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Abstract

An ambitious climate policy can cause tensions in societies with low trust and deep social divisions, as illustrated by the Yellow Vests movement that emerged to oppose a carbon tax in France. This study examines public preferences for policies to achieve energy security and climate change mitigation goals in the context of the energy crisis caused by Russia's invasion of Ukraine. We conducted a discrete choice experiment on a representative sample of 10,000 people in Poland, a country heavily reliant on fossil fuels, and used a willingness-to-pay approach. We found that there is a strong aversion to a carbon tax among citizens – one which is only slightly mitigated by redistribution policies – and that income and age play a significant role in shaping preferences for climate and energy policies. People with lower incomes (bottom quartile) place less value on achieving climate change (15%) and energy security (10%) goals than the general population (17% and 14% willingness to pay, respectively). Younger individuals (aged 18-34) are willing to forego a greater share of their income to mitigate climate change than those aged 55 or older (28% vs. 12%), but are less willing to forego income (11% vs. 16%) to reduce fuel imports from Russia. Finally, we quantify the heterogeneity of preferences regarding redistribution measures and evaluate their efficiency, illustrating how discrete choice experiments can help mitigate the risks of social tensions associated with introducing a carbon tax.

Keywords: carbon tax, redistribution, climate change, discrete choice experiment, willingness to pay

JEL: H23, D74, Q41, Q54

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1. Introduction

Climate policies have the potential to spark social conflicts in countries with high rates of social distrust, scepticism towards climate change, and a lack of political representation. Additionally, climate policies such as carbon taxes, often perceived as the most efficient climate policy instrument, can destabilise mitigation efforts (McCright et al., 2016) as they can be a burden on household budgets. This socio-ecologic conflict is embodied by the "end of the month" vs. "end of the world" dilemma (Martin and Islar, 2021), whereby the elite prioritise climate change mitigation over the needs of financially struggling social groups. This conflict, often accentuated by class divisions, can fuel radical political movements and anti-elitist discourse.

Despite being an effective tool, carbon taxes are also politically controversial, with a significant portion of the population showing greater opposition towards carbon taxes than other climate policies. This opposition is amplified by low levels of political trust (Levi, 2021), which restricts politicians' use of this instrument (Umit and Schaffer, 2020). Acceptance of carbon taxes is higher among those who are well-educated or more affluent, whereas highly consuming individuals and those who declare high energy costs are more resistant to adopting such policies (Sommer et al., 2022). In this context, it is important to understand how carbon taxes impact social groups that prioritise short-term financial stability over concerns about global warming. To do this, we must answer two questions: (1) What are the differences among groups of people in their willingness to forego income to achieve energy and climate policy goals? (2) Which redistributive measures can mitigate carbon tax aversion among groups most exposed to energy price spikes?

This paper aims to answer these questions by assessing individual willingness to support climate change mitigation and energy security measures while estimating the threshold of aversion and acceptance of two redistributive policies: cash transfers and full subsidies for green investments. It is also essential that these questions are addressed within the context of the energy crisis caused by the ongoing war in Ukraine, which may make the public more reluctant to support new policies or taxes. Therefore, we conducted a discrete choice experiment to estimate preferences for climate change mitigation and improved energy security in Poland, an emblematic Central and Eastern European nation. Households in Poland are highly exposed to the effects of a new carbon tax (Antosiewicz et al., 2022a) as most families live in privately-owned single-family houses, rely on fossil fuels for household heating, and drive outdated cars.[1] The introduction of the Emission Trading System for residential buildings and individual transport (ETS-II) in the late 2020s may lead to widespread social discontent as it will directly impact society through higher energy prices.

