INSTITUTE
OF ECONOMIC STUDIES
Faculty of Social Sciences
Charles University

NATURE-BASED, STRUCTURAL, OR SOFT MEASURES OF ADAPTATION? PREFERENCES FOR CLIMATE CHANGE ADAPTATION MEASURES TO LIMIT DAMAGES FROM DROUGHTS

Milan Ščasný
Iva Zvěřinová
Alistair Hunt

IES Working Paper 16/2019

Institute of Economic Studies,
Faculty of Social Sciences,
Charles University in Prague

[UK FSV – IES]

Opletalova 26
CZ-110 00, Prague
E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Institut ekonomických studií
Fakulta sociálních věd
Univerzita Karlova v Praze

Opletalova 26
110 00 Praha 1

E-mail : ies@fsv.cuni.cz
http://ies.fsv.cuni.cz

Bibliographic information:
Ščasný M., Zvěřinová I. and Hunt A. (2019): "Nature-Based, Structural, or Soft Measures of Adaptation? Preferences for Climate Change Adaptation Measures to Limit Damages from Droughts" IES Working Papers 16/2019. IES FSV. Charles University.

Nature-Based, Structural, or Soft Measures of Adaptation? Preferences for Climate Change Adaptation Measures to Limit Damages from Droughts

Milan Ščasný[a,b]
Iva Zvěřinová[b]
Alistair Hunt[c]

[a]Institute of Economic Studies, Faculty of Social Sciences, Charles University
Opletalova 21, 110 00, Prague, Czech Republic
[b]Charles University Environment Centre, José Martího 407/2, 162 00, Prague, Czech Republic
[c]University of Bath, Bath, BA2 7AY, United Kingdom
Email (corresponding author): milan.scasny@czp.cuni.cz

June 2019

Abstract:
The objective of this paper is to examine preferences of citizens of three European countries regarding various adaptation plans and measures to limit damages from drought under climate changes. For this purpose, we conducted a survey in the Czech Republic, Italy, and the United Kingdom. We utilize discrete choice experiments and estimate marginal willingness-to-pay for a variety of technical, nature-based, and non-structural soft measures. The results differ substantially between countries and across the adaptation measures with the mean willingness to pay to be in a range of 5 to 26 PPS EUR. However, there is a large heterogeneity in willingness-to-pay across and within the countries. Rainwater harvesting is found to be one of the most preferred measures in each of the three countries, followed by small water reservoirs and wetlands in the Czech Republic, large reservoirs in the UK, and tax relief on water efficient technologies in Italy. We gather data on the perceived effectiveness and perceived base level of implementation of the various measures to explain the differences in preferences across populations. We identify three distinct latent classes implying large, modest, and even negative willingness to pay estimates in each three countries. The results can be used to inform policy makers about the acceptability of policy mixes.

JEL: Q54, Q51
Keywords: Climate change adaptation, discrete choice experiments, willingness to pay, policy acceptability, droughts, technical measures, nature-based (green) measures, soft non-structural measures

1. Introduction

Public support for climate change measures is a key factor in influencing willingness or reluctance of policy makers to adopt such measures (Steg et al. 2006). This paper examines preferences of citizens of three European countries regarding adaptation plans and measures to limit damages from droughts. The importance of this research stems from the recognition that climate change may result in increases in the frequency and severity of drought events across parts of Europe and in a range of other locations in the world (Kovats et al. 2013). An informed response to this risk demands that we get a better understanding of preferences across the population with regard to actions that might mitigate the risk. This paper therefore seeks to i) identify the strength of preferences for a much broader range of actions to preserve water availability in the face of droughts than have been considered in previous empirical studies; ii) explain heterogeneity in willingness-to-pay with socio-psychological variables, such as perceived effectiveness and perceived degree of implementation of the adaptation measures. In doing so, the paper examines the role of perceptions in influencing individuals' preferences, and seeks to substantially increase the degree of realism with respect to the economic evaluation of such adaptation actions and broader drought resilience strategies.

For this purpose, we conducted a cross-country survey in the Czech Republic, the United Kingdom and Italy, the results of which are reported here. We utilized discrete choice experiments (Louviere, Hensher, & Swait, 2006) to elicit individual preferences for adaptation options and their characteristics, and estimate mixed logit with fully dependent attributes and latent class model to derive marginal willingness-to-pay for all attributes of adaptation policies.

Section 2 provides an overview of the literature that undertakes valuation of the benefits of climate adaptation measures generally, and droughts specifically. Section 3 then outlines details of the discrete choice experiments and the survey instrument whilst Section 4 gives details of the econometric model we use to generate estimates of willingness to pay for the specific adaptation measures. These results and our analysis of their determinants are presented in Section 5, before Section 6 draws out conclusions.

Our results show a higher willingness-to-pay for specific structural measures (natural and technical) than for non-structural measures, though with variation across the three countries; UK respondents offer lower willingness to pay than Italy or Czech Republic. Similarly, the results also show – with the exception of Italy - that structural measures are regarded as being more effective than non-structural measures. Furthermore, across the three countries, only

25% and 30% of the populations regard current levels of implementation as being sufficient. These differences in preferences suggest that acceptable adaptation strategies with regard to drought management may need to be both more vigorously pursued than are done currently, and that they are tailored carefully in each of these countries.

2. Literature review on willingness to pay for climate change adaptation measures

In recent years, stated preference (SP) methods have increasingly been used to evaluate climate change adaptation measures and programmes through the measurement of people's preferences for the non-market benefit components of these measures. In considering application of a SP designed study, this body of SP studies is valuable in identifying the ways in which climate risks are perceived more generically. For instance, severity of climate risks is recognised as being important in determining the strength of people's preferences; people who perceive the consequences to be more severe tend to be willing to pay more for its reduction and consider adaptation measures to be more useful, (Fischer and Glenk, 2011, in the context of river flooding; Dobes, Scheufele, & Bennett, 2015, for cyclone damage alleviation; Tinh & Hung 2014, for river flooding; California Urban Water Agencies, 1994, for water resource management; Devkota, Maraseni, & Cockfield, 2014, for flooding; Layton & Brown, 2000, for ecosystems). Similarly, probability and frequency of occurrence of extreme weather events are also found to be important in determining WTP values. Thus, people who perceive a given climate event to be more likely to occur will tend to be willing to pay more, (Brouwer & Schaafsma, 2013; Clark et al., 2002; Veronesi, Chawla, Maurer, & Lienert, 2014 – all with respect to flood events), whilst a higher WTP is commonly found to be associated with a greater frequency of a type of event (Seifert, Botzen, Kreibich, & Aerts, 2013; Tinh & Hung, 2014; Clark, Griffin, & Novoty, 2005 – all with respect to flood events). The segment of the population affected is also likely to be important in determining relative WTP. For example, risk reduction measures as they apply to children are found to be valued more than for adults in the context of urban waste-water flooding (Veronesi et al., 2014).

Additionally to the risk attributes, characteristics of adaptation measures may determine public acceptability of respective adaptation actions and hence affect individual willingness to pay for such actions. These characteristics include: ancillary benefits (for example, people are willing to pay more for adaptation measures with positive environmental effects (Jaramillo, 2009; Ryffel, Rid, & Grêt-Regamey, 2014; Mahmud, 2011)); spatial scale and population (the larger the area over which the risk reduction occurs, and the more people benefitting from the risk reduction, the higher is the WTP (Ryffel et al., 2014)), and; sequencing (the WTP is

higher for preventative adaptation measures rather than reactive measures (Glenk & Fischer, 2010, in the flood context).

Several studies on public acceptability of climate change mitigation policies also include measures of policy specific features, such as perceived effectiveness and perceived fairness of policy. Both these concepts were found to be important factors explaining acceptability (Cools et al. 2011; Eriksson, Garvill, and Nordlund 2006; 2008; Schade and Schlag 2000; 2003 for perceived effectiveness only). However, these variables were rarely used in studies on preferences for adaptation measures. Fischer and Glenk (2011) found that an adaptation measure (council insurance of buildings) is more preferred the greater is the perception of efficiency and that this belief is a key factor in influencing preferences. This paper adds to this literature by exploring how perceived effectiveness of the adaptation measures helps to explain preferences for these measures.

In relation to drought adaptation measures, whilst a range of studies have elicited WTP values for aspects of water availability and supply, these primarily focus on individuals' preferences for specific measures including irrigation, decentralised water supply systems, control regimes and alternative forms of public regulations. Bakopoulou et al. (2010), for example, used a contingent valuation survey instrument to investigate farmers' knowledge of water recycling in Thessaly, Greece, their willingness to use recycled water for irrigating purposes, and their willingness to pay for such a water resource. They found that in the case of freshwater scarcity, farmers were willing to pay a premium for recycled water in order to avoid water scarcity. Related to this, a study undertaken in South-East Queensland, Australia (Tapsuwan, Burton, Mankad, Tucker, and Greenhill (2014)) found – using a choice experiment SP design - that whilst there is significant WTP for rainwater tanks and recycled water systems, WTP is higher for the latter measure. Indeed, it is only in the case of recycled water systems that WTP is greater than the market price for installing greywater systems.

Among the studies that elicited preferences for avoiding water shortages, Dupont (2013) estimated the mean WTP to avoid water use restrictions (amounting to a 30% reduction of water availability) at around 12-13 USD/hh/month, which is similar to the amounts that customers are found to be willing to pay monthly to avoid water shortages in California (California Urban Water Agencies 1994).

Hensher et al. (2005) explored how WTP differs according to the level of service provision of water supply and wastewater treatment in Canberra, Australia. Specifically, they look to establish the willingness to pay to avoid interruptions in water service and overflows of

wastewater, differentiated by the frequency, timing and duration of these events. These attributes are indeed found to be important: households are willing to pay to reduce the frequency and the duration of water service interruptions and wastewater overflows. A subsequent study, Hensher et al. (2006), used a choice experiment approach to elicit WTP measures from households and businesses to avoid water restriction measures in the instance that a drought occurs. They find that WTP to avoid low-level restrictions and non-permanent high-level restrictions are actually negligible; respondents would prefer to adjust their water use schedules instead of paying more for water use.

