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PUBLIC ACCEPTABILITY OF CLIMATE CHANGE MITIGATION POLICIES: A DISCRETE CHOICE EXPERIMENT

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Public Acceptability of Climate Change Mitigation Policies: A Discrete Choice Experiment

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Abstract

Our study examines public acceptability of the EU's future mitigation targets. Using the discrete choice experiment, we elicit the preferences of about 4,098 respondents from the Czech Republic, Poland, and the United Kingdom for the GHG emission reduction policies that differ in four attributes: emission reduction target, burden sharing across the EU Member States, the distribution of costs within each country, and cost. The three specific reduction targets we analysed correspond to the EU 2050 Roadmap and deep decarbonisation policy (80% target), the climate-energy 2014 targets (40% target), and the status quo policy (20% target); each will result in a specific emission trajectory by 2050. Our results reveal stark differences between the three countries. Czechs would be on average willing to pay around EUR 13 per household and year for the 40% GHG emission reductions by 2030 or EUR 17 for 80% reduction target by 2050, and the citizens of the UK are willing to pay about EUR 40. Conversely, the mean willingness to pay of the Polish household for adopting more stringent targets is not statistically different from zero. The willingness to pay for adopting 40% and 80% targets are not statistically different in any of the examined countries. However, we found that the preferences in all three countries are highly heterogeneous. In addition, we provide an insight into the preferred characteristics of the future GHG emission reduction policies.

Keywords:

discrete choice experiments; climate change mitigation policy; consumer preferences; burden sharing; cost distribution; GHG emission targets

JEL:

Q48, Q51, Q54, Q58

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1. Introduction

The Paris Agreement adopted on December 12, 2015 provides a framework for combating global warming worldwide, with the key objective of limiting the rise in global temperature to below 2°C by 2100. It even calls for energetic efforts to be made to contain the rise to 1.5°C and the 'global emissions ceiling' must be reached 'in the shortest-possible time', with countries targeting emissions neutrality in the second half of the century. All countries should share responsibility, but in different proportions determined primarily by their historic level of responsibility and their current level of development.

All policies proposed for implementation in order to comply with the Paris Agreement face the challenge of policy infeasibility. Decision-makers are usually reluctant to pursue unpopular policies, or policies which the public is simply not willing to endorse or accept. Understanding public acceptability can thus help to overcome a barrier to the successful implementation of even unpopular policies. This is very important especially regarding policies that may have global impacts and bring costs and benefits that are spread unevenly in space and time. This is the case of climate mitigation policy.

The present study contributes to the recent research and debate by examining public acceptability of the EU's future mitigation targets yielding future benefits and costs, altogether with several options for burden sharing and cost distribution. Specifically, we elicit preferences and estimate willingness to pay (WTP) of the Czechs, the British, and the Poles for three different EU emission reduction targets – 20% by 2020, 40% by 2030, and 80% by 2050 – and several options to share the burden among the EU countries and costs among citizens of each country.

The three GHG emission reduction targets present three different emission trajectories resulting in three different global temperature increases and likely impacts by 2100. More specifically, the 80% reduction target by 2050 corresponds to the EU's Roadmap for Moving to a Competitive Low-Carbon Economy in 2050 (EC, 2011) and to a pathway to achieve deeper emission cuts by the middle of the century. Deep decarbonisation policy is also supported by the COP 21 Agreement adopted in Paris on December 12, 2015, which calls for energetic efforts to contain the rise in temperature by 1.5°C and the emphasises that the 'global emissions ceiling' must be reached 'in the shortest-possible time'. The less strict 40% target then corresponds to the climate-energy integrated 40-27-27 EU target, as updated by the European Council in October 2014 (EC, 2014). The remaining target is the status quo policy that would result in a 20% reduction in EU emissions by 2030, as already committed to by the European Commission (Decision 406/2009/EC, Directive 2009/28/EC, Directive 2012/27/EU). Volumes of GHG emissions will remain stable after reaching the target in both of the less stringent 40% and 20% emission mitigation policies. As a consequence of these emission trajectories, by 2100 global average temperature would increase by 2.6 ºC to 4.8 ºC (the 20% target), or 1.2 ºC to 2.8 ºC (the 40% target), respectively, compared to an increase of 0.7 ºC to 2.2 ºC owing to the 80% target, and would result in severe, or moderate impacts, respectively, compared to mild impacts due to the strictest target.

In principle, policy acceptability is an attitude towards an object (policy) and is the basis for policy preferences. Attitudes are influenced by various factors – socioeconomic status, income, values, beliefs and worldviews, and beliefs about policy characteristics. There are many such factors, which are examined by diverse approaches and methods. This study combines an economic approach (the discrete choice experiment) and a social-psychological approach (attitudinal measures), which allows us to provide an insight into the main drivers of policy acceptability. Data from three nationally representative samples are analysed. More than 4,000 respondents were interviewed in September and October 2015, just a couple of weeks before the Polish general election and a few months before the COP 21 in Paris.

In general, more than a half of the citizens in the three countries are in favour of each of the EU policy targets. Our results nevertheless reveal stark differences between the three countries. The largest percentage of those in favour of the policy targets could be found among the Czech households who would be on average willing to pay around EUR 13 for 40% or EUR 17 for 80% GHG emission reductions. On the other hand, the UK households would be willing to pay EUR 44 and EUR 46, respectively, although fewer UK respondents have overall positive attitudes towards the targets. The mean WTP of the Polish households for adopting more strict emission targets is not statistically different from zero, with a preference for the status quo 20% reduction target. Still, the preferences in all countries are highly heterogeneous. In addition, there is a clear general preference for the polluter-pays principle at both national and EU levels, with the exception of Poland, where the EU-wide distribution based on countries' GDP was preferred by similar percentage of respondents.

The following part of this paper reviews relevant literature, while section 3 describes the survey method and the discrete choice experiment method. Following this, a description of the sample is given, including knowledge of climate change impacts, evaluation of emission targets and perceived fairness. Section 5 reports public preferences for the three GHG reduction targets and perceived fairness, while the following section performs econometric analysis of individual preferences for all attributes of mitigation policies, introducing the econometric model, estimation results, and WTP simulation for eight policy packages. The final section summarises the results and provides policy recommendations.

2. Literature review

The first issue related to research on policy acceptability is the definition and measurement of *acceptability* itself. As shown in previous research (Batel, Devine-Wright, & Tangeland, 2013; Dreyer, Teisl, & McCoy, 2015; Dreyer & Walker, 2013), answers to questions on general acceptability or support for a policy may sometimes differ substantially. People may generally accept the idea of some unspecified climate policy, but may strongly oppose fuel taxes or are in general not willing to pay for any climate change mitigation policy. Consequently, realistic scenarios including the costs and characteristics of the instruments are needed to elicit answers closer to what the respondent would identify with and act upon. Therefore, we propose to use the discrete choice experiment method in combination with attitudinal measures. Some WTP studies have already been successfully conducted (see Alló & Loureiro, 2014; Nemet & Johnson, 2010 for reviews).

In general, public acceptability of policies is influenced by at least two types of factors and their interactions[1]: **i) individual** characteristics, and **ii) characteristics of the policy** (see Zvěřinová et al. 2014 for a systematic review). Looking first at **individual characteristics**, social-psychological studies have identified the positive effect of biospheric and pro-environmental values and awareness of the consequences of climate change (e.g. Dietz, Dan, & Shwom, 2007; Leiserowitz, 2006; Poortinga, Spence, Demski, & Pidgeon, 2012; Steg,

[1] The effects of policy characteristics are interlinked with social-psychological variables mentioned above and hence the individual characteristics of the respondent (Kim, Schmöcker, Fujii, & Noland, 2013).

Dreijerink, & Abrahamse, 2005), personal and social norms (Cools et al., 2011; Harring & Jagers, 2013; Schade & Schlag, 2003), trust (Dietz et al., 2007; Harring & Jagers, 2013; Sælen & Kallbekken, 2011) and actual knowledge about climate change (Dietz, Dan, & Shwom, 2007; O'Connor, Bard, & Fisher, 1999).

The evidence for the influence of several **socio-demographic characteristics** is inconclusive (Zvěřinová et al., 2014). The findings are in general consistent only for the positive effect of income on WTP (Nemet & Johnson, 2010). The evidence for the effect of gender is rather mixed (Zvěřinová et al., 2014), which may indicate the dependence of this relationship on other factors, such as the characteristics of the policy. Younger (Adaman et al. 2011; Carlsson et al. 2012; Hanemann, Labandeira, and Loureiro 2011; Hersch and Viscusi 2005; 2006) and more educated people (Adaman et al. 2011; Carlsson et al. 2012; Hersch and Viscusi 2005; 2006; Kotchen, Boyle, and Leiserowitz 2013; Li et al. 2004) tend to be willing to pay more.