The Yellow Vests[2] are one of the most well-known contemporary social movements that were triggered by climate policies. Their movement led to the withdrawal of a diesel tax by the French government through strikes and riots that brought the nation to a standstill. Their activities illustrate that bottom-up movements

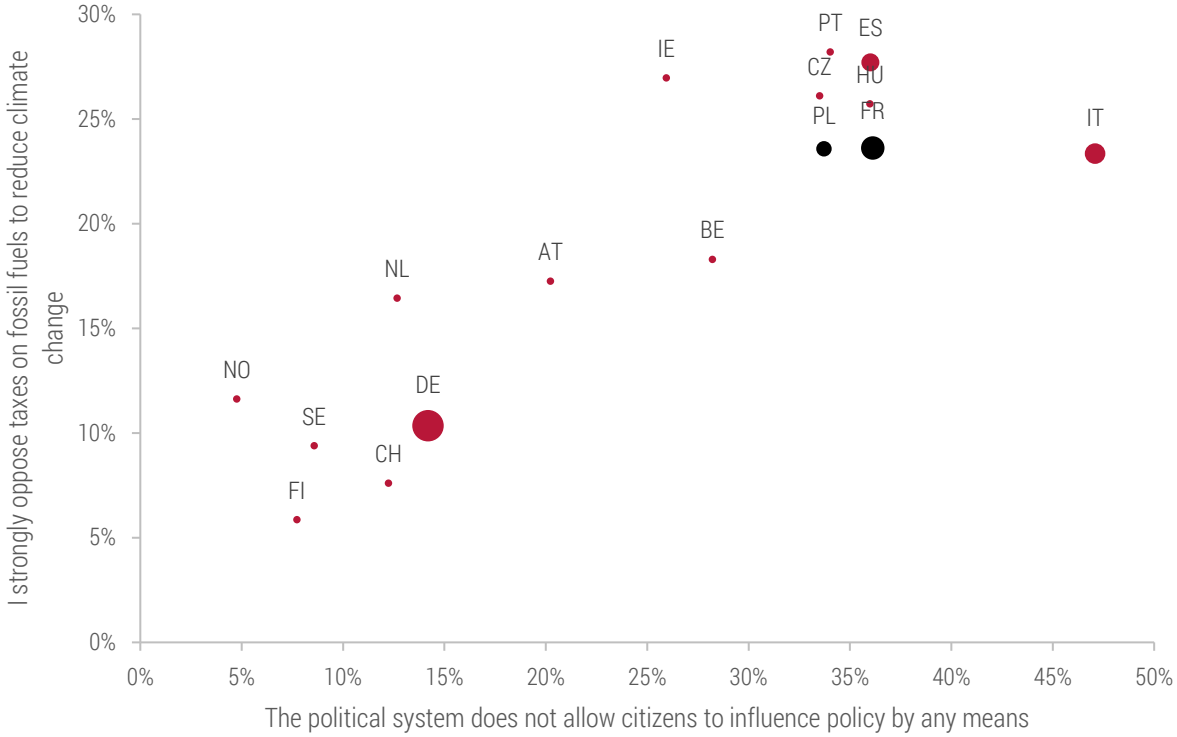
[1] In 2018, 45% of households in Poland used coal to heat their homes. Almost two-thirds of Polish households own cars, with the average vehicle being 12 years old (GUS, 2019), making Poland one of Europe's largest and most obsolete car fleets.

[2] As a bottom-up, anti-systemic successor of the trade union movement, protests by the Yellow Vests sprouted up across France in 2018, constituted by growing sentiments of social injustice and demands for stronger citizen agency in political decisions (Grossman, 2019). The Yellow Vests protested high distrust in politicians, misrecognition, and disrespect by the "ruling class" towards the "common people" (Kipfer, 2019; Lianos, 2019).

organised around a particular social struggle can successfully oppose carbon tax adoption, even in societies like France, which are generally supportive of climate policies (Douenne and Fabre, 2020). Social structures in Poland and France share several similarities; both are politically divided, less trustful (both socially and politically), and more sceptical about climate change than the European Union average (Fairbrother et al., 2019). Similarly to France, people in Poland and other Central and Eastern European countries demonstrate strong opposition to carbon taxes and declare a widespread sense of political underrepresentation (Figure 1).

The Yellow Vest protesters believed that the French government's proposed tax increases disproportionately affected low-income individuals or those struggling financially. Furthermore, they argued that the policies hurt the working class (Mehleb et al., 2021), especially those who rely on individual transport, including petrol- and diesel-fuelled cars. Poland shares these features and could be a fertile ground for the next Yellow Vest movement. Unlike France, the carbon tax in Poland has not yet been the subject of social tensions.