The focus of existing literature has been to explore WTP for single measures. The current study adds to this body of literature by investigating WTP measures for a considerably greater range of actions that respond to drought conditions than has previously been considered and in doing so simulates a real-life situation where a number of alternative actions are typically compared.

3. The Survey and study design

The questionnaire was tested and developed throughout qualitative pre-survey and several pilot rounds in the three countries. The version elaborated during summer 2015 and spring 2016 was tested on a representative sample of the Czech adult population (N=3,847) using the CAWI survey mode in February-March 2016. Results of this survey led us to believe that the DC design was sufficiently user-friendly to be adopted in the multi-country survey that is described in this study. Specifically, the characteristics of alternative drought adaptation measures were judged to be well-understood, and the ability of respondents to make informed choices was perceived to be sufficient.

The questionnaire consisted of questions related to the screening and quota criteria adopted; the nature of the climate risks and threats respondents may be faced with during his/her lifetime (Section 1); familiarity with floods, droughts and heat wave events (Section 2); knowledge about climate change (Section 3); discrete choice experiments focusing on the trade-off between the impacts due to droughts or floods as expressed as i] proportion of people at risk, and ii] severity of impacts (Section 4); discrete choice experiments that ask respondents to trade-off between alternative types of adaptation measures that could reduce impacts of droughts or floods (Section 5); and socio-demographics (Section 6).

Design of discrete choice experiments

The objective of this discrete choice experiment is to explore the trade-offs that may be made between alternative adaptation measures that reduce the negative impacts of drought. Its novelty is that, in incorporating a wide range of different measures, the DCE attempts to simulate a greater degree of realism than has been attempted in the literature to date. In this study, respondents are asked to choose between alternative public adaptation programmes that would reduce drought impacts. The choice experiment consists of five attributes: technical measures (3 levels and no new), nature-based measures (2 levels and no new); supplementary soft non-structural measures (6 levels and no new); proportion of people at risk (3 levels and status quo of 14%), and cost expressed as an increase in monthly water bill paid by a household (5 levels and no cost), see Table 1. An example of the choice cards used is shown in Figure 1.

< Table 1 >

< Figure 1 >

Each respondent was asked to choose the best public adaptation programme from the three alternatives – Plan A, Plan B, and No Change. This choice process was repeated five times for different versions of Plans A and B. The efficient design of the experiment consisted of 100 choice tasks that were organised in 20 blocks by NGENE software (Choicemetrics, 2014).

Survey and Data

The questionnaire survey was conducted in the Czech Republic, the United Kingdom and Italy between 23rd June and 14th August 2016. The three countries were selected for the purpose of comparison, based on their different political and socio-economic contexts. We surveyed inhabitants of these countries aged 18 to 69 years, stratified in terms of gender, age, region and education. The percentages in all categories are not statistically different from the quota set based on national statistics.

Data were collected through online access panels using web-based questionnaires. Web-based instruments were chosen, as they provide the possibility for more complicated experimental designs and randomization. We screened out 1% of all respondents, as they did not comply with the definition of the target population. To select samples of respondents from the online access panels, quota sampling was applied. The proportion of people who were filtered out on quota ranged from 24% in the Czech Republic to 45% in the UK. In general, the

proportion of respondents who did not finish filling out the questionnaire was low, about 10 % in all national samples.

< Table 2 >

In total, we gathered 8,078 valid questionnaires, including 764 questionnaires in the pilot wave. There were no significant differences between the questionnaire used in the pilot wave and in the main wave, thus we included the pilot data in the dataset. The main difference was that we changed levels of the cost attribute in the discrete choice experiments after estimating the priors. While we used five nominal values of the monthly costs covering 3 EUR to 30 EUR in the pilot, we slightly increased the range of amounts offered to 3 EUR to 45 EUR in the main wave.

As some respondents may complete the questions without properly reading them, all cases with the overall time shorter than 50% of the median time in a given country subsample were excluded from the final sample and labelled as "speeders". After excluding speeders and undertaking data cleaning, the final sample includes 7,038 valid observations in total – see Table 2. We use further a split sample treatment in Italy and in the UK to analyse preferences for limiting the impacts either due to floods or droughts. In this paper, we use 4,151 valid observations from respondents answering the experiment on limiting the impacts due to droughts.

< Table 3 >

4. Econometric model

Respondents' preferences and willingness to pay for drought adaptation programmes are inferred from the choices respondents make in the discrete choice experiments. Theoretical foundations for quantitative modelling of consumers' utility functions are provided by the random utility theory (McFadden, 1974).

We assume that respondents will choose the drought adaptation programme if their willingness to pay for the program is greater than the cost of this program (p). The model is based on the following logic: a respondents *i*'s utility associated with choosing alternative *j* out of the *J* available alternatives in choice task *t* can be expressed as:

$$V_{ijt} = \mathbf{X}_{ijt}\mathbf{b}_i + p_{ijt}a_i + e_{ijt}\,, \qquad (1)$$

where $\mathbf{X}$ represents a vector of alternative-specific attributes, *p* is an additively separable cost. Vector β and α are coefficients to be estimated and they indicate marginal utilities for the specific measures to reduce the impacts and marginal utility of income, respectively.

We do not observe willingness to pay, but we posit that if the respondent chooses the policy, then the willingness to pay for it, WTP*, must be greater than the cost of that alternative. It implies that an individual will choose alternative *j* if $V_{ijt} > V_{ikt}$ for all k and j, and the probability that alternative j is chosen from a set of J alternatives becomes

$$P(j|J) = \frac{\exp\left(\boldsymbol{X}_{ijt}\left(\sigma_i\mathbf{b}_i\right) + p_{ijt}\left(\sigma_i a_i\right)\right)}{\sum_{k=1}^{J}\exp\left(\boldsymbol{X}_{ikt}\left(\sigma_i\mathbf{b}_i\right) + p_{ikt}\left(\sigma_i a_i\right)\right)} \qquad (2)$$

In our main models, we allow the coefficients can differ across respondents and are assumed to follow an a priori specified multivariate parametric distribution. In the mixed logit (MXL) models, all attribute coefficients are random and freely correlated; all coefficients are assumed to be normally distributed. Implicit value of the willingness to pay for policy attribute x, is then given as –b/a. Because the coefficients are assumed random variables following the specified probability distributions, the model is typically estimated using the maximum simulated likelihood method (Revelt & Train, 1998).

We also estimate a latent class (LC) model that tackles preference heterogeneity in a different way than MXL – instead of assuming continuous parametric distributions of individual parameters it uses a finite number of preference types (latent classes) which are probability weighted to best describe population level preferences. Each respondents' probability of membership in any given class may be defined as a function of the respondent's characteristics. This approach might be of particular interest, if population level preferences are better characterized by a mixture of a few discrete preference types rather than a continuous distribution.

Contrast to conditional logit both mixed logit and latent class logit are not restricting to assume proportional substitution between alternatives in a choice set (i.e. independence from irrelevant alternatives) and can account for unobserved taste variation between respondents either within continuous or discrete setting, respectively. The estimation results from the conditional logit with clustered standard errors across the respondents (assuming repeated choices as dependent) are provided in the Online Supplementary Information material (the online SI).

In the choice experiments, there were three alternatives (J=3) and the third one placed on the right was always the status quo that described the situation in future up to 2040 without the policy. Staying at the status quo always costs nothing. Each cost bid was expressed as an increased monthly bill for water consumption paid by a household. The bids in each of the three countries were shown on the choice cards in national currencies. We estimate MXL, CL and LC models in preference space, but use cost factor in PPS EUR equivalents. The marginal WTP values are derived in PPS EUR as well, standard errors around the means are estimated by the delta method.

Specifically, the indirect utility is defined as follows

$$V_{ijt} = \boldsymbol{MEASURE}_{ijt}\boldsymbol{b}_i + RISK_{ijt}c_i + COST_{ijt}a + e_{ijt} \qquad (3)$$

where X is a vector of eleven adaptation measures (including technical, nature-based, and soft non-structural) and RISK denotes the proportion of people who will be at risk due to droughts and all these attributes of an adaptation measure are random assumed to be fully correlated. COST measures cost of a program and it is assumed to be fixed. Vector of coefficients ***b***, scalars *c* and *α* are estimated by mixed logit (see the results presented in Table 4).[1]

The mixed logit model that controls for perceived effectiveness and the base level of implementation of each measure is as follows

$$V_{ijt} = \boldsymbol{X_{ijt}}\left(\boldsymbol{b1_i} + \boldsymbol{b2}\cdot\boldsymbol{EFFECT_{ijt}} + \boldsymbol{b3}\cdot\boldsymbol{IMPL_{ijt}}\right) + RISK_{ijt}c_i + COST_{ijt}a + e_{ijt} \qquad (4)$$

[1] The MXL model with the alternative-specific constant is estimated to find average preference and hence WTP for the adaptation program regardless the attributes of this program. This model is defined as
$\mathrm{V_{ijt}} = \mathrm{ASC(adapt)_{ijt}b_i} + \mathrm{COST_{ijt}a} + \mathrm{e_{ijt}}$.
In order to find the effect of more detailed information on climate change impacts that were provided to one group of our respondent, we also estimated the basic model defined around this utility:
$\mathrm{V_{ijt}} = \mathrm{ASC(adapt)_{ijt}(b_i} + \mathrm{INFO_{ijt}b1_i)} + \mathrm{COST_{ijt}a} + \mathrm{e_{ijt}}$.
These results are provided in Appendix I.

where X and RISK are random fully correlated non-monetary attributes of a program, COST is fixed monetary-attribute. The terms EFFECT and IMPL are two vectors of the measure-specific dummies on perceived effectiveness, and perceived level of implementation, respectively, that are interacted with corresponding adaptation measure, X and every two-way interactions are fixed factors; see Table 5 for the results.
Last, we estimate latent class model assuming three latent classes the main effects (see Table 6).