Turning to the second type of factors, there are of course many attributes by which policies are characterized. Not all of them, however, are relevant or comprehensible to the public. In general, three main categories of policy characteristics have been identified as important influences on public acceptability: perceived policy **effectiveness**, (perceived) **fairness** linked either to distribution of costs or burden-sharing rules, and **use of revenues**. Yet the specifications of these characteristics differ substantially in most of the studies. For instance, perceived effectiveness of a policy might be measured by impact on behaviour or by emission reduction. Moreover, the effects of policy characteristics are interlinked with social-psychological variables and hence the individual characteristics of the respondent (Kim, Schmöcker, Fujii, & Noland, 2013). Of other policy attributes, several studies aimed at specific policy instruments, such as permits versus taxes (Bristow et al., 2010) or forestry practices (Layton and Levine, 2003). Ancillary benefits of the climate change mitigation policy which might be quite substantial (Ščasný et al., 2015), may also play quite a decisive role in respondents' decision making (Brännlund & Persson, 2012; Cole & Brännlund, 2009; Longo, Hoyos, & Markandya, 2011). Moreover, people may prefer mitigation targets over adaptation, as found, for instance, by Alló & Loureiro, 2014). Nevertheless, the two key factors of policy acceptability identified are effectiveness and fairness, which are also examined in our study.[2]

Studies that included effectiveness of policies found that people are more likely to vote or willing to pay more for policies that they **perceive as effective**, i.e. that a policy will achieve its objectives. Overall, the price that people are willing to pay for improved environmental effectiveness is quite high – for example Australians were willing to pay EUR 27[3] per month for an additional 1 °C of prevented temperature increase according to a survey conducted in 2008 (Akter, Bennett, and Ward 2012). Dietz and Atkinson (2010) found that people from Southwark, UK, are willing to pay EUR 270 or EUR 579 per year for medium and high improvement in national climate-change mitigation. The acceptability, support or willingness to pay increase if the expected mitigation is more successful in preventing the temperature increase (Akter, Bennett, & Ward, 2012), reducing GHG or CO_2 emissions (Longo, Markandya, & Petrucci, 2008) or improving environmental quality (e.g. air quality; Dietz & Atkinson, 2010). Many people, however, do not know what consequences may be associated with a temperature increase of 2 °C (Reynolds, Bostrom, Read, & Morgan, 2010). One way to deal with this is to specify the effects in the questionnaire. Hence in our questionnaire, we provided information about the effects of climate change if not mitigated and if mitigated as corresponding to the three GHG emission reduction targets, providing that the rest of the world would adopt equivalent measures.

Perceived fairness of distribution of policy costs has been identified as another key factor influencing WTP for climate policy (Berrens et al. 2004 and Li et al. 2004; Wiser 2007 and 2003). There are various principles of cost distribution or burden-sharing rules which have been discussed in negotiations on both national and international levels. The rules can be applied to international relations and agreements (i.e. between different states) or within

[2] Although the effect of the **use of policy revenues** on policy acceptability is not yet explored in depth, the results suggest that it is one of the key factors. Carson, Louviere and Wei (2010) analysed albeit only preferences (not WTP) for different policy options and their particular characteristics. Similarly, Bristow et al. (2010) found that allocation of revenues into the general budget is quite unacceptable. On the other hand, there is no significant difference between the options of reducing local council tax, cutting income tax, providing a lump sum of money or stimulating energy efficiency. In sum, respondents in this study slightly preferred stimulation of energy efficiency over using revenues in the general budget, but not over tax cuts. The results of Sælen and Kallbekken (2011) indicate that earmarking generally improves policy acceptability or support in the case of fuel taxation. On the other hand, earmarking for income distribution would not result in increased acceptability of any tax increase at all.

[3] In order to enable comparison between studies that estimated WTP values, we always converted the original figures in national currencies presented in the studies into 2012 EUR values using purchasing power parity and consumer price index for the year stated in the study.

countries to allocate costs among citizens. Specifically, for national level, the costs could be distributed equally (i.e. per capita), or differentiated by level of income, production, or emissions released. The cost distribution can also be described by the principles of taxation: all pay either the same amount, the same percentage of income, or those with higher incomes pay a higher income percentage (progressive taxation) (Brännlund and Persson 2012; Cole and Brännlund 2009). At the international level, in addition to these principles, rules based on population density can be used. Moreover, the general rules may be specified by methods of evaluation, e.g. the polluter-pays principle can be specified as a tax per unit or paying above a set limit, between countries by emissions per capita or according to the total burden.

Some studies found that respondents prefer the polluter-pays principle and distribution based on ability to pay (Dietz & Atkinson, 2010) and progressive, rather than regressive, taxation (Brännlund & Persson, 2012; Cole & Brännlund, 2009). An empirical study conducted among students suggests that domestic distribution and payment vehicles are more important than international cost distribution and burden sharing (Cai, Cameron, & Gerdes, 2010). However, a study of the general public of the United States and China indicates that people can still consider international burden sharing rules and presumably prefer options which impose lower costs on their country (Carlsson et al., 2013). This study did not include domestic distribution as an attribute therefore it is not possible to evaluate which characteristics are more important for respondents. Since the evidence on preferred cost distribution or burden sharing is rare in general, research is needed to identify which cost distribution rule is most acceptable and for which public. There is also no current study on public acceptability of climate policy which examines the effects of policy characteristics, particularly cost distribution and burden sharing among the EU Member States, using choice experiments on nationally representative samples of several European countries thus providing detailed country comparison. The present study aims to fill this research gap.

3. The survey and the study design

3.1. *Survey method and sampling*

Nationally representative samples of the adult population in the Czech Republic, the United Kingdom and Poland were surveyed in September and October 2015 within the EU funded project CECILIA2050. The three countries were selected based on their different political stances in the European climate policy debate and distinct national contexts (including economy, dominant energy production sources, and national climate policies and goals) for the purpose of comparison. Population of the UK (with 64.3 million) is the third largest among the 28 EU Member States and Poland is the sixth largest one (38 million), while the Czech Republic with about 10 million inhabitants belongs to the medium-sized EU countries. The UK economy produces the highest per capita GDP among the three analysed with the second largest GDP in the EU and 10th highest GDP per capita among the 28 EU states. Czech and Polish economies are less productive, with GDP per capita ranked at 20th and 24th place (15th and 23rd if GDP is purchasing power corrected). Poland and the Czech Republic belong to carbon-intensive economies, having third and fourth highest volume of GHG emissions per GDP (1.0 and 0.8 Mg per one billion EUR GDP). On the other hand, the UK economy belongs to one of the least carbon intensive EU Member States with only 0.3 Mg GHG per billion euros, which is the sixth best performance in the EU28. The subsamples were drawn from the three surveyed populations using quota sampling with quotas for gender, region, age and education.

Data were collected using web-based questionnaires administered either by interviewers personally (CAPI) or by online access panels (CAWI). The combination of the survey modes was chosen in order to alleviate possible generalizability issues caused by lower internet coverage rates in the Czech Republic and Poland (78% and 75% respectively of households in 2014; Eurostat, 2014). Since internet coverage reached 90% of British households in 2014 (*ibid.*), only CAWI questionnaires were distributed in the UK.

Given the goals of this study, computer assisted interviews were the most suitable option. Measures of policy acceptability need to include specific characteristics of the policies and instruments. This is crucial to obtain valid and meaningful responses (see above). Thus, we utilize discrete choice experiments, which allow for diverse specifications of several policy attributes to be evaluated by the respondents. Randomisation of the policy characteristics in the choice sets as well as the order of items where there are multiple-item, scaled questions increase flexibility and avoid bias due to the ordering effect. On the other hand, this approach is more demanding in terms of the instrument. Web-based instruments provide both the possibility for more complicated experimental designs and randomizations as well as a well-designed environment which is easy to navigate and use for the respondents.

In the self-administered mode, however, there is no control over the interview situation and respondents' behaviour in it. Some respondents may flip through the questions without properly reading them, thus providing invalid answers. Therefore, we identified cases with very short response time and excluded them from the analyses. More specifically, we monitored the time respondents needed to fill each section of the questionnaire in the CAWI mode in each country. All cases with the overall time shorter than 48% of median specific for a given subsample were excluded from the final sample as speeders.[4]

In total, the interview was conducted with almost 5,500 respondents, including 680 respondents interviewed in the last pilot round. After cleaning the data and excluding 9.4% of speeders from the Czech CAWI and 14.1% from the Polish CAWI sample, we ended up with a total of 4,098 valid observations, 1,581 in the Czech Republic, 1,266 in Poland, and 1,251 in the United Kingdom (see Table 1).

Table 1. National samples and identification of speeders

country	mode	N (completed)	% of speeders	**N valid**
Czech Republic	**CAWI**	1,270	9.4%	**1,150**
	CAPI	431	NA	**431**
Poland	**CAWI**	974	14.1%	**837**
	CAPI	429	NA	**429**
United Kingdom	**CAWI**	1,420	11.9%	**1,251**

[4] The definition of speeder based on 48% median follows the recommendation of SSI (Survey Sampling International, 2013). The median value was computed separately for each section, information treatment, age category, and country. Time length values of respondents who took much longer (3*median) to fill given section or interrupted the task and finished later were replaced by the median value. In fact, it took much longer to fill the questionnaire when additional information about climate change was provided, and by older respondents.