Figure 1. Opposition to a carbon tax and feelings of political underrepresentation by nation (%)



Note: plot size is representative of a given country's relative population share in Europe.
Source: own elaboration based on European Social Survey 8, 2018.

The energy crisis that began at the end of 2021, followed by Russia's invasion of Ukraine in 2022, put additional pressure on the energy and climate policy agenda in Europe. Therefore, it is crucial to uncover the energy and climate policy preferences of those societies that were indirectly but heavily affected by current and future circumstances. In this regard, the example of Poland is essential for studying preferences regarding climate change, energy security, and the risks of social tensions caused by the introduction of a carbon tax. To this end, our paper makes three key contributions.

First, we unveil preferences regarding climate change mitigation and improved energy security in the context of the Russian invasion of Ukraine. We evaluated the choices of more than 10,000 individuals regarding hypothetical carbon taxes that differed in redistribution mechanism, their effects on the climate, energy security, and income.

Our discrete choice experiment provides valuable insights into climate change mitigation and energy security measures, allowing individuals to trade off between policy options. We identified a strong public aversion to carbon taxes that remained similar despite increasing gains from redistribution policies – when offered the same income with or without a climate policy, more than 50% of participants preferred no climate policy, regardless of the redistribution measure (cash transfer or full subsidy for green investments).

However, the impacts of income premiums and penalties differed. For each level of income difference, a penalty considerably reduced preference for a carbon tax, while an equivalent premium did not increase this preference. Moreover, opponents and supporters of a carbon tax tend to consecutively overestimate and underestimate the prevalence of their opinions (Drews et al., 2022). In their research, (Carattini et al., 2018) identified drivers and barriers to public support for carbon taxes and provided evidence-based suggestions for their design. (Klenert et al., 2018) argued that enhancing public acceptability of carbon pricing was essential for closing the gap between actual carbon prices and those required to achieve ambitious climate change mitigation. Our study is the first to explore public preferences in the context of an ongoing war that has heavily impacted the region's energy market (Antosiewicz et al., 2022b).

Second, we demonstrate a significant heterogeneity in preferences towards climate change mitigation and energy security among the population in Poland. Specifically, respondents place a higher value on climate change and air quality-related attributes than energy security. On average, respondents were willing to forego 17-18% of their incomes towards mitigating climate change and improving air quality, and 11% to reduce reliance on Russian fuels. However, they would also require compensation of 14% of their incomes if their access to energy and individual commuting were limited. Our study also finds that income and age play a significant role in shaping preferences towards climate and energy issues. Respondents with lower incomes attach less importance to climate change mitigation and energy security compared to the general population (by 2-4 pp), while younger respondents are more concerned about climate change than older respondents (a 28% willingness to pay, compared to 12%). Contrastingly, young respondents are willing to pay substantially less (11%) than older respondents (16%) to lower fossil fuel imports from Russia. Although our estimates agree with the previous valuation of climate change mitigation in European countries (Ščasný et al., 2017) and air quality (Viscusi et al., 2008), we provide novel information by making respondents trade off between climate and energy-security-related attributes.

Third, our study suggests viable redistribution measures based on the results of a discrete choice experiment. We find that cash transfers are preferred by lower-income groups and would help alleviate tensions arising from climate policies (Köppl and Schratzenstaller, 2022). By using preferences for the effects of carbon taxes (i.e. climate change mitigation, secure access to energy), we propose redistribution measures that could help minimise carbon tax aversion by lowering the income penalties of the tax. Our findings suggest that a cash transfer targeted at low-income households would be required from relatively low carbon tax rates (5%). We provide precise estimations of the effectiveness of particular redistribution measures and demonstrate how discrete choice models can help improve public policies. Previous studies have shown that allocating revenue from a carbon tax towards environmental initiatives can enhance public acceptance by improving environmental awareness and behaviour (Gevrek and Uyduranoglu, 2015; Kallbekken et al., 2011). According to the literature review, the effects of existing climate rebates on carbon pricing popularity are limited (Mildenberger et al., 2022) and associated with a minor increase in acceptance of a carbon tax (Levi, 2021). However, our contribution takes a different approach by using experimental methods to provide recommendations for redistribution policies in a more general sense.

