersion in their stated WTP for the good.

Table 3 shows that respondents with higher knowledge scores have overall higher scale parameters, which is in line with the findings presented in Table 1. The treatment, however, does not seem to significantly affect the scale for respondents with low knowledge; the estimated standard error is almost twice as large as the point estimate. Finally, although we find that treatment does increase the scale parameter for respondents with high knowledge score, this effect is not statistically significant. Overall, we take this as evidence that objective signals of knowledge do not affect the scale (e.g., the precision) of the utility function for public goods.

4.4 Objective signals and WTP

While the above results show that signals do not have an effect on the scale of the utility function (i.e. an effect on its error term variance), it is entirely possible that there could still be an asymmetric effect on the individual preference parameters, and hence respondents' WTP. To test for an effect of signals on WTP, we estimate a MNL model where for each choice attribute we include interactions with knowledge levels and treatment-related indicator variables. As before, we split the sample into 4 different groups of CWC respondents: high quiz scorers and low quiz scorers and treatment and control group. Higher scorers are defined as individuals scoring above the mean (7 or 8) and low scorers are individuals scoring below the mean (0-6). We allow a subject's preference for each attribute of the public good to vary by their knowledge group and treatment status in the following way:

$$\mathbf{x}_{ij} = (\theta_1 KNL_i + \theta_2 Treatment_i + \theta_3 KNL_i \cdot Treatment_i) x_j$$

A significant coefficient on θ_2 indicates that receiving any test score significantly affects subject *i*'s preference for attribute *j*. A positive and significant coefficient implies being in the treatment group significantly increases the preference for that attribute. A significant coefficient on θ_3 indicates a marginal effect for treatment on the high knowledge group for attribute *j*. A positive and significant coefficient implies that well-informed subjects receiving a signal that they are indeed well-informed causes them to have significantly greater preference for attribute *j*.

Table 4 shows effects on both preference parameters (left hand panel) and WTP estimates for each attribute (right-hand panel). For preferences, those with high scores who received the treatment have significantly different preferences from high scoring individuals who did not. Further, treatment by itself had no significant effect on the preferences of the low scoring group. For well-informed individuals, treatment caused a significant increase in the preference for larger marine reserves and a significant decrease in the preference for marine reserves if informed that the area was important to fisheries and/or the oil/ gas industry.

The significant effect of treatment on preferences acts to increase estimated WTP for the public good. Knowing one's score only produces significant effects for those with high scores. The effects are quite substantial on both levels and standard errors. Being told your quiz score cause a significant increase in WTP for an enlargement of the protected CWC area to 5,000 km^2 – from -854.05 NOK to 507.88 NOK (-$142 to $85). For a large increase in the size of reserve to 10,000 km^2, this increase in WTP due to knowing your score is -262.63 NOK (insignificant) to very significant 775.90 NOK (-$44 to $129). In both cases, there is a very significant reduction in the standard errors of WTP estimates for the treated group: the simulated standard error on WTP decreases by roughly 50% for nearly every attribute including size. Although the high scoring control group had a negative mean WTP for increasing the reserve's size, larger standard errors make the mean estimate not significant from zero at the 5% level. We find no such systematic influence of signals on WTP for the low scoring group either in levels or variation in WTP.

The magnitude of these results is somewhat surprising: high scorers being informed of their level of knowledge declare significantly higher WTP to provide that good. We can make only very limited inference as to the mechanism for this result but we can note that the result is only present for high scorers. Consequently, we can infer that the mechanism is related to the level of knowledge of the individual in addition to uncertainty over the accuracy of their knowledge. Due to the field experiment's design, though, we cannot explicitly tell precisely how beliefs about one's knowledge state interact with the objective signal.

One appealing strictly neoclassical explanation is that uncertainty about the accuracy of a consumer's information matters for stated WTP for public good provision. Appendix A outlines a strictly Bayesian model in which objective signals about knowledge affect WTP for well-informed risk averse agents more than less-informed risk averse agents. In the model uncertainty over knowledge leads to uncertainty over valuation for the public good. This uncertainty manifests as uncertainty over expected utility with respect to a numeraire good. Risk aversion leads to greater increases in WTP for the public good for well-informed agents relative to less informed agents. An important feature of this model is that the consumer must budget a set amount of resources to providing public goods so that curvature of the utility function of the private good is sufficiently pronounced.