3.2. *The instrument*

The questionnaire was tested and developed throughout several pilot rounds. The first version was tested in the Czech Republic by qualitative semi-structured interviews which also served as a basis for specification of some questions and options provided to the respondents. The elaborated version was tested on a representative sample of the Czech adult population (N=727) by CAWI mode in September 2014. The collected data were used to check validity and later reliability of the instrument and to further develop some of the questions. The last pilot round was carried out in all of the surveyed countries in both survey modes. Only minor changes were implemented after the last pilot (N=680). Translations of the questionnaire to Polish and English were double-checked between the different language versions and also in the last pilot round.

The questionnaire consisted of seven major parts. Screening questions on socio-demographic characteristics of the respondents were placed at the beginning to check the quota attainment. The second part included measures of general value orientation (Schwartz, 1992), trust towards institutions and people in general, and perception of and knowledge about climate change. The perception of the effects of climate change was measured both prior to and after receiving information on climate change being provided in the third section.

Individual preferences for policy characteristics were elicited in the next two parts of the questionnaire. Two discrete choice experiments were accompanied by questions on perception of policy characteristics included in the experiments. Respondents could familiarize themselves with these characteristics and better understand them before committing a decisive response in the choice experiments. While the first choice experiment aimed at perceived fairness of cost distribution and burden sharing for various emission reduction targets for the European Union (analysed in this paper), the second choice experiment targeted perceived effectiveness of the policy instrument and preferences for revenue use with the 80% reduction target set (not analysed here).

Part six included several other social-psychological constructs – the New Environmental Paradigm scale (Dunlap, Van Liere, Mertig, & Jones, 2000), questions measuring personal norms (Stern, Dietz, Abel, Guagnano, & Kalof, 1999), and ascription of responsibility for tackling climate change. Finally, we asked about respondents' environmentally significant behaviours in the public sphere and the remaining socio-demographic characteristics, such as income, family, etc.

3.3. *The discrete choice experiment*

In order to explore public preferences for climate policies and their characteristics, we designed a choice experiment containing four attributes. The first three attributes described the policy: emissions reduction target for the European Union (20% by 2020, 40% by 2040, 80% by 2050), distribution of costs among the European Union countries (linear to wealth, per capita, per emissions), and cost distribution among the citizens of the given country (linear, per capita, progressive, and linked to emissions), see Table 2 and an example of the choice card in Figure 2.

The three GHG emission reduction targets present three different emission trajectories. We informed our respondents that after achieving the two less stringent, emission volumes will remain stable or may even slightly increase at least until 2050. It implies that each stricter target includes all less stringent targets that are presented in our design. As highlighted above, the three reduction targets correspond to the EU's Roadmap (by 80% by 2050), to the EU's 2014 integrated targets (by 40% by 2030 then remaining stable), and to the status quo situation (20% reduction by 2030 and then emissions remaining more- or-less stable). As a consequence of these emission trajectories, global average temperature would increase much more due to the 20% mitigation policy than due to the 80% reduction policy (see Figure 1 that also describes the impacts). In line with scientific knowledge, both the average temperature increase and the impacts as presented as uncertain, providing the temperature interval and a notion of likeliness.

The remaining attribute was the increased monthly costs to the respondent's household, which allows us to estimate the willingness to pay for each level of the policy attributes. The costs varied between EUR 20 and EUR 150 and the nominal values were recalculated into national currencies using purchasing power standard. Both attributes and their levels were chosen in accordance with the aims of this study and based on the results of the qualitative pre-survey.[5]

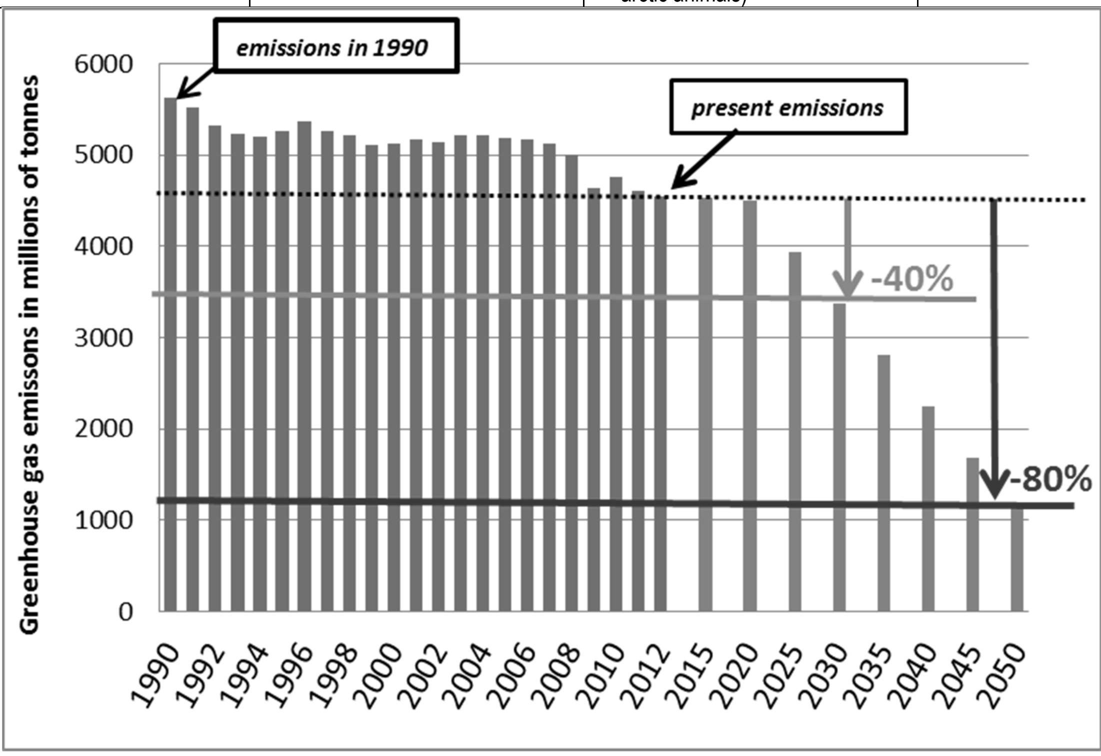
Table 2. Design of the choice experiment for acceptability of policy instruments

Attribute	Levels
Emissions reduction target for the European Union (increase in global average temperature by 2100)	• **-20%** by 2020 (+**2.6–4.8°C** by 2100) • **-40%** by 2030 (+**1.2–2.8°C** by 2100) • **-80** by 2050 (+**0.7–2.2°C** by 2100)
	Status Quo: 20% reduction by 2020; current policy
Distribution of costs among the European Union countries	• richer states pay more • states with higher population pay more • higher emitting states pay more
	Status Quo: richer states pay more
Distribution of costs among the citizens of *[country]*	• everyone pays the same amount • everyone pays the same income percentage • the rich pay a higher income percentage • those who emit more pay more
	Status Quo: everyone pays the same amount
Increased monthly costs for your household	€20, €33, €65, €95, €130, €150
	Status Quo: €0

[5] Note that the cost levels reflected the expected WTP levels, not necessarily the actual expected costs per household.

Figure 1. Choice experiments design: Emissions reduction targets for the European Union

	20% reduction by 2020	40% reduction by 2030	80% reduction by 2
Amount of greenhouse gas emissions	emissions remain more- or less as now, may slightly increase **(black dotted line)**	-20% by 2020 -40% by 2030 then, remain stable **(orange)**	-20% by 2020 -40% by 2030 -80% by 2050 **(dark red line)**
Policy status	policy that has been agreed at the EU and is currently being implemented	EU commitment, measures not implemented yet	EU commitment, measur implemented yet
Increase in global average temperature by 2100 relative to 1986-2005 level - if the rest of the world adopts equivalent emission reduction targets	**2.6 ºC** to **4.8 ºC**	**1.2 ºC** to **2.8 ºC**	**0.7 ºC** to **2.2 ºC**
Likely impacts	**Severe** • **large** drop in agricultural production • loss of **most** coastal areas • **substantial threat** to human health caused by disease, malnutrition, heat waves, floods and droughts • **widespread** extinction of animal and plant species, loss of their habitats	**Moderate** • **moderate** drop in agricultural production • loss of **many** coastal areas • **some** threat to human health caused by disease, malnutrition, heat waves, floods and droughts • extinction of **some** animal and plant species and loss of their habitats (especially coral reefs, arctic animals)	**Mild** • **the most severe imp** climate change are prev • some effects of global v will be felt, however **severe** as in the other re scenarios



In each choice situation, respondents were presented with three options, namely two proposed new policy options and a status quo option, that is, the continuation of the current approach and already implemented policies that will reach the 20% reduction target by 2020, but that will not reach the stricter target in later years.

The experimental design of our study consisted of 72 choice-tasks, blocked into twelve questionnaire versions with six choice tasks per respondent. The order of choice tasks in each version was randomized for each respondent, to mitigate potential anchoring or framing effects. The design was optimized for D-efficiency (Sándor and Wedel, 2001; Ferrini and Scarpa, 2007) of the multinomial logit model using Bayesian priors (Huber and Zwerina, 1996; Scarpa and Rose, 2008).