5. Survey Results

Perception of effectiveness and implementation of measures to limit drought damage

First, we test whether perceived effectiveness of the measures to increase drought resilience can explain willingness to pay for these measures, as might be expected. Therefore, we included dummy variables for "perceived effectiveness" in the MXL models. In the questionnaire, we asked respondents to evaluate how effective these measures would be in their country on a 7-point Likert scale and a "don't know" option was provided as well. We defined dummy variables for "perceived effectiveness" to one if a respondent chose one of the two highest categories on the scale, meaning that the measures are perceived as very effective at leas. Figure A1 and Figure A2 in the Appendix II report the percentage of people in each of the three countries who perceive structural and non-structural measures to be effective or not. Rainwater harvesting is perceived as one of the most effective measure in each country, with 49 to 69 % of respondents who perceived these measures as very effective. However, two nature-based adaptation measures (specifically creating wetlands and changing the use of agriculture land) are evaluated as effective by almost the same share of respondents as rainwater harvesting in the Czech Republic (about 60 %). The nature-based measures are perceived less effective in Italy and in the United Kingdom, however. Half of Italian respondents and 43 % of UK respondents find changing the use of agriculture land effective. The UK respondents rate building large reservoirs and dams as the second most effective measure, while building large dams is the least effective measure among all structural measures for the Czechs. Among the structural measures – technical or natural – large reservoirs and dams are perceived to be less effective in the Czech Republic and Italy, whereas the UK respondents perceive constructions of small water reservoirs and ponds the least effective to adapt to the impacts of droughts.

The Italians perceive the non-structural measures to be more effective than the UK respondents and the Czechs (see Figure A2 in the Appendix). Specifically, a much larger share of respondents from Italy think that improvement of land use planning (68 %), followed by tax relief on water efficient technologies (64 %), information provision (64 %), and risk management plans (59 %) are effective adaptation options than shares of the Czechs and the UK respondents. Higher charges for large water extraction are regarded as the least effective measure among all presented measures.

Second, we test whether people who perceive that a specific measure has been implemented insufficiently are willing to pay more for implementation of the measure than these measures that are judged to be adequately implemented. This perception was also measured on a 7-point Likert scale. We define the dummy variables for "insufficient implementation" to equal to one if a respondent chose two lowest categories on the scale. Again, these dummies are used later in the econometric models. We find that the percentage of respondents who think that a certain measure has been implemented insufficiently is much smaller than the percentage of respondents who perceive a given measure to be effective. In particular, water reservoirs, dams and ponds are perceived to be insufficiently constructed by the Czechs and Italians. There are about 20% of Italians and 15 - 30 % of Czechs who think the presented measures have not been implemented sufficiently, while only small share (7 - 14 %) of the UK respondents consider adaptation measures to be insufficiently implemented.

Figure A3 and Figure A4 in the Appendix show the percentages of people who consider that current levels of implementation are sufficient, or not, for structural and non-structural measures, respectively. Only small shares of respondents perceive that the structural measures are introduced sufficiently (ranging from 14 % to 25 %). The Czechs are more critical than the other countries' citizens in evaluation of implementation levels of rainwater harvesting, creating wetlands and changes in the use of agriculture land: only one-third perceive these measures as insufficiently implemented. Non-structural measures are evaluated similarly as structural measures, though differences between the countries are larger. About one-third of the UK respondents and the Italians are content with the degree of implementation of water consumption restrictions and degree of information provision.

Preferences for adaptation plans and measures

The status quo – that assumes no new drought adaptation plan and corresponds to no additional costs - was preferred in about 19 per cent of the choice tasks by Italians and Czechs,

and in 24 per cent cases by respondents from the United Kingdom. Ignoring specific adaptation measures and the proportion people at risk, on average, respondents are willing to pay for the proposed adaptation program 56 PPS EUR (s.e. 4.12) in the UK, 107 PPS EUR (s.e. 10.2) in Italy, and 110 PPS EUR (s.e. 10.0) in the Czech Republic. The mean WTP for Italy and the Czech Republic are not statistically different one from the other (Wald 0.032, p=.86), but each is different from the UK respondents WTP estimate ($Wald_{ITA}$=21.65, $Wald_{CZ}$=24.61). There is large heterogeneity in preferences of respondents in each country, indicated by large coefficients of standard deviation of the mean. These results are presented in Table A1 in Appendix.

Our main MXL model includes all eleven specific adaptation measures plus a proportion of people who will be at risk. These results are reported in Table 4 where Panel A reports the coefficient estimates and the corresponding WTP estimates are provided in the lower panel B. The first three measures listed in all tables present the structural technical measures (large reservoirs and dams, small reservoirs and ponds, and rainwater harvesting), whilst the next two are the nature-based structural measures (creating wetlands, changing use of agriculture land). The remaining six are non-structural soft measures that usually complement the structural measures. Proportion of people at risk and the cost attribute follow.

With all factors freely correlated in the mixed logit, the estimates of all coefficients are significant and have expected signs.[2] The results reveal stark differences among the countries and across the adaptation measures, however. We also find huge heterogeneity in respondents' preferences. In particular, preferences are heterogeneous particularly for the two soft non-structural measures based on pricing (tax relief and water use charges) and for water use restrictions, whereas preference for the proportion of people at risk is less heterogeneous. Preferences of the UK respondents respondents are relatively more heterogeneous than preferences of Italians and the Czechs.

< Table 4 >

Evaluating the three distinct groups of adaptation measures, we find that the UK respondents prefer more the technical structural measures, with the mean WTPs between 14.5 to 17.9 PPS

[2] Without freely correlated factors, the coefficient for the proportion of people at risk is not significant at any convenient level in Italy and in the Czech Republic that indicates the choices on the proportion at risk and the measures that may reduce these risks to be dependent.

EUR. On the other hand, the Czechs prefer most both nature-based structural measures (24.5 – 25.9 PPS EUR), followed by two technical measures that build small reservoirs or rainwater harvesting (22.7 – 24.3 PPS EUR). Italians prefer most rainwater harvesting as well (23.6 PPS EUR), but they also prefer the non-structural soft measures – information on efficient water use, drought risk management plans, land use planning (around 18-19 PPS EUR). They like in particular tax relief on water efficient technologies. This measure is the second-best valued, with the mean WTP of 23 PPS EUR, while the Czech are willing to pay two-thirds and the UK respondents a third of this value. Larger acceptability of the non-structural measures in Italy can be explained by wider experience of Italians living generally in more warm and dry climatic conditions than people in the UK and in the Czech Republic used to live. Italians also consider the non-structural soft measures more effective to combat the climate change effects.

Among the structural technical measures, Italians and Czechs prefer least constructing of large reservoirs and dams, whereas this measure is the first-best among all eleven measures proposed in our experiment for the UK respondents. In each case however the mean WTP is between 10 and 11 PPS EUR. Rainwater harvesting is the most preferred technical measure in Italy and the Czech Republic, with the mean WTP 20.7 EUR and 19.4 EUR, respectively.

Czechs are also willing to pay a substantial amount for the nature-based measures (creating wetlands, and use of agriculture land), 19.4 and 18.5 PPS EUR. Preference of UK respondents and Italians is more modest for the nature-based measures, with WTP about 9 PPS EUR in the UK and 10-13 PPS EUR in Italy.

WTP for the non-structural soft measures is in a range of 4-6 PPS EUR in the UK, 3-9 PPS EUR in the Czech Republic, while the WTP range for the soft measures is much wider for Italy (8-18 PPS EUR). Among the soft measures, the UK respondents and Czechs prefer most improved land use planning (6 PPS EUR and 9 PPS EUR), whilst Italians prefer most tax relief on water efficient technologies (23 PPS EUR). There is only one *ex post* soft measure offered in the choice experiment (water consumption restrictions) and people are willing to pay for it more in Italy (11 PPS EUR) and less in the remaining two countries (4-5 PPS EUR).

In our next MXL models we interact each of the eleven adaptation measures with two dummy variables. The first dummy measures whether a given measure is perceived very effective to reduce the impacts. The second dummy indicates whether a respondent think that a given measure has been implemented insufficiently. In the amended MXL model, all adaptation attributes and costs enter as random fully correlated factors, while the both sets of interaction terms are fixed. The estimates from this MXL model are presented in Table 5 Panel A. We find

the estimates of the mean for all random factors remain all positive and significant, except the coefficient of the mean for higher charges for water use in the Czech Republic that is positive but not significant. Preferences are heterogeneous for all attributes and in each country, except preferences for droughts risk management plans that seems to be a fixed factor. In each country, preference for the proportion of the people who will be at risk is similar and the mean is about 2 PPS EUR per each percentage point.

< Table 5 >

Eleven coefficients of the interaction terms with effectiveness are all positive and significant, implying that perceived effectiveness of a measure considerably increases public acceptance of adaptation programs in each country. If an adaptation measure is perceived to be very effective, WTP is increased roughly about 70%, see Table 5 Panel B. Effect of the effectiveness still varies across the measures. For instance, the Czech respondents who think that large reservoirs and dams are very effective are willing to pay almost four times more (32.9 EUR) than those who did not think so (6.9 EUR). Those who consider higher charges for water extraction not very effective are willing to pay virtually nothing, while those who think they are very effective are willing to pay 17 EUR. UK respondents and Italians reveal sharp differences in evaluation of information provided on efficient water use – those who think information provision is very effective measure are willing to pay 13.8 and 24.3 EUR respectively, while those who do not think that information provision is very effective are willing to pay less than 6 EUR. Perceived effectiveness does not have large effect only in the case of the use of agricultural land (in CZ and Italy) and restrictions in water consumption (UK), still the WTP is almost 30% larger if they are perceived to be very effective.