There are of course other behavioral explanations like a connoisseur effect for the public good or an intrinsic social responsibility prompted by the objective signal informing individuals they are indeed well-informed. There is suggestive evidence for this explanation since the treated high scoring group was willing to pay more for increased reserve size but their preferences for all private attributes for the oil, gas and fishing industries were unaffected. We are not aware of any work which evaluates how objective signals about a particular public good affect altruistic or impurely altruistic motives for giving. Alternatively, it could be that high scoring types thought they were less informed than they actually were and subsequently increased their WTP on hearing this "good news".[25] This type of explanation where not only signals matter, but also the way in which the signal differs from the prior, has some recent support in experimental work (Eil and Rao 2011 and Grossman and Owens 2012).

An even larger question is what this result implies for choice experiments in general. If actual WTP for a public good is so intimately tied to knowing the accuracy of one's information state, it is surprising. Clearly, we do not imply that the optimal stated preference protocol should include objective signals of

[25] We also note, that since the increase was the highest (and only significant) for the two size-related attributes, this corresponds to respondents who had high knowledge score and being told about it to be less likely to choose the SQ alternative (which was the baseline for the two size-related attributes).

respondents' information states, but we do acknowledge that these results have implications for both the robustness of WTP estimates and the proper interpretation of WTP estimates. Our results imply that WTP estimates are not only a function of true information states of the respondents but *beliefs* about those information states.

5. Conclusions

In this paper, we test whether increases in experience with and increases in knowledge about a public good affect stated WTP estimates in the same way. First, we find that increases in either knowledge or experience are associated with increases in both the scale and level of WTP estimates. This result has very important implications for stated preference demand estimation. A defining characteristic of stated preference demand estimation is that participants are given a significant amount of information about the public good at the beginning of the survey. If additional information about a public good affects the demand for it in the same way as additional experience with it, then the amount of objective information provided in stated preference demand estimation could affect WTP estimates. In this paper, we are not able to identify the causal effect of additional objective information on valuation for a good, but this is an appealing line of future research. Further, in some cases more informed WTP estimates are desirable since stated preference WTP estimates are often used to inform the design of a subsequent ballot initiative and voters often acquire information on political issues before casting ballots.

Second, we find that objective signals of a participants' knowledge about a good causes an increase in agents' willingness to pay for provision of that good. The marginal effect of additional knowledge on WTP is significant and large for subjects who are randomly assigned treatment in which they receive an objective signal about the accuracy of their knowledge. In effect, then, well-informed individuals are willing to pay significantly more for the good when in the treated group. Unfortunately, we are not able to determine the precise mechanism for how objective signals about knowledge affect WTP. There are several possible explanations which we are not able to reject as possible explanations and as a result our second result prompts further questions for additional research.

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Table 1 – The effects of information on choice uncertainty

Beach quality study			Cold water corals study		
Attribute	**Coefficient (s.e.)**	**WTP [GBP] (s.e.)**	**Attribute**	**Coefficient (s.e.)**	**WTP [NOK] (s.e.)**
SQ	0.1515 (0.0999)	1.14 (0.79)	$SIZE_5$	-0.0398 (0.0432)	-87.71 (97.2214)
BH_1	0.4707*** (0.0611)	3.53 (0.49)	$SIZE_{10}$	0.1096** (0.0437)	241.78*** (91.1841)
BH_2	0.6268*** (0.0679)	4.71 (0.55)	OIL/GAS	0.0587** (0.0272)	129.55** (59.6379)
HR_1	0.5012*** (0.0722)	3.76 (0.64)	$FISH$	0.1099*** (0.0288)	242.51*** (64.1483)
HR_2	0.6240*** (0.0692)	4.69 (0.63)	HAB	0.7123*** (0.0544)	1571.55*** (143.0891)
DM_1	0.7692*** (0.0643)	5.78 (0.55)	FEE	-0.4533*** (0.0496)	–
DM_2	0.8716*** (0.0664)	6.55 (0.61)	–	–	–
FEE	-0.1332*** (0.0071)	–	–	–	–
Covariates of scale					
EXP	0.0901*** (0.0214)	–	KNL	0.4356*** (0.0827)	–
Model characteristics					
LL	-4135.5		LL	-4759.73	
McFadden's pseudo R^2	0.1186		McFadden's pseudo R^2	0.0626	
AIC/*n*	1.8985		AIC/*n*	2.0358	
n (observations)	4366		*n* (observations)	4683	
k (parameters)	9		*k* (parameters)	7	