Figure 2. Example of choice card

Policy characteristics	**Policy A**	**Policy B**	**Current policy**
Emissions reduction target for the European Union	**80%** reduction by 2050	**40%** reduction by 2030	**20%** reduction by 2020
Increase in global average temperature by 2100 if the rest of the world complies equivalently	**0.7 °C to 2.2 °C**	**1.2 °C to 2.8 °C**	**2.6 °C to 4.8 °C**
Likely impacts	Mild	Moderate	Severe
Distribution of costs among the European Union countries	states with higher population pay more	higher emitting states pay more	richer states pay more
Distribution of costs among the citizens of **[the UK]**	everyone pays the same income percentage	those who emit more pay more	everyone pays the same income percentage
Increased monthly costs for your household	£130	£130	£0
Which policy do you consider the best taking into account you and your household?	Policy A	Policy B	Current policy

4. Data description

4.1. *Socio-demographics*

The basic characteristics of the sample populations are summarized in Table 3. The country subsamples are representative of national populations in terms of gender, age, region and education. The presented percentages in all categories are not statistically different from the quota set in the sampling process (chi-square test, 5% level). There are 18% and 20% of respondents with tertiary education in the Czech Republic and Poland respectively, while 35% British respondents have a university degree. The shares of more educated people in the country samples comply with the general population and are not overrepresented as is the case in some web-based surveys. Median household monthly income is 3,200 PLZ in Poland, 26,600 CZK in the Czech sample, and 1,580 GBP in the UK, and these values correspond to national statistics as reported by Eurostat.

Since there was only a minority of people actively engaged in an environmental group (3% to 7%) and only a few respondents correctly answered all six questions on the causes and effects of climate change (1% to 3% in Table 3), we can conclude that the sample is not composed of large shares of highly informed respondents or experts in the field and well reflects the lay public.

Table 3. Descriptive statistics, in %.

		Czech Republic	Poland	United Kingdom
		N=1581	**N=1266**	**N=1251**
Gender	*Female*	52.3	50.7	50.8
Age	*18-35*	38.4	37.0	35.8
	36-50	28.1	28.5	31.3
	51-69	33.5	34.4	32.9
Education	*primary and lower secondary*	48.7	42.4	41.4
	upper secondary	33.8	37.7	23.3
	tertiary	17.5	20.0	35.3
Number of children in household	*none*	62.6	64.5	69.6
	1 or 2	34.8	32.6	24.5
	3 and more	2.6	3.0	5.9
Membership in environmental NGO	*Yes*	3.2	3.1	7.7
Knowledge about climate change	*all right*	1.7	0.5	2.6
	1 or 2 wrong	39.1	29.2	30.7
	3 or 4 wrong	44.6	51.2	43.4
	5 or 6 wrong	14.5	19.1	23.3

4.2. *Knowledge about climate change and perceived impacts*

While there are some pieces of information about the causes and general effects of climate change that are acknowledged by the majority of people in all surveyed countries, there is also quite significant uncertainty about these issues and even some common and serious misconceptions. More than two thirds of the respondents agreed that the enhancement of the greenhouse effect is caused by higher levels of CO_2 (71% to 76% in national samples, Table 4) and that higher concentrations of greenhouse gases are a consequence of humans burning fossil fuels (66% to 71%). Still, there is some scepticism regarding the cause of climate change; almost one third of the British and Polish respondents think that current climate change is primarily caused by natural forces and not by people. Less than one fifth (15% to 20%), however, correctly disagreed that global warming is caused by the ozone hole. More than a half agreed with the statement and around a third did not know whether to agree or not.

Similarly, a large share of the respondents agreed that global warming means warmer weather everywhere on Earth in the future (46% to 63%).

Table 4. Agreement with statements about causes and effects of climate change

		Czech Republic	United Kingdom	Poland
The enhancement of the greenhouse effect is primary caused by the ozone hole in the earth's atmosphere.	*Disagree*	17.3%	15.3%	19.7%
	Agree	**53.0%**	**52.2%**	**56.3%**
	DK	29.7%	32.5%	23.9%
The enhancement of the greenhouse effect is caused by higher levels of CO_2 (carbon dioxide) in the atmosphere.	*Disagree*	4.4%	7.0%	8.0%
	Agree	**70.8%**	**71.1%**	**76.1%**
	DK	24.9%	21.8%	15.9%
The major cause of increased atmospheric concentration of greenhouse gases is humans burning fossil fuels.	*Disagree*	11.6%	12.2%	14.4%
	Agree	**70.9%**	**65.7%**	**67.8%**
	DK	17.5%	22.1%	17.9%
Current climate change is primarily caused by natural forces and not by people.	*Disagree*	63.5%	47.4%	49.1%
	Agree	**18.4%**	**29.6%**	**33.2%**
	DK	18.1%	23.0%	17.8%
Global warming (also called climate change) means that the weather will be warmer everywhere on Earth in the future.	*Disagree*	26.8%	30.8%	16.2%
	Agree	**53.5%**	**45.6%**	**63.3%**
	DK	19.7%	23.7%	20.5%
The earth is actually cooling.	*Disagree*	51.4%	34.2%	37.1%
	Agree	**14.2%**	**20.5%**	**25.0%**
	DK	34.4%	45.2%	37.9%
	N	1,581	1,251	1,266

Although not so extensive, some uncertainty is also apparent in respondents' perceptions of the likelihood of certain effects (either positive or negative); most often among the British. Moreover, perceived likelihood of climate change impacts seems to be quite stable, as the perception of the majority of respondents became invariant after providing several options of information on climate change impacts within the randomized treatments. Overall, negative effects of climate change are perceived as quite likely to occur, while positive effects are more often perceived as unlikely to happen (Table 5). Respondents in all countries are generally aware of possible negative consequences for the environment (plants and animals), 54% to 63%, and more than one third of them think that climate change is likely to be a serious problem for their country as a whole. Interestingly, negative impacts on respondents and their nearby surroundings are more often seen as unlikely among the Czechs and the British, but not among the Poles. Very few perceived the positive impacts likely to appear; 23% of Poles perceive the positive impacts of climate change on new business opportunities, whereas there are only 11% of such respondents in the Czech Republic.

Table 5. Perceived likelihood of climate change effects (initial evaluation before information treatments)

Climate change will...		**Czech Republic**	**United Kingdom**	**Poland**
Negative impacts:				
… be a serious problem for species of plants and animals and their natural habitats.	*Unlikely*	3.1%	2.6%	3.8%
	*Middle**	28.8%	32.8%	32.4%
	Likely	63.3%	54.0%	58.2%
	DK	4.9%	10.6%	5.6%
… have negative impacts on my own health and well-being.	*Unlikely*	13.2%	11.0%	8.4%
	*Middle**	44.0%	46.0%	41.3%
	Likely	31.8%	26.1%	39.3%
	DK	10.9%	16.9%	11.1%
… be in general a serious problem for me and my family.	*Unlikely*	15.1%	11.7%	9.2%
	*Middle**	49.0%	48.7%	45.9%
	Likely	23.8%	25.1%	33.2%
	DK	12.1%	14.5%	11.7%
… be in general a serious problem for the country as a whole.	*Unlikely*	8.0%	6.0%	6.7%
	*Middle**	45.2%	42.4%	40.0%
	Likely	38.8%	38.8%	44.0%
	DK	8.0%	12.7%	9.2%
Positive impacts:				
… save billions in health care costs in the country due to fewer winter related diseases and fewer deaths during the colder months.	*Unlikely*	54.8%	31.7%	38.2%
	*Middle**	29.8%	39.3%	34.4%
	Likely	4.1%	12.6%	12.2%
	DK	11.3%	16.3%	15.1%
… positively affect food production in the country(new varieties of plants can be grown. longer growing season).	*Unlikely*	22.6%	12.0%	25.3%
	*Middle**	48.3%	49.9%	42.5%
	Likely	17.7%	21.1%	17.1%
	DK	11.4%	17.0%	15.1%
… create new business opportunities.	*Unlikely*	27.5%	16.6%	15.5%
	*Middle**	43.3%	46.6%	42.7%
	Likely	11.5%	19.3%	23.1%
	DK	17.7%	17.5%	18.8%
	N	1,581	1,251	1,266

Note: Original variable elicited with 7-point Likert-type scale (1=Unlikely; 7=Likely) was recoded as follows: three middle categories into *Middle*, two categories on the extremes into *Unlikely* and *Likely* respectively.