The effect of the perceived extent of implementation is in most cases not significant. In some cases, if a respondent thought that a measure has not been sufficiently implemented has a lower rather than higher WTP. We find this surprising effect on the structural measures and in Italy in particular. It seems that those who think that a certain measure has not been so far implemented widely also think that these measures should not be also introduced in the future. There are however exemptions. For instance, those who think that large reservoirs and dams have not been sufficiently built are willing to pay slightly more, 7.6 PPS EUR, than those who perceived this measure not very effective neither not sufficiently implemented. Information provision and land use planning is also significantly more preferred by those Italians who considered them not sufficiently implemented. If respondents thought that the two pricing soft measures (tax relief and water charges) have not been implemented by sufficient extend, there are willing to pay much more for their implementation. This holds at

least in the two less dry countries, in the UK and, even with a stronger effect, in the Czech Republic.

In Table 6, we report the WTP estimates for the latent class model with three classes (we report full model estimates in the online SI). In each country, the three classes consist of i] one class that is always largest, with very strong preferences for an adaptation programs and hence very large WTP values (*class supporting adaptation*); ii] a class in the middle where respondents share modest preferences, though with implied WTP values that are close to the mean WTP estimates derived from the mixed logit. Probability of belonging to this class is between 19% (CZ) and 39% (Italy); iii] members of the remaining class 3 are against any adaptation measure, implying the negative or zero WTP values for each adaptation attribute in each country. There is 17–21 % probability of belonging to this class.

< Table 6 >

The membership of *the class supporting adaptation* accounts for 64 % of the sample in the Czech Republic, 53 % in the United Kingdom, and 43 % in Italy. Acceptability of the measures is qualitatively same for this class as for the MXL model: the Czechs and Italians prefer rainwater harvesting, small reservoirs, and both nature-based structural measures; among the structural measures, WTP for large reservoirs and dams is smaller, but not for the respondents from the UK who like them the most, with WTP 43 PPS EUR. The largest WTP values are estimated for the structural measures and are approximately 40 PPS EUR in the UK and slightly above 40 PPS EUR in the Czech Republic. In Italy, the WTP for rainwater harvesting and tax relief on efficient technologies is almost 100 PPS EUR. The WTP for the least preferred adaptation (always one of the non-structural) measure is still very high – 18 PPS EU for water use charges in CZ, 19 PPS EUR for consumption restrictions in the UK, and 41 PPS EUR for drought risk management plans in Italy.

As a standard for communication protocol, the research confirms that respondents should be fully informed about a possible programme and its expected impacts when making their choices. It is however well documented that providing detailed information might affect respondents preferences and hence their WTP either way. We follow a standard procedure in our study and provided detailed information on climate change impacts in our questionnaire. However, to examine the possible effect of these information on WTP values, we split our sample and provided only a minimum amount of information needed to understand the impacts to a half of our respondents, lacking the detailed information that was provided to the other half of our respondents. We find that providing the detailed information about the

impacts resulted in larger willingness to pay for an adaptation program in Italy only.[3] Since we analyse the data pooled from the two groups, it implies that the WTP values for Italy present conservative, lower bound, estimates. Our results suggest, as presented in Appendix, Table A2 that the willingness to pay values for fully informed respondents only might be 20–25 % larger than the estimates presented in this paper for the Italian respondents.

6. Conclusions and discussion

This paper reports on a discrete choice survey undertaken in three countries - the Czech Republic, Italy and the UK - in order to elicit preferences relating to potential future public drought adaptation programmes. A distinct feature of the study is that a wide range of possible structural and non-structural measures are presented to the respondents for consideration. They were asked how they would rank alternative programmes, each consisting of a suite of eleven specific drought-limiting measures and proportion of people who will be at risk due to expected adverse impacts. The results differ substantially between countries; respondents in the UK are found to have stronger preferences for structural measures, such as large reservoirs, than those in Italy or the Czech Republic. These preferences are expressed in terms of both higher WTP values as well as a belief in their effectiveness or the extent to which these measures have been already implemented. In contrast, Italian respondents have a strong preference for non-structural measures to limit drought damage. We suggest that these patterns reflect the degree to which the respective populations are familiar with the measures, as well as the extent to which there is recognition that water resource availability is a current concern or a future concern if exacerbated by climate change.

The high degree of heterogeneity across respondents and countries therefore emphasises the need – not previously identified in the climate adaptation literature – for a high degree of caution when considering the transfer of benefit estimates between contexts. The corollary, in terms of policy implications, is that acceptance of new, and perhaps cost-effective, adaptation measures in the UK and Czech Republic, is likely to be contingent on greater public awareness of the changing need for them as well as their efficacy. The generally lower WTP

[3] Without providing the detailed information, the WTP was 88 PPS EUR and it is 132 PPS EUR with the information ($\chi 2=8.93$, p=0.003), see Table A2 in Appendix. Detailed information about the climate change impacts does not affect respondents preferences in the UK ($\chi 2=0.76$, p=0.38) or in the Czech Republic ($\chi 2=2.47$, p=0.12).

values derived from the UK respondents perhaps reflect this, as well as a significant degree of climate change scepticism.

ACKNOWLEDGEMENT

This research has received funding from the Grant Agency of the Czech Republic grant no. 19-26812X within the EXPRO Program "Frontiers in Energy Efficiency Economics and Modelling - FE3M", and from the H2020-MSCA-RISE project GEMCLIME-2020 under GA 681228 (secondment). The survey was conducted thanks to the EU funded project ECONADAPT No. 603906. Responsibility for any errors remains with the authors.

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Figures

Figure 1: Example of a choice card – adaptation measures to limit drought damage

FIRST CHOICE

 Plan characteristics to limit **drought** damage:	**Plan A**	**Plan B**	**No plan**
Technical measures	Large reservoirs and dams	Small water reservoirs and ponds	No new
Natural measures	Creating wetlands	No new	No new
Non-structural measures	Higher charges for large water extraction	Improved land use planning	No new
Proportion of people affected by restrictions in water use by 2040 (currently 10 %)	13 %	9 %	14 %
Increased monthly costs for your household (per year)	£10 (£120)	£15 (£180)	£0 (£0)
Which option do you consider to be the best?	Plan A	Plan B	No plan

Tables

Table 1. Attributes and levels of discrete choice experiments

Attribute	**Levels**
Technical measures	• Rainwater harvesting • Small water reservoirs and ponds • Large reservoirs and dams • No new
	Status Quo: No new
Natural measures	• Changes in the use of agricultural land • Creating wetlands • No new
	Status Quo: No new
Non-structural measures	• Water consumption restrictions • Higher charges for large water extraction • Tax relief on water efficient technologies • Improved land use planning • Drought risk management plans • Information provision regarding efficient water use • No new
	Status Quo: No new
Proportion of people affected by restrictions in water use (currently 10 %)	• 13%(14-1) • 11%(14-3) • 9%(14-5)
	Status Quo: 14%
Increased monthly costs for your household	• 3€ • 10€ • 15€ • 25€ • 45€
	Status Quo: 0€

Table 2: Percentages of non-response according to reason

Reason	**Italy**	**UK**	**CZ**	**Total**
incomplete	9%	10%	10%	10%
excluded: quota	36%	45%	24%	39%
excluded: screen out	2%	0%	2%	1%

Table 3: National samples and identification of speeders

Country	**N – complete and valid, incl. speeders**	**Final N –representative, excluding speeders (% speeders)**	**N – with the experiment on the impacts due to droughts, excl. speeders**
UK	3,414	3,073 (9 %)	1,521
Italy	3,281	2,655 (10%)	1,320
Czech Republic	1,383	1,310 (5%)	1,310
TOTAL	8,078	7,038 (8%)	4,151

Note: Here and in the following tables, 'N' denotes number of observations.

Descriptive statistics of each sample

	CZ (n=1,310)		UK (n=1,521)		ITA (n=1,320)	
	mean	std	mean	std	mean	std
female	0.50	(0.5)	0.52	(0.5)	0.49	(0.5)
age (years)	44.34	(14.34)	43.40	(14.64)	43.59	(13.19)
family with a child	0.33	(0.47)	0.32	(0.47)	0.35	(0.48)
family with retired people	0.27	(0.45)	0.26	(0.44)	0.31	(0.46)
size of residence up to 5,000 people	0.29	(0.46)	0.17	(0.37)	0.16	(0.36)
size of residence above 5,000 and less than 100,000 people	0.43	(0.5)	0.19	(0.4)	0.44	(0.5)
size of residence more than 100,000 people	0.28	(0.45)	0.64	(0.48)	0.41	(0.49)
household income (national currency a month)	27,929	(12,110)	1,984	(1,156)	1,658	(942)
household income (PPS EUR a month)	1735	(752)	2072	(1207)	1652	(938)
information about household income not provided	0.13	(0.34)	0.16	(0.37)	0.16	(0.36)