The remainder of this paper is structured as follows. Section two presents the data and descriptive statistics. Section three introduces the models used in the study, while section four presents the results. Section five concludes the paper.

2. Data and descriptive statistics

2.1. Experimental framework

In order to elicit the preferences of Polish society, we conducted a discrete choice survey experiment using vignettes based on four distinct attributes: (1) climate change mitigation; (2) improvements in air quality; (3) a limit on Russian fuel imports; (4) uninterrupted supply of electricity and transportation fuels (Table 1). Respondents were given the option to decide if a new carbon tax should be introduced and how it should be redistributed. Two standard revenue recycling schemes were offered as basic categories for this purpose: (i) a monthly cash benefit for all families; (ii) a subsidy to finance green investments in environmentally friendly technologies. These two categories have been previously applied in policy reviews to assess the distributional effects of climate policies (Vona, 2023), in energy-economy modelling (Bourgeois et al., 2021), and other experimental studies (Dechezleprêtre et al., 2022).

The participants viewed five screens with vignettes,[3] each with two policy options, and each option having four attributes (i.e. climate change, air quality, fuel imports, energy supply) with randomly drawn levels. One of the options (at random) was the "status quo," meaning that it did not include a new policy and redistribution alternative. The options differed between their "gains and losses"; a monetary attribute which represented changes in respondents' incomes due to the introduction of a new climate policy. The gains/losses were randomly drawn from a uniform distribution in the range of -0.24 to 0.24. We used emojis (pictograms), a universal and widespread mode of communication, to better visualise the choices on the vignettes. To our knowledge, this is the first such adaptation of emojis in a vignette experiment in Poland.

Table 1. The attributes used in the experiment

Attribute	Level		
	1	2	3
Climate change impacts	**Major**  A major decline in crop yields, a significant threat to life due to catastrophic heatwaves, flooding, and droughts	**Limited**  A moderate decline in crop yields, a moderate threat to life from catastrophic heatwaves, flooding, and droughts	**Minimal**  No changes in crop yields, low risk to life from catastrophic climate events
Diseases caused by poor air quality	**No change**  50,000 deaths annually	**Limited by half**  25,000 deaths annually	**Limited to minimum**  less than 5,000 deaths annually

[3] Before seeing the vignettes, each participant was presented with information on interpreting each attribute (Appendix 1, Table A1).

Table 1. The attributes used in the experiment (continued)

Purchases of Russian fuels	No change imports of 10 billion m^3 of gas and 16 million tons of oil annually	Limited by half imports of 5 billion m^3 of gas and 8 million tons of oil annually	Limited to zero
Access to electricity and individual transport	No change	Interrupted access no electricity once a week for 1 hour and 2 Sundays a month without a car	Energy rationing no electricity every day for 1 hour and all Sundays of the year without a car
Policy options	No change	Carbon tax and new cash benefit Tax on coal, gas and oil consumption at home and a monthly cash benefit from the state budget for all families in Poland	Carbon tax and full investment subsidy Tax on coal, gas and oil consumption at home and one-off, full co-financing from the state budget for heat pumps, photovoltaic panels, thermal retrofitting, or an electric car
Net monthly income of your household in a given option	$\{-24\%, -20\%, -16\%, \ldots, 0, \ldots, 16\%, 20\%, 24\%\}$		
Monthly benefit/loss for your household			

Source: own elaboration.

Our sample size (n = 10,281) was sufficient to investigate the main effect size among various subgroups. The projected sample size required to estimate the effect size of around 2 pp in the binary outcome (choosing a particular policy) was approximately 1,800 participants per subgroup (9,000 choices), with standard parameters of alpha (the significance level) equal to 0.05 and power equal to 0.8.

The experiment received ethical approval from the Rector's Committee for Ethics of Research with Human Participants at the University of Warsaw (Decision 156/2022). We also registered the experiment with the American Economic Association's registry for randomised controlled trials (RCT IDs: AEARCTR-0009482).