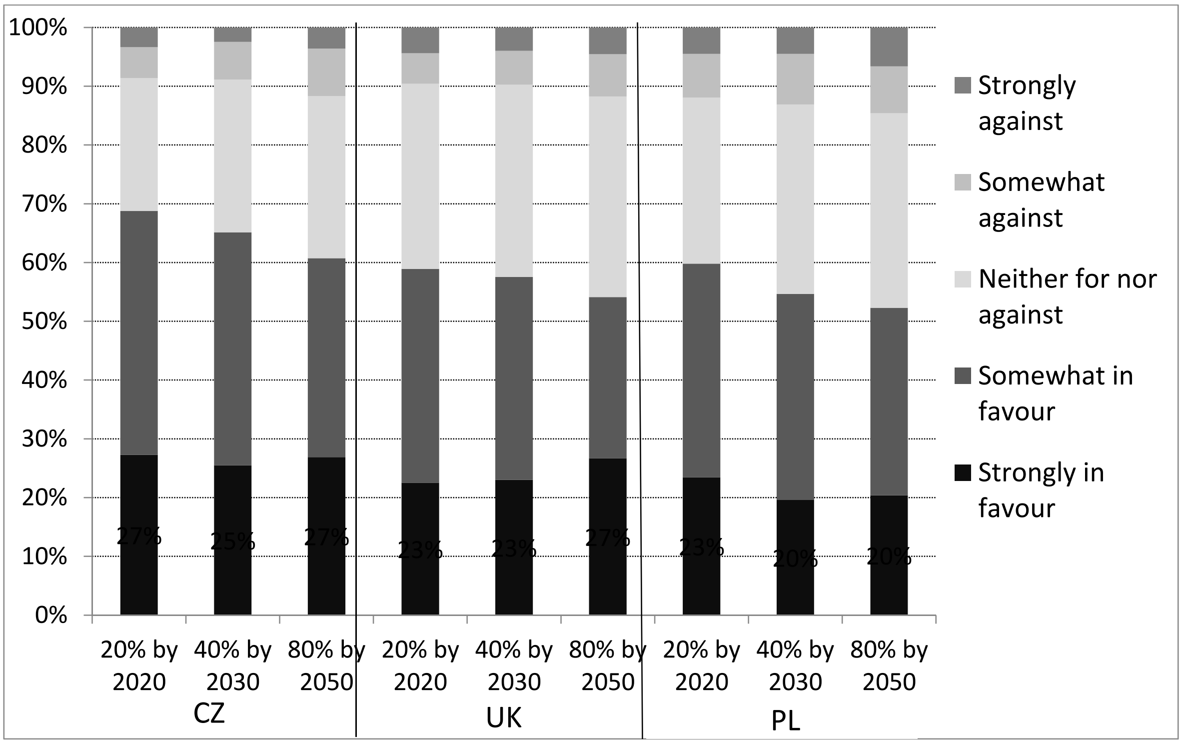
5. Acceptability of the reduction targets and perceived fairness

Two of the policy attributes included in the discrete choice experiment concern distribution of costs – the burden sharing rules among the EU countries and cost distribution within the surveyed countries. As stated before, the key effect of cost distribution on policy acceptability and preferences lies in citizens' perception of the distribution as fair or unfair.

Before the choice tasks, while presenting the attributes of discrete choice experiments, we asked our respondents whether they are generally in favour of the three EU GHG reduction targets and if they support the presented options on the burden sharing and cost distribution. We found that the European Union's greenhouse gases emission reduction targets (-20% by 2020, -40% by 2030, and -80% by 2050) are in general acceptable to a majority of people from the three countries where we conducted the survey. Only a minority of people (less than 15 %) are against the strictest emission reduction target, by -80% by 2050. Still, about 30% of respondents are not certain and are neither for nor against any of these targets, and their share slightly increases with the increasing stringency of the target.

The 40% reduction target, which is close to what has been agreed at the COP 21 in Paris in December 2015, is accepted by 65% of the Czechs, 58% of the Poles and 55% of the British, whereas there are only 8%, 10%, and 14%, respectively, who are against the agreed 40% reduction target. The least acceptable is the 2050 target (ranging from 12% of Czech and British respondents to 15% of Polish respondents who are against this target). However, there are small but statistically significant differences between the countries. While a larger share of Czechs than the inhabitants of the other two countries is in favour of the targets, people from Poland are more often than the others somewhat against the targets (see Figure 3).

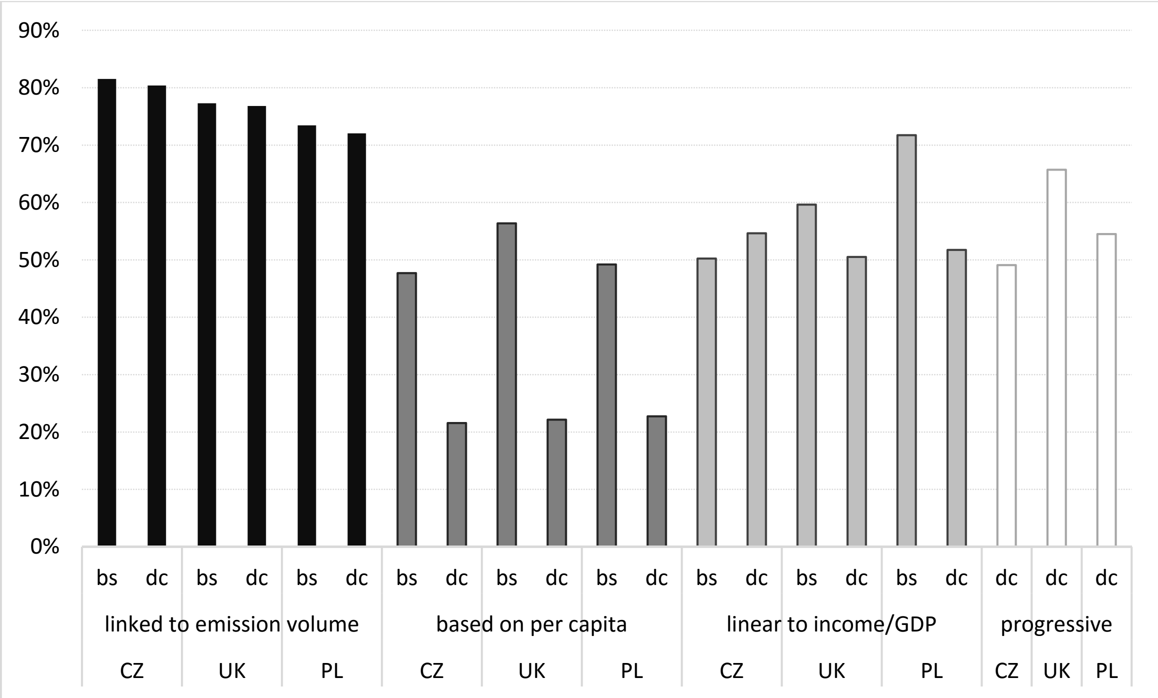
Figure 3. Public acceptability of EU's greenhouse gases emission reduction targets (N=4,098)



Note: Q: Are you, or are you not generally in favour of the following possible European Union's greenhouse gases emission reduction targets?

In each of the three EU countries, the majority of the respondents consider the burden sharing and cost distribution linked to released emissions as the most fair, although the Poles – having the most carbon intensive economy – favour this option relatively less.

Figure 4. Perceived fairness of burden sharing and cost distribution of the emission reduction targets, percentage of people who perceived given option as unfair.



Note: Burden sharing across the EU Member States (bs) and distribution of the cost within a country (dc) is linked to GHG emissions released by a country or household respectively ("emission)", to GDP or income either linearly ("linear") or progressively ("progressive"), or that is based on population ("per capita"). The percentage of respondents who perceived the given option as fair is measured by last three categories on the 7-points Likert-type scale.

In general, we also found that people are satisfied with the EU climate policy, but they are willing to pay only the share for which they think they are responsible. Most respondents think that business, industry, government and the EU should take action. Although most of the respondents feel morally obliged to bear in mind the environment and nature in their everyday behaviour, they perceive their own contribution to greenhouse gas emissions as negligible.

6. Modelling preference for climate change mitigation policies

6.1. *Econometric model*

In what follows we infer respondents' preferences and willingness to pay for changes in the EU climate policy from the choices they made in the discrete choice experiments (Bateman et al. 2004; Boyle 2003; Champ, Boyle, and Brown 2003; Hensher, Rose, and Greene 2005; Alberini and Kahn 2006; Carson and Louviere 2011; Hess and Daly 2014; Carson and

Czajkowski 2014). Theoretical foundations for quantitative modelling of consumers' utility functions are provided by the random utility theory (McFadden, 1974). The state-of-practice in modelling consumers' preferences using discrete choice data is the mixed logit (MXL) model. The model is based on the following logic: respondent *i*'s utility associated with choosing alternative *j* out of the *J* available alternatives in choice task *t* can be expressed as:

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

where $\mathbf{X}$ represents a vector of alternative-specific attributes, p is an additively separable cost, $\mathbf{b}$ and α are coefficients. Note that the coefficients are indexed by respondents – in the MXL model respondents' coefficients can differ and are assumed to follow an *a priori* specified multivariate parametric distribution.

The stochastic component *e* allows for unobservable factors that affect individuals' choices. It has an unknown, possibly heteroskedastic variance $\left(\mathrm{var}\left(e_{ijt}\right) = s_i^2\right)$. The model is usually identified by normalizing this variance, making the error term $\varepsilon_{ijt} = e_{ijt} \cdot \sigma_i$, where $\sigma_i = \pi \big/ \left(\sqrt{6}s_i\right)$, identically and independently, extreme value type 1 distributed with a constant variance $\mathrm{var}\left(\varepsilon_{ijt}\right) = \pi^2/6$. This specification of the error term leads to convenient expression of choice probabilities – 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

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

Note that in the above specification, as a result of normalization the preference parameters became $\sigma_i\mathbf{b}_i$ and $\sigma_i a_i$. Due to the ordinal nature of utility (the preference coefficients do not have direct interpretation anyway), this specification still represents the same preferences for individual i.