Table 4: MXL model all factors correlated, preference space

Panel A

	CZ			UK			ITA		
	coeff		**s.e.**	**coeff**		**s.e.**	**coeff**		**s.e.**
mean (random)									
Large reservoirs/dams	1.2469	***	0.1432	1.7644	***	0.1321	1.3099	***	0.1356
Small reservoirs/ponds	1.8650	***	0.1403	1.4234	***	0.1208	1.2461	***	0.1339
Rainwater harvesting	1.9939	***	0.1385	1.6029	***	0.1336	1.8820	***	0.1418
Wetlands	2.1241	***	0.1383	1.3748	***	0.1262	1.0802	***	0.1197
Use of agricultural land	2.0110	***	0.1321	1.3144	***	0.1176	1.1773	***	0.1264
Information on efficient use	0.7706	***	0.1424	0.8818	***	0.1507	1.4228	***	0.1789
Drought risk mng. plans	1.0623	***	0.1519	0.9217	***	0.1339	1.4458	***	0.1810
Land use planning	1.3120	***	0.1609	1.1278	***	0.1534	1.5550	***	0.1618
Tax relief on efficient tech	1.2376	***	0.1618	0.8701	***	0.1540	1.8325	***	0.1687
Higher charges for extraction	0.5800	***	0.1695	0.5234	***	0.1794	0.8402	***	0.1747
Consumption restrictions	0.7950	***	0.1562	0.7813	***	0.1368	1.4743	***	0.1654
Proportion at risk	0.1425	***	0.0283	0.1701	***	0.0279	0.2052	***	0.0309
Cost (PPS Euro)	-0.0821	***	0.0046	-0.0983	***	0.0050	-0.0796	***	0.0051
Variances									
Large reservoirs/dams	6.0575	***	1.1239	5.2644	***	0.9602	3.8044	***	0.8531
Small reservoirs/ponds	5.2317	***	0.9093	3.3843	***	0.7223	4.4541	***	1.2169
Rainwater harvesting	4.6145	***	0.8112	5.9084	***	0.9862	6.8868	***	1.2245
Wetlands	3.3575	***	0.6240	6.6839	***	1.0293	4.4437	***	1.0349
Use of agricultural land	3.5254	***	0.7274	4.5673	***	0.8557	5.0775	***	0.9143
Information on efficient use	2.2314	***	0.7341	4.2533	***	1.0310	6.2257	**	2.5111
Drought risk mng. plans	3.2891	***	0.9803	2.4536	***	0.7187	6.8445	***	1.7911
Land use planning	5.6806	***	1.2004	6.3070	***	1.3348	5.5343	***	1.2047
Tax relief on efficient tech	6.8739	***	1.5030	6.7214	***	1.3927	6.3190	***	1.4262
Higher charges for extraction	8.7746	***	2.0524	9.8989	***	1.8782	6.4508	***	1.6237
Consumption restrictions	6.9143	***	1.4220	4.3766	***	1.0212	5.2813	***	1.2788
Proportion at risk	0.1976	***	0.0376	0.2956	***	0.0442	0.2906	***	0.0657
Model specification									
LL	-4276.21			-5034.20			-4417.03		
No. obs.	15720			18252			15840		
No. ID	1310			1521			1320		
df	78			78			78		

Panel B

	CZ		UK		ITA	
	mean	**s.e.**	**mean**	**s.e.**	**mean**	**s.e.**
Large reservoirs/dams	15.19	(1.63)	17.94	(1.26)	16.45	(1.63)
Small reservoirs/ponds	22.72	(1.53)	14.48	(1.15)	15.65	(1.72)
Rainwater harvesting	24.29	(1.51)	16.30	(1.28)	23.64	(1.8)
Wetlands	25.88	(1.37)	13.98	(1.11)	13.57	(1.49)
Use of agricultural land	24.50	(1.38)	13.37	(1.05)	14.79	(1.63)
Information on water efficient use	9.39	(1.71)	8.97	(1.55)	17.87	(2.17)
Drought risk mng. plans	12.94	(1.82)	9.37	(1.37)	18.16	(2.2)
Land use planning	15.98	(1.86)	11.47	(1.54)	19.53	(2.08)
Tax relief on efficient tech	15.08	(1.89)	8.85	(1.55)	23.02	(2.14)
Higher charges for extraction	7.07	(2.03)	5.32	(1.82)	10.55	(2.2)
Consumption restrictions	9.68	(1.9)	7.95	(1.39)	18.52	(2.17)
Proportion at risk	1.74	(0.32)	1.73	(0.26)	2.58	(0.37)

Table 5: MXL model with fully correlated random attributes and fixed interaction terms on perceived effectiveness and low extend of implementation

Panel A. MXL estimates

	Czech Republic			United Kingdom			Italy		
	coeff		s.e.	coeff		s.e.	coeff		s.e.
mean (random)									
Large reservoirs/dams	0.6426	***	0.1815	1.3260	***	0.1435	1.1246	***	0.1759
Small reservoirs/ponds	1.6684	***	0.1980	1.2059	***	0.1318	1.1576	***	0.1855
Rainwater harvesting	1.9607	***	0.2122	1.3258	***	0.1460	1.5168	***	0.2218
Wetlands	1.7035	***	0.1776	1.1048	***	0.1306	0.8454	***	0.1497
Use of agricultural land	1.8711	***	0.1937	1.0385	***	0.1222	1.1957	***	0.1626
Information on efficient use	0.5360	***	0.1899	0.5267	***	0.1615	0.4701	*	0.2462
Drought risk mng. plans	0.8146	***	0.1821	0.7878	***	0.1644	1.1011	***	0.2355
Land use planning	1.1352	***	0.2307	0.6526	***	0.2001	0.8465	***	0.2596
Tax relief on efficient tech	0.6027	**	0.2406	0.7010	***	0.1798	0.9531	***	0.2518
Higher charges for extraction	0.1172		0.1963	0.3990	**	0.1769	0.6705	***	0.2118
Consumption restrictions	0.5056	**	0.1992	0.6555	***	0.1634	1.0027	***	0.2186
Proportion at risk	0.2070	***	0.0318	0.1927	***	0.0272	0.1895	***	0.0323
Cost (PPS Euro)	-0.0936	***	0.0058	-0.0968	***	0.0047	-0.0823	***	0.0059
very effective (fixed)									
Large reservoirs/dams	2.4399	***	0.2528	1.2582	***	0.1752	0.7837	***	0.1890
Small reservoirs/ponds	0.8299	***	0.2022	0.7987	***	0.1571	0.4453	**	0.1978
Rainwater harvesting	0.7518	***	0.1933	0.6969	***	0.1592	0.6848	***	0.2096
Wetlands	0.8934	***	0.1674	0.6140	***	0.1483	0.8518	***	0.1852
Use of agricultural land	0.4136	**	0.1752	0.7469	***	0.1405	0.3687	**	0.1705
Information on efficient use	0.2330		0.2437	0.8096	***	0.2264	1.5271	***	0.2865
Drought risk mng. plans	0.7320	***	0.2589	0.3098		0.2170	0.8156	***	0.2589
Land use planning	0.5165	*	0.2716	0.5686	**	0.2356	0.9458	***	0.2885
Tax relief on efficient tech	0.7664	***	0.2787	0.3718		0.2276	1.1191	***	0.2849
Higher charges for extraction	1.4715	***	0.3257	0.4664	**	0.2363	0.8798	***	0.2966
Consumption restrictions	0.9052	***	0.2590	0.1690		0.2130	0.8613	***	0.2476
insufficient implementation (fixed)									
Large reservoirs/dams	0.0670		0.3042	-0.7688	***	0.2919	-0.3580		0.2674

Small reservoirs/ponds	0.4344	*	0.2406	-0.1475		0.2686	-0.2154		0.2765
Rainwater harvesting	-0.2822		0.2152	-0.0380		0.2698	0.3157		0.2778
Wetlands	0.4512	**	0.1877	0.2279		0.2292	-0.0603		0.2159
Use of agricultural land	0.7899	***	0.1975	0.0114		0.2200	-0.4695	**	0.2344
Information on efficient use	0.3041		0.2891	-0.1368		0.4049	0.3027		0.3576
Drought risk mng. plans	-0.1253		0.2968	-0.0252		0.3621	0.1548		0.3523
Land use planning	0.1078		0.3194	0.1341		0.3531	0.4214		0.3616
Tax relief on efficient tech	0.7633	**	0.3220	0.1754		0.3328	0.0123		0.3331
Higher charges for extraction	0.6656	*	0.3682	0.1181		0.3674	-0.6439	*	0.3709
Consumption restrictions	0.3289		0.3463	0.2623		0.3978	0.4447		0.3583
variances									
Large reservoirs/dams	6.7212	***	1.4696	3.3951	***	0.6831	4.5725	***	0.9445
Small reservoirs/ponds	7.7626	***	1.4570	2.3871	***	0.5542	4.6174	***	0.9985
Rainwater harvesting	6.9159	***	1.2249	3.7940	***	0.6837	6.1486	***	1.0636
Wetlands	3.7051	***	0.7951	4.9188	***	0.7355	5.5360	***	1.1120
Use of agricultural land	3.5587	***	0.7059	3.1748	***	0.5599	4.7761	***	0.9095
Information on efficient use	2.8407	***	0.8328	3.1439	***	0.8092	9.4821	***	2.6714
Drought risk mng. plans	0.3367		0.3087	0.2608		0.3207	-0.2268		0.2856
Land use planning	8.4837	***	1.7205	8.0094	***	1.5600	7.9510	***	2.1718
Tax relief on efficient tech	10.0291	***	2.0649	5.6778	***	1.2202	8.6754	***	2.3070
Higher charges for extraction	6.2400	***	1.3664	6.2341	***	1.3393	8.6840	***	1.9874
Consumption restrictions	7.1126	***	1.5773	2.9130	***	0.8733	8.3442	***	1.8398
Model specification									
LL	-4147.87			-4966.03			-4364.71		
No. obs.	15720			18252			15840		
No. ID	1310			1521			1320		
k (no. parameters)	113			113			113		