Table 2 – The effects of information on taste parameters and WTP

Beach quality study					Cold water corals study				
Attribute	**Coefficient (s.e.)**		**WTP [GBP] (s.e.)**		**Attribute**	**Coefficient (s.e.)**		**WTP [NOK] (s.e.)**	
	Main effects	**Interactions (*EXP*)**	**Low experience**	**High experience**		**Main effects**	**Interactions (*KNL*)**	**Low knowledge**	**High knowledge**
SQ	-0.031 (0.1051)	0.8289*** (0.205)	-0.22 (0.7319)	13.8*** (5.0015)	$SIZE_5$	-0.1382* (0.083)	0.1569 (0.1139)	-164.32 (104.292)	37.03 (153.2)
BH_1	0.4443*** (0.0653)	-0.0437 (0.1245)	3.12*** (0.4893)	6.93*** (2.282)	$SIZE_{10}$	-0.0792 (0.0867)	0.3685*** (0.1165)	-94.13 (106.427)	573.35*** (151.273)
BH_2	0.5514*** (0.0728)	0.109 (0.1412)	3.87*** (0.5404)	11.42*** (2.9391)	***OIL/GAS***	-0.0304 (0.0566)	0.1596** (0.074)	-36.09 (67.5564)	256.02*** (98.764)
HR_1	0.4199*** (0.0755)	0.2092 (0.1443)	2.95*** (0.5983)	10.88*** (3.4976)	***FISH***	0.1948*** (0.0589)	-0.0658 (0.0768)	231.57*** (72.5052)	255.59** (102.503)
HR_2	0.5009*** (0.0753)	0.3489** (0.1426)	3.52*** (0.6051)	14.7*** (4.0584)	***HAB***	0.8478*** (0.0642)	0.1795** (0.085)	1007.84*** (113.358)	2035.69*** (286.394)
DM_1	0.7375*** (0.0668)	-0.1019 (0.1293)	5.18*** (0.5397)	10.99*** (2.9792)	***FEE***	-0.8412*** (0.0865)	0.3366*** (0.1125)	–	–
DM_2	0.8059*** (0.0688)	0.0119 (0.1338)	5.66*** (0.5778)	14.14*** (3.6187)					
FEE	-0.1425*** (0.0075)	0.0847*** (0.0138)	–	–					

Model characteristics

LL	-4118.3248	LL	-4708.69
McFadden's pseudo R^2	0.1222	McFadden's pseudo R^2	0.0727
AIC/*n*	1.8940	AIC/*n*	2.0161
n (observations)	4366	*n* (observations)	4683
k (parameters)	16	*k* (parameters)	12

Table 3 – The effects of objective signals on choice uncertainty

Cold water corals study		
Attribute	**Coefficient (s.e.)**	**WTP [NOK] (s.e.)**
$SIZE_5$	-0.0314 (0.0448)	-66.39 (96.2244)
$SIZE_{10}$	0.123*** (0.0463)	260.33*** (90.6029)
OIL/GAS	0.0606** (0.0284)	128.19** (59.1948)
FISH	0.1103*** (0.0307)	233.42*** (63.5447)
HAB	0.7366*** (0.0755)	1558.48*** (140.951)
FEE	-0.4726*** (0.0609)	–
Covariates of scale		
KNL	0.3252*** (0.1179)	–
Treatment	-0.0792 (0.1427)	–
KNL*Treatment	0.2153 (0.1659)	–
Model characteristics		
LL	-4743.60	
McFadden's pseudo R^2	0.0658	
AIC/*n*	2.0297	
n (observations)	4683	
k (parameters)	9	