Given that we wish to estimate WTP for non-monetary attributes $\mathbf{X}$, it is convenient to introduce a modification which is equivalent to using a money-metric utility function (estimating preference parameters in WTP space, Train and Weeks, 2005):

$$U_{ijt} = \sigma_i a_i \left(\boldsymbol{X}_{ijt} \frac{\sigma_i \mathbf{b}_i}{\sigma_i a_i} + p_{ijt} \right) + \varepsilon_{ijt} = \sigma_i a_i \left(\boldsymbol{X}_{ijt} \boldsymbol{\beta}_i + p_{ijt} \right) + \varepsilon_{ijt} . \tag{3}$$

In this specification, the estimates obtained by a researcher are a product of the scale and marginal utility of income $\sigma_i a_i$ and the scale-free coefficients $\boldsymbol{\beta}_i$ corresponding to each of the choice attributes $\mathbf{X}$, which can be readily interpreted as respondents' marginal WTP for non-monetary attributes.[6]

There exists no closed form expression of (2) when the coefficients are assumed random variables following the specified probability distributions. Instead, the choice probability can be simulated by averaging over D draws from the assumed distributions (Revelt and Train, 1998). As a result, the simulated log-likelihood function becomes:

$$\log L = \sum_{i=1}^{N} \log \frac{1}{D} \sum_{d=1}^{D} \prod_{t=1}^{T_i} \frac{\exp\left(\sigma_i a_i \left(\boldsymbol{X}_{ijt} \boldsymbol{\beta}_i + p_{ijt} \right)\right)}{\sum_{k=1}^{J} \exp\left(\sigma_i a_i \left(\boldsymbol{X}_{ikt} \boldsymbol{\beta}_i + p_{ikt} \right)\right)} . \tag{4}$$

Maximizing the simulated log-likelihood function in (4) allows us to derive coefficient estimates, while the inverse of the negative of the Hessian at convergence becomes the approximation of the asymptotic variance-covariance matrix, allowing for deriving the standard errors associated with model estimates.

[6] Recall that calculating marginal WTP (implicit price) of an alternative requires calculating the marginal rate of substitution of the commodity for a monetary attribute. In the case utility function coefficients are known this becomes their ratio: b_i / a_i . If the model follows the specification described in (3), the ratio is: $\frac{(\sigma_i a_i) \cdot \beta_i}{\sigma_i a_i} = \beta_i$ and hence the coefficients associated with non-monetary attributes can be directly interpreted as marginal WTP (in the unit in which p is specified).

6.2. *WTP for policy attributes*

The discrete choice experiment data was used to model respondents' preferences using the approach outlined just above. Table 6 presents the results of the MXL models for each of the countries.[7] The models are estimated in WTP space and hence the coefficients of the non-monetary attributes can readily be interpreted as marginal WTP (in EUR).[8] All WTP values are expressed in EUR 2014 purchasing power standard.

The results reveal stark differences between the countries. With respect to the preferences for more ambitious targets of the EU climate policies, while the Czech households would be on average willing to pay around EUR 13 for each month for 40% or EUR 17 for 80% GHG emission reductions, and the UK households would be willing to pay EUR 44 and EUR 46, respectively, the Polish households' mean WTP for adopting these targets vs. the current 20% target was not statistically different from zero. The mean WTP for adopting 40% and 80% targets are not statistically different from one another in any of the examined countries, indicating the utility change from adopting the 80% reduction target vs. the 40% reduction target is negligible. In line with these results, the citizens of the Czech Republic and the UK are generally supportive of the prospected climate policy, as indicated by negative mean WTP associated with the alternative specific constant for the alternative representing the status quo policy (irrespectively of the attribute level differences), while the Poles prefer the status quo policy to any new policy option. However, the preferences in all countries are highly heterogeneous, as indicated by the estimates of the standard deviations of the WTP distributions relative to the means of these distributions. This means that while some respondents have strong preferences and hence large WTP for more stringent emission targets, others could perceive them as not acceptable, resulting in much larger WTP for staying at the 20% target, i.e. keeping the status quo.[9]

[7] In the MXL models, all attribute coefficients are random and freely correlated; all coefficients were assumed to be normally distributed, with the exception of the coefficient representing the product of the scale and marginal utility of income $\sigma_i a_i$, which was assumed to follow lognormal distribution to constrain its sign. For the lognormally distributed coefficient, the estimated mean and standard deviation of the underlying normal distribution is reported. The cost enters the model with a negative sign and was scaled by a factor of 100 to facilitate convergence.

[8] The models were estimated using custom code developed in Matlab which is made available from github.com/czaj/DCE under Creative Commons BY 4.0 license. The maximum likelihood function was simulated using 10,000 Sobol draws (Czajkowski and Budziński, 2015), using different starting points and optimization techniques, to make sure it reached the global optimum.

[9] Recall that the preferences were elicited under the assumption that non-European countries 'comply equivalently', which was found not reliable by 36 % of the Poles, 44 % of the British and 50 % of Czechs.

Table 6. The results of the MXL models of consumers' WTP based on the discrete choice experiment data

	Czech Republic		United Kingdom		Poland	
	means	**standard deviations**	**means**	**standard deviations**	**means**	**standard deviations**
	coefficient (s.e.)	**coefficient** (s.e.)	**coefficient** (s.e.)	**coefficient** (s.e.)	**coefficient** (s.e.)	**coefficient** (s.e.)
target = 20% (ref.)	0	0	0	0	0	0
target = 40%	13.19*** (2.78)	37.05*** (2.75)	45.79*** (6.26)	97.55*** (10.00)	-1.76 (2.53)	31.15*** (2.94)
target = 80%	17.04*** (3.02)	46.77*** (2.89)	43.57*** (8.36)	149.21*** (10.11)	-0.14 (2.57)	32.59*** (1.73)
burden sharing = linear (ref.)	0	0	0	0	0	0
burden sharing = fixed	3.61 (2.56)	25.26*** (3.04)	-8.39 (5.43)	25.85*** (8.07)	-3.08 (2.16)	10.48*** (1.68)
burden sharing = emission	14.98*** (2.56)	22.14*** (2.62)	27.13*** (6.21)	47.36*** (6.70)	-2.49 (2.33)	11.88*** (1.90)
cost distribution = linear (ref.)	0	0	0	0	0	0
cost distribution = fixed	-12.78*** (2.96)	16.33*** (2.88)	-15.72** (7.49)	41.23*** (7.37)	-6.28** (3.05)	14.75*** (1.59)
cost distribution = progressive	3.81 (3.09)	33.07*** (3.28)	23.21*** (8.02)	61.75*** (12.15)	4.47 (3.02)	22.23*** (2.32)
cost distribution = emission	20.94*** (3.41)	49.10*** (4.01)	33.17*** (9.12)	81.69*** (8.65)	12.48*** (3.50)	24.31*** (3.17)
status quo (alternative specific constant)	-12.82*** (3.82)	81.80*** (5.44)	-39.07*** (8.82)	161.16*** (16.57)	15.95*** (3.03)	83.65*** (4.83)
-cost(100 EUR)*scale	1.39*** (0.07)	1.33*** (0.17)	0.58*** (0.08)	1.78*** (0.24)	2.02*** (0.16)	2.27*** (0.36)

Model diagnostics

	Czech Republic	United Kingdom	Poland
Log-likelihood (constant only)	-10,064.28	-7,933.06	-6,914.07
Log-likelihood	-7,711.40	-6,014.17	-5,022.28
McFadden's pseudo R^2	0.2338	0.2419	0.2736
Ben-Akiva Lerman's pseudo R^2	0.4746	0.4846	0.5763
AIC/*n*	1.6373	1.6170	1.3367
n (observations)	9,486	7,506	7,596
k (parameters)	54	54	54

Regarding the preferences for burden sharing rules, households from the Czech Republic and the UK significantly prefer the distribution of policy costs based on the emissions of the EU countries to income-based or per-capita based rules, for which the citizens of these countries are statistically indifferent. The mean WTP for the burden sharing linked to emission volumes is EUR 15 (s.d. EUR 22.1), and EUR 27 (s.d. EUR 47.4), respectively.

In contrast, Polish households are not so eager to implement emission based burden sharing between countries – they are, on average, indifferent concerning different burden sharing rules (the differences are not statistically significant).