*Note: *** 1%, ** 5%, * 10%*

Panel B. WTP in PPS EUR

	Czech Republic						United Kingdom						Italy					
	not effective, implemented sufficiently		very effective		implemented not sufficiently		not effective, implemented sufficiently		very effective		implemented not sufficiently		not effective, implemented sufficiently		very effective		implemented not sufficiently	
Large reservoirs/dams	6.87	***	32.94	***	7.58	**	13.70	***	26.71	***	5.76	*	13.66	***	23.18	***	9.31	***
Small reservoirs/ponds	17.83	***	26.70	***	22.47	***	12.46	***	20.72	***	10.94	***	14.06	***	19.47	***	11.44	***
Rainwater harvesting	20.95	***	28.99	***	17.94	***	13.70	***	20.90	***	13.31	***	18.42	***	26.74	***	22.26	***
Wetlands	18.20	***	27.75	***	23.03	***	11.42	***	17.76	***	13.77	***	10.27	***	20.61	***	9.54	***
Use of agricultural land	20.00	***	24.41	***	28.44	***	10.73	***	18.45	***	10.85	***	14.52	***	19.00	***	8.82	***
Information on efficient use	5.73	***	8.22	***	8.98	***	5.44	***	13.81	***	4.03		5.71	*	24.25	***	9.39	**
Drought risk mng. plans	8.70	***	16.53	***	7.37	**	8.14	***	11.34	***	7.88	**	13.37	***	23.28	***	15.25	***
Land use planning	12.13	***	17.65	***	13.28	***	6.74	***	12.62	***	8.13	**	10.28	***	21.77	***	15.40	***
Tax relief on efficient tech	6.44	**	14.63	***	14.60	***	7.24	***	11.09	***	9.06	**	11.58	***	25.17	***	11.72	**
Higher charges for extraction	1.25		16.98	***	8.37	**	4.12	**	8.94	***	5.34		8.14	***	18.83	***	0.32	
Consumption restrictions	5.40	**	15.08	***	8.92	**	6.77	***	8.52	***	9.48	**	12.18	***	22.64	***	17.58	***
Proportion at risk	2.21	***					1.99	***					2.30	***				

*Note: Proportion of people at risk is not interacted with the effectiveness and sufficiency dummies. *** 1%, ** 5%, * 10%.*

Table 6. Mean WTP in PPS EUR derived from latent class model

	Czech Republic			United Kingdom			Italy		
	class1	class2	class3	class1	class2	class3	class1	class2	class3
Large reservoirs/dams	29.6 ***	8.4 ***	-13.4 ***	42.6 ***	8.0 ***	-0.5	56.6 ***	15.9 ***	-5.6 **
Small reservoirs/ponds	45.3 ***	8.8 ***	-12.3 ***	33.7 ***	7.3 ***	-5.5 **	70.7 ***	13.2 ***	-5.1 *
Rainwater harvesting	45.3 ***	7.5 ***	-6.7	39.8 ***	6.3 ***	0.5	99.2 ***	16.0 ***	1.1
Wetlands	44.1 ***	6.3 ***	-3.0	38.9 ***	5.5 ***	-7.0 ***	71.4 ***	9.4 ***	-3.3
Use of agricultural land	41.3 ***	7.8 ***	-2.8	33.9 ***	5.3 ***	-5.6 ***	78.0 ***	10.6 ***	-5.3 **
Information on efficient use	22.8 ***	0.5	-12.3 **	27.7 ***	1.1	-3.2	56.1 ***	22.0 ***	-3.7
Drought risk mng. plans	27.0 ***	3.3 **	-11.8 **	24.3 ***	4.2 ***	-5.7 **	41.1 **	23.3 ***	-5.9 **
Land use planning	31.2 ***	4.2 ***	-16.4 ***	32.3 ***	4.8 ***	-6.7 **	70.7 ***	19.1 ***	-5.9 **
Tax relief on efficient tech	30.7 ***	0.8	-10.4 **	28.2 ***	1.3	-0.5	98.7 ***	16.4 ***	-5.2
Higher charges for extraction	17.7 ***	3.5 **	-19.1 ***	26.9 ***	4.1 ***	-13.3 ***	44.1 ***	11.2 ***	-6.8 **
Consumption restrictions	23.4 ***	2.4 *	-18.5 ***	19.2 ***	3.2 ***	-6.7 **	55.5 ***	17.2 ***	-6.5 **
Proportion at risk	4.8 ***	1.3 ***	-1.4	5.7 ***	1.5 ***	-0.7	13.6 ***	1.5 ***	-0.1
Membership probability	64%	19%	17%	53%	26%	21%	43%	39%	18%

*** 1%, ** 5%, * 10%; see the online SI for the parameter estimates.

Appendixes

Appendix I. Additional MXL models

Table A1. MXL model with ASC for adaptation, preference space.

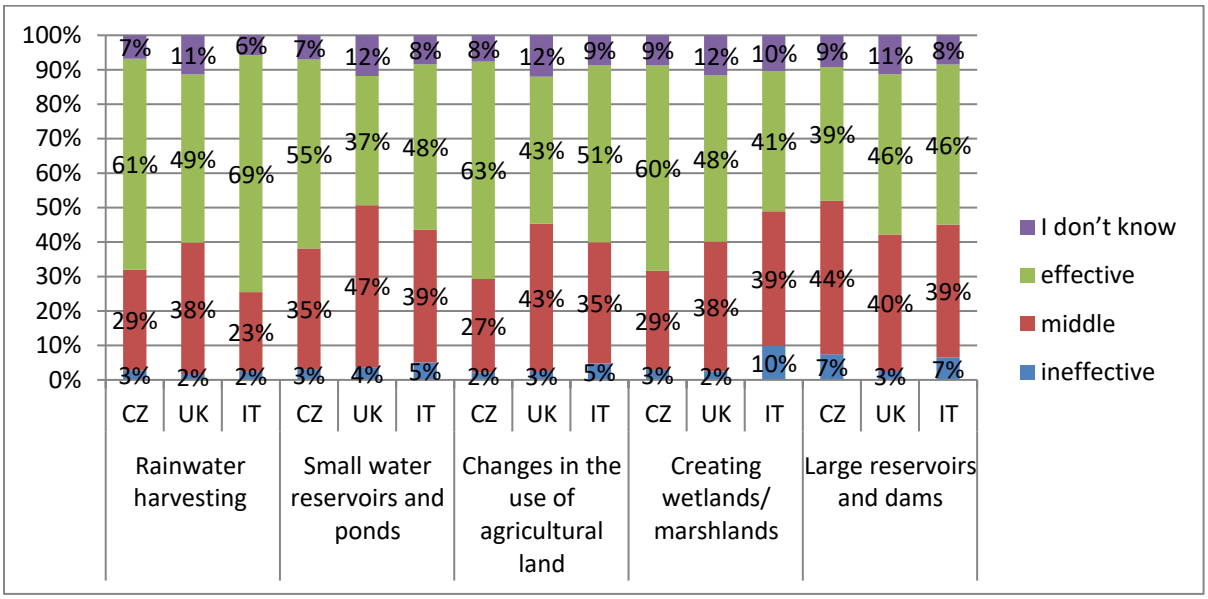
	UK		ITALY		CZECH	
	Coeff	std.error	Coeff	std.error	Coeff	std.error
Mean						
ASC(adaptation)	3.6569	0.1985	4.0008	0.2416	4.0536	0.2431
Cost (in PPS EUR)	-0.0653	0.0040	-0.0373	0.0030	-0.0369	0.0028
SD						
ASC(adaptation)	4.4472	0.2351	4.5476	0.2843	4.3758	0.2657
Cost (in PPS EUR)	0.0848	0.0047	0.0616	0.0042	0.0561	0.0037
Number of obs.	18,252		15,840		15,720	
Log likelihood	-5007.50		-4498.89		-4454.16	
WTP (PPS EUR)	mean	Std. Error	mean	Std. Error	mean	Std. Error
WTP for adaptation	56.04	4.12	107.20	10.19	109.75	10.01

Table A2. MXL model with ASC for adaptation controlling for providing detailed information about climate change impacts.

	UK		ITALY		CZECH	
	Coeff	std.error	Coeff	std.error	Coeff	std.error
Mean						
ASC(adaptation)	3.7118	0.2533	3.2552	0.2478	3.7361	0.2505
ASC * information	-0.2408	0.2910	1.6384	0.3481	0.5231	0.3316
Cost (in PPS EUR)	-0.0667	0.0040	-0.0372	0.0030	-0.0386	0.0029
SD						
ASC(adaptation)	4.3789	0.2218	4.0517	0.2415	3.8346	0.2295
ASC * information	0.0402	0.4639	3.0303	0.5113	2.2609	0.4983
Cost (in PPS EUR)	0.0851	0.0045	0.0627	0.0041	0.0609	0.0037
Number of obs	18,252		15,840		15,720	
Log likelihood	-5005.1		-4490.5		-4448.4	
WTP (PPS EUR)	mean	Std. Error	mean	Std. Error	mean	Std. Error
no information	**55.69**	4.60	**87.57**	9.05	96.73	9.04
with information	**52.08**	4.19	**131.65**	13.19	110.28	10.62
Wald test of equality (p-value)	0.68 (0.407)		19.58 (0.000)		2.47 (0.116)	

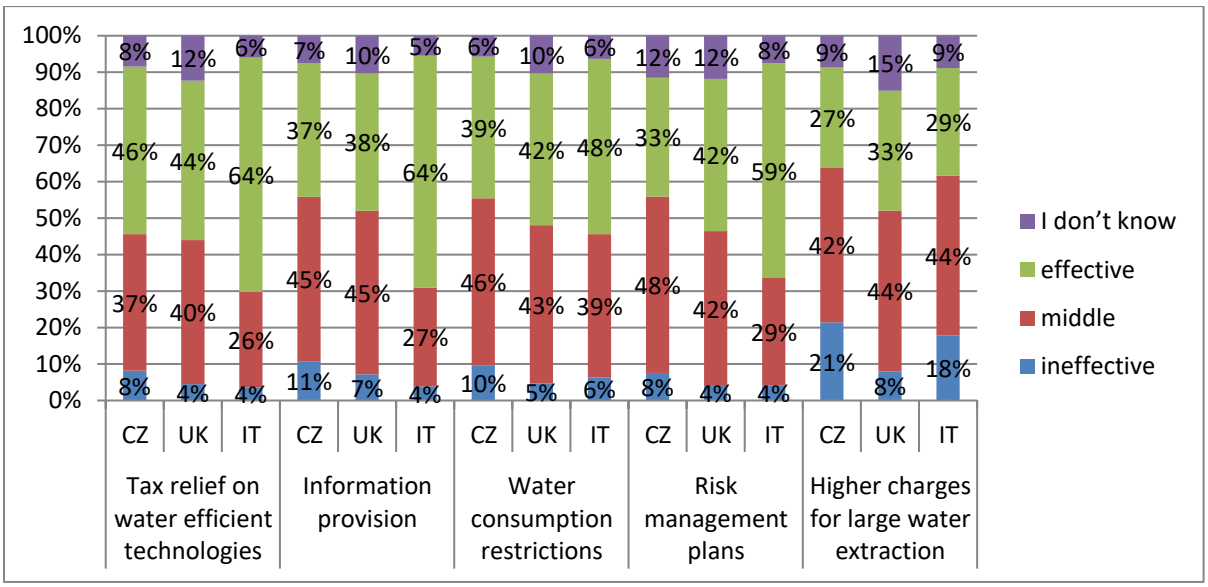
Appendix II. Perceived effectiveness and level of implementation of measures