Table 4 – The effects of objective signals on taste parameters and WTP

	Cold water corals study							
	Coefficient (s.e.)				WTP [NOK] (s.e.)			
	Main effects	**Interactions (*KNL*)**	**Interactions (*Treatment*)**	**Interactions (*KNL*Treatment*)**	**Low knowledge and no treatment**	**High knowledge and no treatment**	**Low knowledge and treatment**	**High knowledge and treatment**
$SIZE_5$	-0.1717 (0.1184)	-0.1371 (0.1641)	0.063 (0.1644)	0.5668** (0.2277)	-236.06 (179.705)	-854.05* (451.095)	-114.18 (125.384)	507.88*** (169.578)
$SIZE_{10}$	-0.0891 (0.1261)	0.0767 (0.1693)	0.0185 (0.1741)	0.5669** (0.2345)	-122.52 (180.175)	-262.63 (412.617)	-160.90 (159.158)	775.90*** (221.207)
OIL/GAS	-0.0122 (0.0813)	0.1567 (0.1076)	-0.0352 (0.1135)	0.0076 (0.1485)	-16.76 (112.068)	-41.39 (501.353)	-217.32 (196.383)	-67.37 (283.822)
FISH	0.1195 (0.0852)	0.0914 (0.1119)	0.1460 (0.1185)	-0.2993* (0.1543)	164.35 (118.124)	-221.94 (518.48)	-27.03 (199.154)	-369.6 (296.607)
HAB	0.8948*** (0.0913)	0.1736 (0.1222)	-0.0906 (0.1276)	0.0199 (0.1688)	1230.24*** (216.962)	5.32 (552.397)	-275.56 (219.509)	-108.89 (314.365)
FEE	-0.7273*** (0.1226)	0.3657** (0.1607)	-0.2246 (0.1726)	-0.0459 (0.2242)	–	–	–	–
Model characteristics								
LL	-4695.99							
McFadden's pseudo R^2	0.0752							
AIC/*n*	2.0158							
n (observations)	4683							
k (parameters)	24							

Figure 1. Example choice card from beach quality study

	Beach A	Beach B	Beach C
Benthic Health and population.	**Small increase** More fish, mammals and birds. Limited potential to notice the change in species numbers.	**Large increase** More fish, mammals and birds and an increased potential of seeing these species.	**No Improvement**
Health Risk (of stomach upsets and ear infections)	**Very Little Risk** – excellent water quality	**5% Risk** – good water quality	**10% Risk** – no improvement
Debris Management	**Prevention** – more filtration of storm water, more regular cleaning of filters and better policing of fly tipping.	**Collection and Prevention** **–** debris collected from beaches more regularly in addition to filtration and policing.	**No Improvement**
Additional cost of travelling to each beach.	£3	£9	£0
Please tick the **ONE** option you prefer.	☐	☐	☐

Figure 2. Example choice card from cold-water corals study

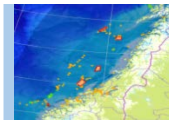
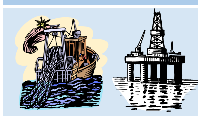
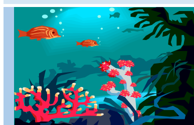
Characteristics		***Alternative 1***	***Alternative 2***	***Alternative 3*** (status quo)
Size of protected area		*5.000* km^2	*10.000* km^2	*2.445* km^2
Attractive for industry		*Attractive for both oil/gas and the fisheries*	*No, not attractive for any industry*	*To some degree attractive for both oil/gas and the fisheries*
Importance as nursery- and hiding area for fish		*Not important*	*Important*	*Not important*
Cost per household per year		*100 NOK/year*	*1000 NOK/year*	*0*
I prefer				

Table 5. Questions from CWC quiz (correct answers in italics)

Question 1: What is a coral?