2.2. Data collection

The survey was conducted in August 2022 using a Computer-Assisted Web Interviewing (CAWI) technique and a nationwide research panel. This panel consists of 150,000 registered, active, and verified Polish citizens and is an established research tool in Poland that is widely used for various studies, including on energy policy preferences (Aruga et al., 2021) or prejudice and hate speech (Bilewicz and Soral, 2022). To ensure a representative sample, we set quotas for key socio-demographic (gender, age, educational level) and geographical (municipality size and region) variables.

The survey consisted of three parts. In the first part, we collected information on a participant's socio-demographic characteristics, energy consumption, individual transportation patterns, and opinions on climate change and energy security. We introduced the discrete choice experiment in part two. In the third part, we asked about their political preferences and levels of trust (social and political) using standard questions and cafeterias from the European Social Survey (including the ESS8 with climate-related variables) to control the precision of our results.

In total, we collected 10,281 surveys from respondents and accounted for two critical sources of bias in the discrete choice experiment: (i) inattention (ii) hypothetical bias. To check for inattention, participants were asked about their favourite colour at a random moment during the survey, and had to select a predetermined one regardless of their preference. An incorrect answer would result in the survey's termination. Therefore, we conclude that participant inattention did not bias the study. We also addressed hypothetical bias (Ladenburg and Olsen, 2014) by emphasizing the real-life importance of the study; informing participants that their answers would later be presented to Polish policymakers. We also included a follow-up question after each vignette, asking participants to indicate their confidence in their choices on a scale of 0-100. Overall, participants were confident in their decisions as the median confidence level was 71, and the bottom quartile was 56 (see Table A2 in Appendix 1). To limit inattention, we provided a time lock for carefully reading the vignette instructions and filling in the answers, making our experiment a good approximation of real-life choices.

Before conducting the experiment on the total sample (n=10,281), we arranged quantitative (n=200) and qualitative (n=16) pilot studies in June 2022. The feedback we received helped us simplify the vignettes, improve the readability of instructions, and provide precise answers. We collected our data in August 2022, and our research was conducted during three significant events that our study encompasses: (i) the Russian invasion of Ukraine, which significantly impacted trade between the EU and Russia and led to hikes in fossil fuel prices, (ii) the inflation rate in Poland, which reached 16% (Statistics Poland, 2022), and (iii) a coal supply shortage caused by the embargo on Russian coal, which led to anxiety among Poles reliant on this fuel for domestic heating (almost half of all households in Poland (Statistics Poland, 2018)) as many were concerned about the availability of coal before the heating season. We analysed and interpreted the results considering the impact these events had on the socio-economic and geopolitical context.

2.3. Sample characteristics

While our experiment involved 10,281 respondents, we noted a slight underrepresentation of men in the sample (45% in the sample vs. 48% in the general population). Additionally, our sample had a lower proportion of individuals above 55 years of age, with a primary education, from small cities, living in old buildings (built before 1980), as well as a slightly smaller proportion of households that use coal stoves for heat and are located in rural areas. We therefore applied weights to ensure the sample's representativeness and rebalanced the data by matching the distribution of key variables such as gender, age, and education, to that of the relevant population structure. We derived the weights by using data from the 2020 Polish Household Budget Survey. Table 2 illustrates the weighted structure of our sample.

Table 2. Sample characteristics

	Sample structure			Population structure
	N	%	% (weighted)	%
Gender				
Men	4,653	45.3	48.0	48.0
Women	5,628	54.7	52.0	52.0
Age group[4]				
18-24	1,027	10.0	7.6	6.8
25-34	2,328	22.6	16.1	13.2
35-44	1,897	18.5	15.3	16.5
45-54	2,061	20.0	21.5	13.4
55 or more	2,968	28.9	39.5	43.9
Education				
Primary	914	8.9	16.3	17.9
Secondary	5,867	57.1	61.8	57.7
Tertiary	3,500	34.0	21.9	24.4
Main heating source[5]				
district heating	4,082	39.7	38.8	40.0
coal	2,456	23.9	26.2	49.0
biomass	815	7.9	7.7	
gas	2,365	23.0	22.0	5.0
heat pump	234	2.3	1.8	3.0
electric stove	329	3.2	3.5	3.0

Note: the sample structure is weighted with our survey weights, and the population structure is weighted with Household Budget Survey weights.
Source: own calculations using data gathered for the experiment and annual data for 2020 from Poland's Household Budget Survey.