Figure A1: Perceived effectiveness of structural measures to limit drought damage – percentages



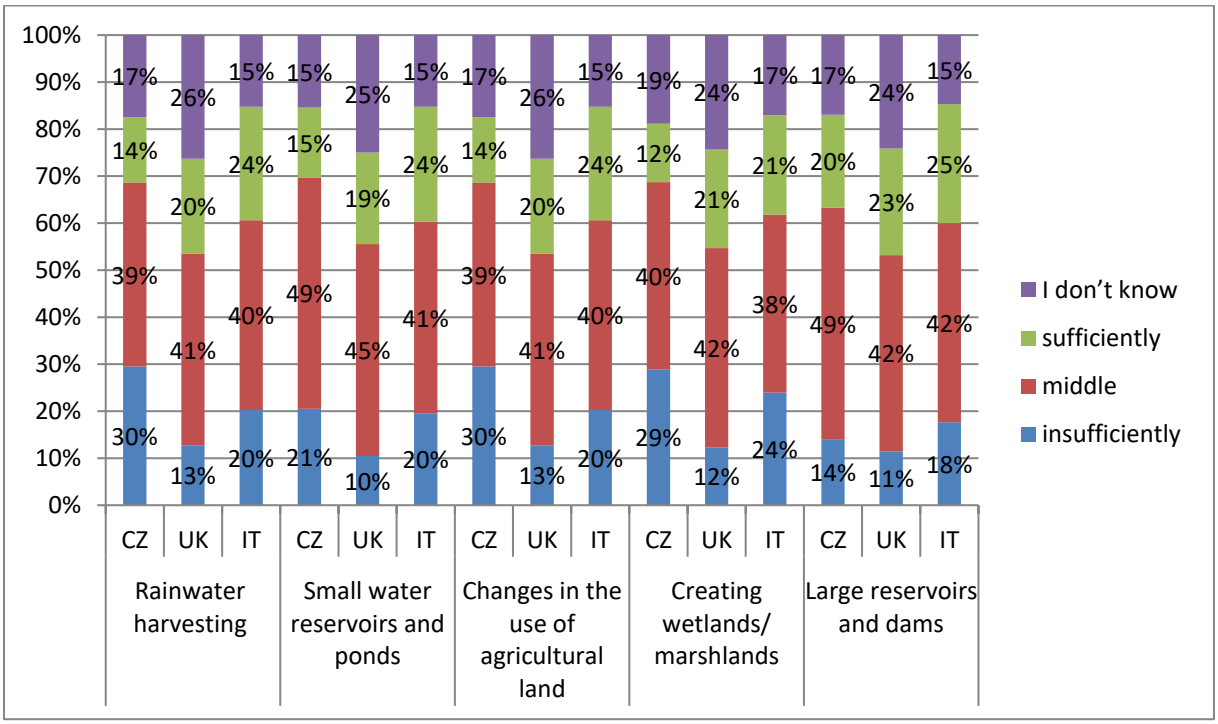
Question: In your opinion, how effective would these measures be if they were introduced in the UK/Czech Republic/Italy?

Figure A2: Perceived effectiveness of non-structural measures to limit drought damage – percentages



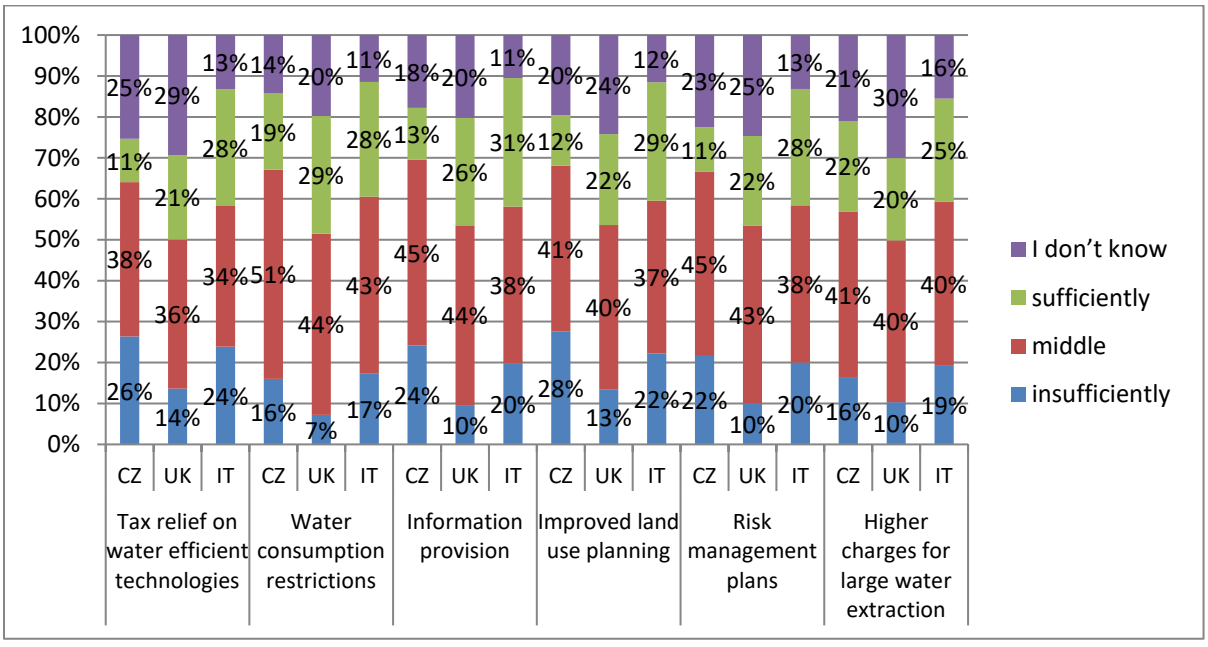
Question: In your opinion, how effective would these measures be if they were introduced in the UK/Czech Republic/Italy?

Figure A3: Perceived degree of implementation of structural measures to limit drought damage – percentages



Question: In your opinion, to what extent have the following measures been already implemented in the UK/Czech Republic/Italy?

Figure A4: Perceived degree of implementation of non-structural measures to limit drought damage – percentages



Question: In your opinion, to what extent have the following measures been already implemented in the UK/Czech Republic/Italy?

Online Supplementary Information material

Table SI1: Conditional Logit estimates and WTP values in PPS EUR

	Czech Republic			Italy			United Kingdom		
	Coeff	t stat	WTP	Coeff	t stat	WTP	Coeff	t stat	WTP
Structural technical measures									
Large reservoirs and dams	0.4372	8.05	15.9 €	0.3883	7.22	15.7 €	0.6102	12.11	18.8 €
Small water reservoirs and ponds	0.6894	13.10	25.1 €	0.4261	8.06	17.2 €	0.4292	8.57	13.2 €
Rainwater harvesting	0.7627	14.74	27.7 €	0.7030	13.94	28.3 €	0.5890	12.13	18.1 €
Structural nature-based measures									
Creating wetlands	0.7204	15.82	26.2 €	0.3520	7.81	14.2 €	0.4985	11.83	15.3 €
Changes in the use of agricultural land	0.7178	15.49	26.1 €	0.4311	9.38	17.4 €	0.4577	10.54	14.1 €
Non-structural soft measures									
Information on efficient water use	0.2497	3.71	9.1 €	0.5179	7.78	20.9 €	0.2820	4.46	8.7 €
Drought risk management plans	0.2949	4.35	10.7 €	0.4997	7.37	20.1 €	0.2261	3.55	7.0 €
Improved land use planning	0.2803	4.39	10.2 €	0.4597	7.16	18.5 €	0.2611	4.36	8.0 €
Tax relief on water efficient technologies	0.2790	4.19	10.1 €	0.5673	8.78	22.9 €	0.1871	3.00	5.8 €
Higher charges for large water extraction	0.0145	0.22	0.5 €	0.1640	2.42	6.6 €	0.1414	2.29	4.4 €
Water consumption restrictions *(ex post)*	0.1493	2.33	5.4 €	0.3235	5.11	13.0 €	0.1180	1.94	3.6 €
Proportion of people at risk	0.0137	1.19	0.5 €	0.0290	2.54	1.2 €	0.0298	2.77	0.9 €
Cost (PPS Euro)	-0.0275	-17.37		-0.0248	-14.86		-0.0325	-21.34	
No IDs	1,310			1,320			1,521		
No cases	15,720			15,840			18,252		
LogL	-5179			-5329			-6229		
LogL(0)	-5757			-5801			-6684		