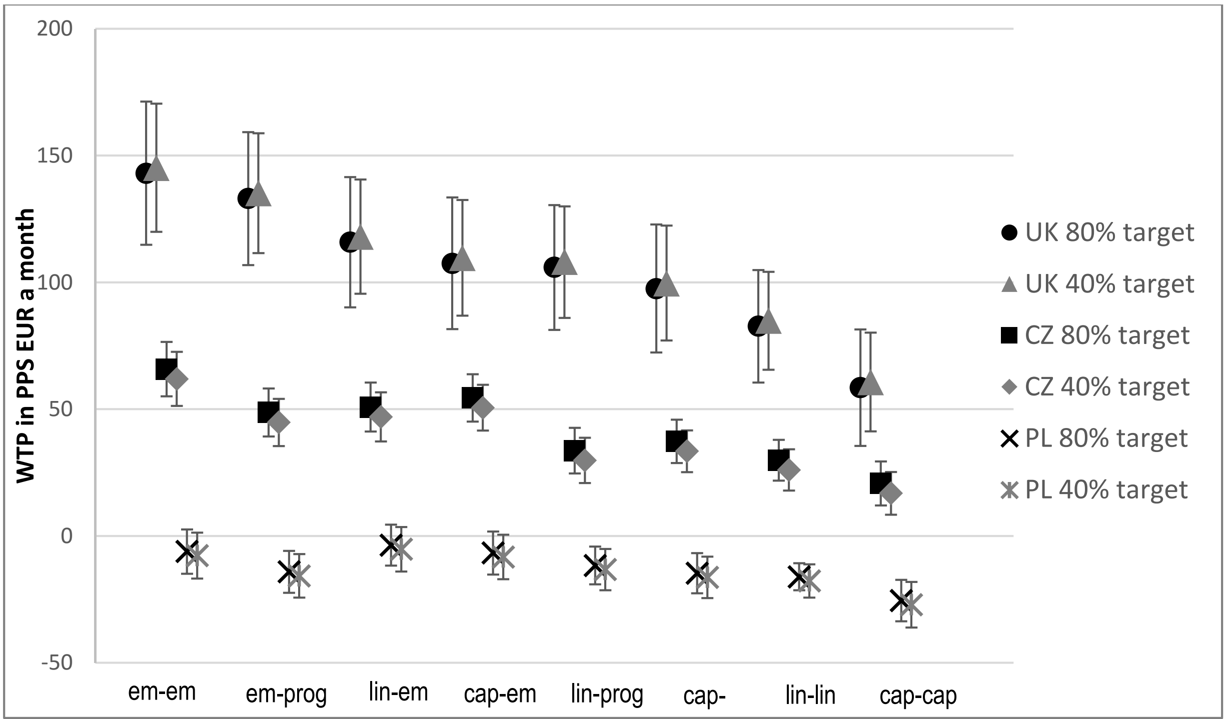
Finally, with respect to the distribution of policy costs within a country, respondents from all surveyed countries are in favour of implementing the polluter-pays principle, i.e. cost distribution based on emissions, and disapprove of even lump sum distribution of the costs (i.e. linked to per capita). The resulting mean WTP for the most preferred option of this attribute is EUR 33.2 (s.d. EUR 81.7) in the UK, EUR 20.9 (s.d. EUR 49.1) in the Czech Republic, and EUR 12.5 (s.d. EUR 24.3) in Poland. Again, there is huge heterogeneity in individual preferences for this policy attribute. In the UK, progressive cost distribution (the richer should pay more) was preferred to the distribution linked linearly to income. However, the emission based option remained the best. Once again, the preferences for all these attributes are highly heterogeneous, as indicated by the significant and relatively high estimates of the standard deviations of WTP distributions.

The coefficient for the costs is negative and significant. It yields the largest absolute value in Poland – the country with the lowest level of income, indicating the largest marginal utility of income in Poland and the smallest marginal utility of income in the UK.

6.3. *WTP simulation for various policy packages*

Figure 5 reports the WTP simulation results using the parameter estimates obtained from the MXL model. The WTP values for ‘a policy package’ are simulated for overall eight different combinations of burden sharing and cost distribution for both 40% and 80% GHG mitigation policies.[10]

Figure 5. Implicit WTP for policy packages, in EUR PPS per month and household.



Note: Abbreviations em, lin, prog and cap describe distribution linked to released GHG emissions, linearly or progressively linked to income or GDP, or based on per capita basis, respectively. The first term refers to burden sharing among the EU Member States, while the second term refers to cost distribution within a country.

At first, we found that the WTP values are very similar for 40% and 80% reduction targets for the same policy package in each country. The British households are willing to pay the most, followed by Czech households. The estimated mean willingness to pay of the Polish households is negative for each policy package departing from the status quo, although the 95% confidence interval also covers positive values for each package that links distribution of domestic costs to their emission volumes.

[10] Simulation of the WTP estimates for three different types of models - multinomial logit, mixed logit, and mixed logit with allowing the attributes levels to be correlated (the model presented here) are provided in supplementary materials.

The order of the eight policy packages is very similar in each of the three countries, with the policies that link the cost distribution to emission volumes considered the best. The British and the Czech households similarly prefer the policy package that links burden sharing as well as cost distribution to emission volumes, and the resulting WTP per household is EUR 145 and EUR 62 respectively.

The second most preferred policy package varies across the three countries. The British households prefer the emission-progressive package with a mean WTP of EUR 135. This option is followed by packages that either link cost distribution to emission volumes or that would be progressively linked to household income. The British would be ready to pay on average between EUR 100 and EUR 118 for each of these four policy options. Linking burden sharing and cost distribution to income linearly yields EUR 85, while the least preferred policy would be lump sum distribution of the burden and cost, with a mean WTP of EUR 60.

As the second most preferred, Czech households prefer a package that consists of linking to emission volumes (emission-progress, linear-emission, or per capita emission) with a mean WTP of EUR 45-51. Policies proposing cost distribution progressively linked to income are less preferred (EUR 30-33). As in the UK, linear-linear package and lump sum distribution are least preferred (EUR 26, and EUR 17, respectively).

Polish households' WTP for the linear-emission package is less negative (EUR -5) than that of Czech and UK households (EUR -8), although the difference is relatively minor. The Poles share the same preference for the least preferred package; WTP yields the lowest values for the linear-linear and lump sum package (EUR -18, and EUR -27, respectively).

7. Conclusions

Our study contributes to the recent debate on climate mitigation policy by examining public acceptability of such policy, focusing on various emission reduction targets and perceived fairness. Specifically, we conducted a questionnaire survey to elicit the preferences of Czech, Polish and British households for three different emission reduction targets; 20% reduction reached by 2020 with no further reductions, which reflects the current situation (status quo), 40% reduction by 2030 (on top of the 20% reduction by 2020) which has been agreed by EU's Council (EC 2014) is also close to the COP 21 Agreement, and a more stringent 80% reduction target by 2050 (in addition to the earlier reductions). We note that these three targets actually correspond to three different EU's GHG emission trajectories, and consequently lead to three different increases in global average temperature by 2100 (2.6 ºC to 4.8 ºC, 1.2 ºC to 2.8 ºC, and 0.7 ºC to 2.2 ºC) and likely impacts (severe, moderate, or mild). Preferences for these three GHG reduction targets are elicited through a policy package that proposes several options to share the burden among EU Member States and to distribute the costs among citizens of the country where our survey participants live.

Our survey was conducted just two months before COP 21 that was held in Paris, in early December 2015. Moreover, data collection process in Poland happened to be a few months before presidential and parliamentary elections. Although interest in parties' programs and public debate was more active than usual, the voting campaign was not in full swing. We note, however, the environmental and climate policy and the attitudes towards the EU were not the issues which dominated the campaign, and were hardly present in the debate. Even if some of the parties are traditionally considered more sceptical about the EU, these concerns were not highlighted and all parties adopted a very balanced approach to avoid losing any potential voters. In conclusion, we do not think that the period of time when the data in Poland was collected influenced the results. Instead, we believe our observations are more general, and illustrate the overall attitudes of Poles towards the costs and benefits for the country associated with participating in any (unilateral or world-wide) program of greenhouse gas emission reductions.

We found that the European Union's greenhouse gases emission reduction targets are in general acceptable by the majority of people from the three countries where the survey was conducted. Less than 15 % are against the most strict emission reduction target only. However, about 30% of respondents are not certain and are neither for nor against any of these targets, and their share slightly increases with the increasing stringency of the targets. We also found that the majority of our respondents consider the burden sharing and cost distribution linked to emission releases the fairest. On the contrary, lump sum (per capita based) distribution of costs is considered the most unfair.

More comprehensive information about public acceptability provides the modelling of individual preferences that were elicited through our discrete choice experiments. We estimated the willingness to pay for each attribute of a policy package as well as simulating the WTP for the whole policy package. For the most preferred policy package (emission-emission), on average, households in the Czech Republic would be WTP almost EUR 62 a month and EUR 145 in the UK. For whole populations, these values can be translated into annual benefits of EUR 0.27 billion and EUR 2.72 billion, respectively for 40% reduction target. It seems that the Poles are indifferent between the status quo (20% reduction target) and the two more strict targets, implying that the Poles are not ready to pay for more strict GHG reducing policy. Still, as in the case of the Czechs and British, how GHG emissions might be reduced is also a concern in Poland, and more importantly, we found the preferences in all three countries are highly heterogeneous, suggesting there are segments of the population that are very reluctant to accept the climate change mitigation policies and there are also population segments that are on the contrary in favour of these policies.