2.4. Descriptive results

In this subsection, we present the descriptive results of our study across three dimensions: (1) income and spending, (2) energy and commuting patterns (3) levels of social and political trust and consciousness of climate change, as these were the defining characteristics of people who identified with the Yellow Vest movement in France.

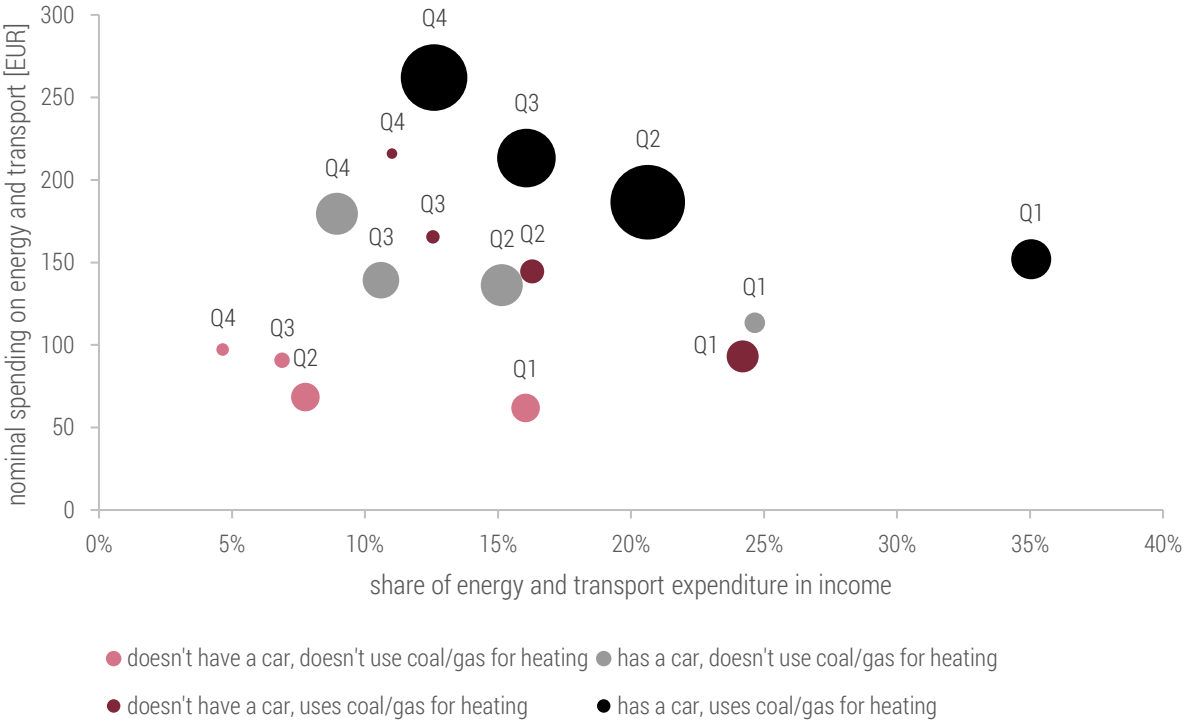
In our sample, respondents with the highest incomes pay the most for energy and individual transport in nominal terms, while the low-income population pays the most in relative terms (Figure 2). We also identified that households that either own a car or heat their homes with coal or gas spend the most on energy and individual transport in nominal (260 EUR per month) and relative terms (35% of their incomes), and constitute the highest

[4] Population structure based on Local Data Bank, 2021.

[5] Population structure based on Household Budget Survey data, 2018.

share of the total population (45%). These findings are vital in terms of introducing a carbon tax as they underscore the disproportionate impact that energy and transportation costs can have on low-income citizens, as they are most vulnerable to increases in energy prices. Our data highlights that a carbon tax would significantly affect these groups by either forcing them to reduce their emissions or swallowing an even larger share of their limited budgets.