Table SI2: MXL model with not correlated factors, preference space

	UK		ITALY		CZECH	
	Coeff	s.e.	Coeff	s.e.	Coeff	s.e.
Mean						
Large reservoirs and dams	1.2841	0.0950	0.6802	0.1062	0.8022	0.1124
Small water reservoirs and ponds	1.0937	0.0912	0.8444	0.0959	1.3811	0.1056
Rainwater harvesting	1.1451	0.0927	1.3608	0.1078	1.4091	0.1015
Creating wetlands	1.1734	0.0831	0.6715	0.0860	1.3458	0.0913
Changes in the use of agricultural land	1.0956	0.0806	0.8354	0.0929	1.3073	0.0939
Information on efficient water use	0.6692	0.1165	1.1687	0.1253	0.4538	0.1199
Drought risk management plans	0.5705	0.1128	0.9854	0.1256	0.5632	0.1231
Improved land use planning	0.7673	0.1066	0.8615	0.1215	0.6378	0.1184
Tax relief on water efficient technologies	0.5729	0.1043	1.1281	0.1178	0.5089	0.1146
Higher charges for large water extraction	0.6735	0.1080	0.5037	0.1229	0.2466	0.1165
Water consumption restrictions (ex post)	0.5038	0.0998	0.7504	0.1165	0.3578	0.1118
Proportion of people at risk reduced	0.0938	0.0254	0.0221	0.0258	-0.0149	0.0273
Cost (in PPS EUR)	-0.1221	0.0064	-0.0658	0.0049	-0.0726	0.0051
SD						
Large reservoirs and dams	-1.0844	0.1571	1.6597	0.1750	1.8901	0.2020
Small water reservoirs and ponds	0.7814	0.2125	0.6755	0.2574	1.1109	0.1684
Rainwater harvesting	1.3534	0.1457	1.5965	0.1692	1.3314	0.1384
Creating wetlands	1.0890	0.1272	-1.1036	0.1297	0.8769	0.1626
Changes in the use of agricultural land	-0.4513	0.1655	1.2616	0.1289	0.8861	0.1673
Information on efficient water use	0.8489	0.2633	0.0262	0.7603	-0.5222	0.3622
Drought risk management plans	0.9606	0.2545	0.9575	0.3050	0.7403	0.4901
Improved land use planning	0.7561	0.2423	1.0174	0.2555	1.0022	0.2890
Tax relief on water efficient technologies	0.1692	0.2252	0.0455	0.5968	-0.1941	0.2793
Higher charges for large water extraction	-0.1800	0.2221	0.1978	0.4132	0.0322	0.4159
Water consumption restrictions (ex post)	0.2947	0.2449	0.9711	0.1912	0.8553	0.2345
Proportion of people at risk reduced	0.5536	0.0385	0.4826	0.0422	0.5561	0.0434
Cost (in PPS EUR)	0.1395	0.0078	0.1020	0.0072	0.0859	0.0072
Model characteristics						
Number of obs	18,252		15,840		15,720	
Number of respondents	1,521		1,320		1,310	
LR chi2(13)	1651.86		1110.69		1024.08	
Log likelihood	-5403.26		-4773.70		-4666.51	

WTP in PPS EUR, mean, (s.e.)	UK	ITALY	CZECH
Large reservoirs and dams	10.52 (0.8)	10.33 (1.66)	11.04 (1.57)
Small water reservoirs and ponds	8.96 (0.75)	12.82 (1.56)	19.01 (1.62)
Rainwater harvesting	9.38 (0.79)	20.67 (2.00)	19.4 (1.66)
Creating wetlands	9.61 (0.68)	10.20 (1.32)	18.53 (1.49)
Changes in the use of agricultural land	8.97 (0.66)	12.69 (1.46)	18.00 (1.5)
Information on efficient water use	5.48 (0.99)	17.75 (2.3)	6.25 (1.72)
Drought risk management plans	4.67 (0.95)	14.96 (2.18)	7.75 (1.76)
Improved land use planning	6.28 (0.88)	13.08 (2.01)	8.78 (1.7)
Tax relief on water efficient technologies	4.69 (0.87)	17.13 (2.07)	7.01 (1.62)
Higher charges for large water extraction	5.52 (0.89)	7.65 (1.92)	3.39 (1.6)
Water consumption restrictions (ex post)	4.13 (0.83)	11.40 (1.92)	4.93 (1.56)
Proportion of people at risk reduced	0.77 (0.2)	0.34 (0.38)	-0.21 (0.38)

Table SI3. Latent class model

Estimates for the Czech Republic

	class 1			class 2			class 3		
	coeff.		std	coeff.		std	coeff.		std
Large reservoirs/dams	0.8382	***	0.0843	2.4616	***	0.5548	-0.8004	***	0.2598
Small reservoirs/ponds	1.2825	***	0.0799	2.5792	***	0.4708	-0.7367	***	0.2873
Rainwater harvesting	1.2826	***	0.0748	2.2014	***	0.4294	-0.4013	*	0.2548
Wetlands	1.2470	***	0.0679	1.8663	***	0.3630	-0.1823	*	0.2468
Use of agricultural land	1.1677	***	0.0695	2.3056	***	0.4160	-0.1676	*	0.2453
Information on efficient use	0.6464	***	0.0918	0.1374	*	0.5553	-0.7369	**	0.3502
Drought risk mng. plans	0.7653	***	0.0946	0.9665	**	0.4242	-0.7054	**	0.3592
Land use planning	0.8817	***	0.0971	1.2374	***	0.4403	-0.9811	***	0.3448
Tax relief on efficient tech	0.8679	***	0.0986	0.2444	*	0.4700	-0.6208	**	0.2968
Higher charges for extraction	0.5006	***	0.0983	1.0273	**	0.4850	-1.1409	***	0.4424
Consumption restrictions	0.6614	***	0.0951	0.7020	*	0.3800	-1.1087	***	0.3231
Proportion at risk	0.1350	***	0.0172	0.3952	***	0.0890	-0.0859	*	0.0664
Cost (PPS Euro)	-0.0283	***	0.0026	-0.2941	***	0.0513	-0.0599	***	0.0133
Membership probability	*64.2%*			*18.5%*			*17.2%*		
No. obs	15720								
No. IDs	1310								
LogLik	-4290.75								
AIC	8663.49								
BIC	8977.66								
k (no parameters)	41								

1% ***, 5% **, 10% *

Estimates for the United Kingdom

	class 1			class 2			class 3		
	coeff.		std	coeff.		std	coeff.		std
Large reservoirs/dams	1.1424	***	0.0819	2.6214	***	0.3605	-0.0608	*	0.2455
Small reservoirs/ponds	0.9052	***	0.0792	2.4071	***	0.3473	-0.6120	**	0.3054
Rainwater harvesting	1.0664	***	0.0763	2.0766	***	0.3346	0.0518	*	0.2563
Wetlands	1.0429	***	0.0657	1.7915	***	0.2471	-0.7790	***	0.2434
Use of agricultural land	0.9082	***	0.0668	1.7402	***	0.2465	-0.6239	***	0.2337
Information on efficient use	0.7431	***	0.0899	0.3766	*	0.3393	-0.3513	*	0.3349
Drought risk mng. plans	0.6531	***	0.0929	1.3950	***	0.3458	-0.6349	**	0.3113
Land use planning	0.8674	***	0.0918	1.5886	***	0.3268	-0.7448	**	0.3042
Tax relief on efficient tech	0.7555	***	0.0960	0.4183	*	0.2990	-0.0507	*	0.2892
Higher charges for extraction	0.7223	***	0.0930	1.3448	***	0.3256	-1.4832	***	0.4422
Consumption restrictions	0.5143	***	0.0953	1.0488	***	0.2691	-0.7393	**	0.3328
Proportion at risk	0.1538	***	0.0170	0.5057	***	0.0666	-0.0772	*	0.0739
Cost (PPS Euro)	-0.0268	***	0.0026	-0.3284	***	0.0384	-0.1111	***	0.0208
Membership probability	*53.2%*			*25.7%*			*21.2%*		
No. obs	18252								
No. IDs	1521								
LogLik	-4978.9								
AIC	10039.7								
BIC	10360								
k (no parameters)	41								

1% ***, 5% **, 10% *

Estimates for Italy

	class 1			class 2			class 3		
	coeff.		std	coeff.		std	coeff.		std
Large reservoirs/dams	0.6824	***	0.1373	1.2146	***	0.2635	-0.5913	**	0.2521
Small reservoirs/ponds	0.8517	***	0.1364	1.0057	***	0.2218	-0.5444	*	0.2842
Rainwater harvesting	1.1961	***	0.1428	1.2212	***	0.2016	0.1216	*	0.2506
Wetlands	0.8609	***	0.1267	0.7149	***	0.1752	-0.3472	*	0.2375
Use of agricultural land	0.9401	***	0.1337	0.8113	***	0.1807	-0.5579	**	0.2382
Information on efficient use	0.6762	***	0.1867	1.6836	***	0.2778	-0.3905	*	0.3412
Drought risk mng. plans	0.4959	**	0.2231	1.7782	***	0.3314	-0.6245	**	0.3102
Land use planning	0.8524	***	0.1675	1.4577	***	0.2320	-0.6276	**	0.2834
Tax relief on efficient tech	1.1893	***	0.1531	1.2525	***	0.2167	-0.5476	*	0.3481
Higher charges for extraction	0.5313	***	0.1523	0.8589	***	0.2084	-0.7246	**	0.3602
Consumption restrictions	0.6685	***	0.1514	1.3144	***	0.2272	-0.6891	**	0.3340
Proportion at risk	0.1634	***	0.0304	0.1160	***	0.0386	-0.0060	*	0.0684
Cost (PPS Euro)	-0.0121	*	0.0071	-0.0764	***	0.0142	-0.1060	***	0.0188
Membership probability	*42.8%*			*38.7%*			*18.5%*		
No. obs	15840								
No. IDs	1320								
LogLik	-4463.7								
AIC	9009.41								
BIC	9323.89								
k (no parameters)	41								

1% ***, 5% **, 10% *

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Univerzita Karlova v Praze, Fakulta sociálních věd
Institut ekonomických studií [UK FSV – IES] Praha 1, Opletalova 26
E-mail : ies@fsv.cuni.cz http://ies.fsv.cuni.cz