1. *an animal*
2. a plant
3. a fungus
4. don’t know

Question 2: At which depths do we find most cold water coral reefs?

1. < 30 meters
2. 30-100 meters
3. *> 100 meters*
4. *don’t know*

Question 3: How much do cold water corals grow annually?

1. *4-25 mm*
2. 25-100 mm
3. >100mm
4. don’t know

Question 4: What do cold water corals eat?

1. They emit secretions that attract fish that they catch and eat
2. *They filter small organisms and suspended matter that happens to pass by*
3. They photosynthesise with the help of a symbiotic algae
4. Don’t know

Question 5: What is the main threat to cold water coral reefs?

1. Predation by fish
2. Destruction by wave action
3. *Bottom trawling*
4. don’t know

Question 6: At what temperature range do cold water corals grow?

1. *0°C to 4°C*
2. 4°C to 13°C
3. 13°C to 18°C
4. don’t know

Question 7: How do cold water corals reproduce?

1. Asexually through budding where a polyp divides into two genetically identical pieces
2. *Sexually where a sperm fertilizes an egg that develops into a larva*
3. Both sexually and asexually
4. don't know

Question 8: How old is the oldest cold water coral reef found off the Norwegian coast?

1. Less than 1000 years old
2. Between 1000 and 8000 years old
3. *Between 8000 to 10 000 years old*
4. don't know

Appendix A: Bayesian Model of WTP as a Function of Objective Signals.

Assume that a consumer is allocating money over privately providing a public good, *G*, and a numeraire private good, *c*, to maximize utility subject to a budget constraint normalized to the price of the private good:

$$\max_{c,G} \quad U(c,G) \quad s.t.\ c + pG = w$$

Assume that utility is concave in the private good *c* but linear in private provision of the public good G. Substituting in for the private good the first order condition is $h'(c^*) = 1/p$.

Consider a risk averse Bayesian updater with an uncertain measure of knowledge *k* and a prior distribution *f(k)* over their true knowledge state. The prior represents uncertainty over the accuracy of their knowledge. A consumer *i* has a mapping from knowledge to utility given by $v_i(k)$. This valuation function can vary across consumers and need not be monotonic. The valuation of the good for consumer *i* is:

$$E[V_i] = \int v_i(k)\, f(k) dk.$$

Assume that the government's payment mechanism for the public good *G* can extract true valuation. In this case, the consumer's problem is reduced to maximizing expected utility over the valuation of the public good:

$$\max_v \quad E[U(w - v_i, v_i)] = \int U\big(w - v_i(k), v_i(k)\big) f(k) dk.$$

By definition, increases in expenditures on the public good must decrease consumption of the numeraire good since $c = w - v_i(k)$. Therefore, if uncertainty over the knowledge of the public good influences valuation of the public good then it also affects optimal private consumption and expected utility. As a result, even if utility is linear in private provision of the public good, uncertainty over valuation of the public good can interact with risk aversion for the private good.

Take two consumers with the same budget constraint and uncertainty over the accuracy of their knowledge described by priors. Assume that full information consumer (a) has a low valuation for the public good and consumer (b) has a high valuation for the public good. If *f(k)* is sufficiently wide then both consumers may not be WTP a positive amount of the public good. If she is sufficiently risk averse then consumer (b) may not want to commit herself to a lower level of consumption of the numeraire good for the chance of earning large returns from providing the public good.

Now consider consumption dynamics for a mean preserving change in *f(k).* For example, a mean preserving decrease in the variance of *f(k)* would result from an objective signal of the consumer's knowledge level *k*.[26] A signal of low quality information doesn't affect variance of the prior distribution. Conversely, a signal of high quality information would either not affect stated WTP for consumer (a) or increase it in the case of consumer (b) as she is now willing to commit herself to lower consumption of the numeraire good. This situation would be consistent with the results from our field experiment. We leave a more detailed formation of this model to future research.

[26] Implicitly we assume here that priors are centered around the true knowledge state on average.