Public acceptability of policies to reach the EU's GHG emission reduction targets may be raised by taking into account distributional consequences, especially introducing distribution of costs based on the people's individual emissions, i.e. implementing the polluter-pays principle (in all three surveyed countries) and of the EU Member States (the latter has been shown in the Czech Republic and in the UK). Special attention should be paid to the communication of climate change policy design to the Polish public, as the Poles are, contrary to the Czechs and British, on average not willing to financially contribute to a stricter GHG reduction policy.

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Supplementary materials

Table 1a. WTP simulation for the 40% emission reduction target

			target 40%							
scenario			P1	P2	P3	P4	P5	P6	P7	P8
burden sharing at the EU			linear	per capita	emissions	linear	per capita	linear	per capita	emissions
cost distribution in a country			linear	per capita	emissons	emissions	emissions	progress	progress	progress
CZ	MNL	**mean**	**13.54**	**-3.13**	**52.11**	**35.46**	**37.23**	**9.87**	**11.62**	**26.51**
		s.e.	3.04	3.38	2.86	2.85	2.77	3.06	3.06	3.08
		q 0.025	7.57	-9.78	46.49	29.86	31.77	3.86	5.65	20.47
		q 0.975	19.52	3.50	57.72	41.04	42.67	15.86	17.62	32.55
	MXL_d	**mean**	**26.50**	**13.10**	**60.65**	**45.68**	**44.94**	**23.15**	**22.43**	**38.14**
		s.e.	3.78	3.99	4.16	4.12	4.14	4.09	4.11	4.10
		q 0.025	19.13	5.32	52.51	37.62	36.84	15.16	14.36	30.14
		q 0.975	33.94	20.94	68.86	53.77	53.02	31.20	30.45	46.16
	MXL	**mean**	**25.99**	**16.84**	**61.91**	**46.93**	**50.53**	**29.78**	**33.42**	**44.79**
		s.e.	4.15	4.29	5.41	4.95	4.63	4.55	4.19	4.74
		q 0.025	17.87	8.38	51.29	37.29	41.52	20.84	25.16	35.46
		q 0.975	34.16	25.18	72.61	56.65	59.61	38.74	41.60	54.07
UK	MNL	**mean**	**-15.37**	**-32.66**	**65.30**	**25.89**	**18.32**	**16.33**	**8.81**	**55.76**
		s.e.	10.58	10.23	8.18	9.51	9.44	9.31	9.51	8.05
		q 0.025	-36.08	-52.73	49.28	7.16	-0.12	-1.87	-9.89	40.01
		q 0.975	5.46	-12.68	81.27	44.46	36.86	34.63	27.31	71.53
	MXL_d	**mean**	**84.83**	**60.74**	**145.16**	**118.04**	**109.62**	**108.07**	**99.65**	**135.21**
		s.e.	10.86	10.82	13.50	12.69	11.96	12.26	12.29	12.98
		q 0.025	63.56	39.49	118.61	93.20	86.33	84.06	75.61	109.89
		q 0.975	106.12	81.81	171.61	143.00	133.24	132.23	123.79	160.78
	MXL	**mean**	**84.94**	**60.73**	**145.18**	**118.10**	**109.65**	**108.14**	**99.65**	**135.21**
		s.e.	9.86	9.91	12.87	11.52	11.64	11.25	11.57	12.04
		q 0.025	65.54	41.22	119.90	95.50	86.84	85.97	77.07	111.55
		q 0.975	104.16	80.19	170.47	140.59	132.49	129.98	122.38	158.82
PL	MNL	**mean**	**-35.88**	**-38.40**	**-15.98**	**-16.66**	**-18.89**	**-27.09**	**-29.34**	**-26.40**
		s.e.	5.24	5.11	4.52	4.57	4.63	4.82	4.79	4.72
		q 0.025	-46.13	-48.39	-24.80	-25.68	-27.99	-36.57	-38.71	-35.66
		q 0.975	-25.60	-28.41	-7.07	-7.64	-9.81	-17.64	-19.94	-17.19
	MXL_d	**mean**	**-45.27**	**-51.37**	**-31.40**	**-33.19**	**-36.20**	**-38.89**	**-41.89**	**-37.09**
		s.e.	6.86	7.05	6.78	6.69	6.77	6.75	6.80	6.90
		q 0.025	-58.69	-65.23	-44.69	-46.33	-49.45	-52.12	-55.24	-50.66
		q 0.975	-31.77	-37.55	-18.09	-20.12	-22.94	-25.71	-28.61	-23.61
	MXL	**mean**	**-17.69**	**-27.07**	**-7.70**	**-5.23**	**-8.32**	**-13.23**	**-16.31**	**-15.73**
		s.e.	3.35	4.58	4.61	4.46	4.50	4.14	4.17	4.36
		q 0.025	-24.33	-36.13	-16.80	-14.01	-17.09	-21.44	-24.51	-24.31
		q 0.975	-11.19	-18.15	1.27	3.49	0.47	-5.14	-8.16	-7.16

Table 1b. WTP simulation for the 80% emission reduction target

			target 80%							
scenario			P1	P2	P3	P4	P5	P6	P7	P8
burden sharing at the EU			linear	per capita	emissions	linear	per capita	linear	per capita	emissions
cost distribution in a country			linear	per capita	emissons	emissions	emissions	progress	progress	progress
CZ	MNL	**mean**	**21.07**	**4.43**	**59.64**	**42.97**	**44.76**	**17.40**	**19.17**	**34.04**
		s.e.	3.01	3.25	2.83	2.93	2.78	3.01	2.94	2.92
		q 0.025	15.21	-1.98	54.11	37.29	39.31	11.50	13.40	28.33
		q 0.975	26.95	10.77	65.21	48.70	50.22	23.32	24.93	39.80
	MXL_d	**mean**	**31.02**	**17.61**	**65.16**	**50.19**	**49.45**	**27.70**	**26.95**	**42.66**
		s.e.	3.88	4.08	4.22	4.21	4.25	4.12	4.17	4.10
		q 0.025	23.43	9.65	56.98	41.99	41.20	19.58	18.79	34.62
		q 0.975	38.69	25.64	73.45	58.49	57.75	35.78	35.09	50.69
	MXL	**mean**	**29.86**	**20.71**	**65.76**	**50.78**	**54.39**	**33.66**	**37.31**	**48.65**
		s.e.	4.10	4.43	5.46	4.94	4.74	4.57	4.35	4.82
		q 0.025	21.83	12.01	55.06	41.15	45.12	24.65	28.73	39.21
		q 0.975	37.87	29.37	76.53	60.50	63.77	42.63	45.87	58.13
UK	MNL	**mean**	**13.53**	**-3.74**	**94.16**	**54.76**	**47.18**	**45.25**	**37.69**	**84.66**
		s.e.	9.11	9.08	7.76	8.36	8.38	8.30	8.63	7.81
		q 0.025	-4.34	-21.56	78.99	38.48	30.83	28.98	20.72	69.30
		q 0.975	31.38	14.02	109.42	71.20	63.72	61.58	54.64	99.93
	MXL_d	**mean**	**82.52**	**58.49**	**142.85**	**115.70**	**107.30**	**105.82**	**97.40**	**132.90**
		s.e.	12.30	12.51	14.67	13.80	13.17	13.45	13.50	14.22
		q 0.025	58.51	34.08	114.05	88.78	81.57	79.41	71.02	105.14
		q 0.975	106.70	82.94	171.76	142.86	133.19	132.25	123.97	160.97
	MXL	**mean**	**82.71**	**58.51**	**142.97**	**115.87**	**107.44**	**105.95**	**97.51**	**133.08**
		s.e.	11.29	11.74	14.35	13.04	13.20	12.55	12.90	13.37
		q 0.025	60.51	35.51	114.85	90.16	81.58	81.23	72.35	106.82
		q 0.975	104.83	81.46	171.26	141.52	133.47	130.44	122.82	159.27
PL	MNL	**mean**	**-34.14**	**-36.69**	**-14.26**	**-14.92**	**-17.17**	**-25.37**	**-27.62**	**-24.68**
		s.e.	5.21	5.07	4.46	4.57	4.65	4.91	4.90	4.76
		q 0.025	-44.32	-46.68	-23.00	-23.89	-26.28	-34.98	-37.22	-33.99
		q 0.975	-23.99	-26.74	-5.51	-5.97	-8.06	-15.74	-17.99	-15.37
	MXL_d	**mean**	**-44.68**	**-50.81**	**-30.82**	**-32.62**	**-35.60**	**-38.32**	**-41.31**	**-36.52**
		s.e.	6.97	7.26	6.98	6.80	6.94	6.93	7.03	7.16
		q 0.025	-58.33	-64.98	-44.46	-45.92	-49.21	-51.91	-55.10	-50.55
		q 0.975	-30.97	-36.56	-17.02	-19.27	-21.95	-24.76	-27.58	-22.50
	MXL	**mean**	**-16.09**	**-25.46**	**-6.09**	**-3.62**	**-6.68**	**-11.63**	**-14.70**	**-14.10**
		s.e.	2.71	4.17	4.45	4.10	4.33	3.79	4.01	4.22
		q 0.025	-21.43	-33.66	-14.89	-11.70	-15.22	-19.06	-22.62	-22.44
		q 0.975	-10.78	-17.33	2.58	4.42	1.76	-4.19	-6.81	-5.87

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