Figure 2. Energy and individual transport expenditures in Polish households by income quartile (%)



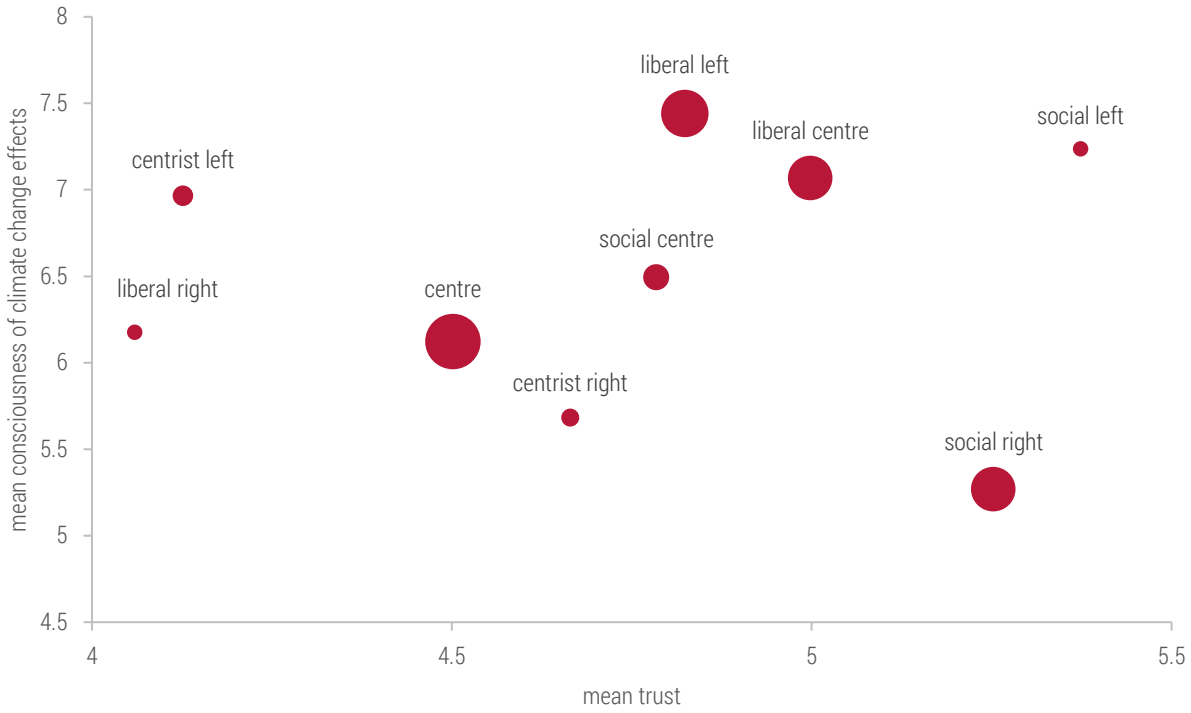
Note: "Q1-Q4" are income quartiles. Plot size is representative of the relative size of a given group in the total population.
Source: own calculations using data gathered for the experiment (2022).

Our results are consistent with other studies on social attitudes towards climate change and energy security, such as the eighth edition of the European Social Survey (ESS8). ESS8 identified 11% of climate change denialists in Poland (Poortinga et al., 2018), which is similar to the results of our sample (12%). We found that almost 70% of people in our sample are highly aware of the adverse effects of climate change, and that differences between particular groups were not particularly pronounced. This outcome aligns with the study's findings on the Yellow Vest movement in France, which showed that Yellow Vest supporters were not anti-ecological, but rather representatives of groups that demanded a more egalitarian approach and effective climate action (Kipfer, 2019). The knowledge that climate change is anthropogenic was widespread, and the share of people who do not believe in climate change was marginal (Douenne and Fabre, 2020).

In the next part, we focus on trust, as low levels of trust and a lack of political representation were distinguishing features of the Yellow Vest movement in France. Political institutions were blamed for growing distrust in the country, and their leaders were accused of having "professionalised politics," separating parties and unions from the people they are supposed to represent (Bergem, 2022). Low trust is believed to be the reason for the spread of populism and anti-elite attitudes among members of the Yellow Vest movement (Algan et al., 2017).

From the very beginning, Yellow Vest initiators and leaders highlighted how detached decision-makers in Paris were from people's everyday lives and issues. Polish society has one of the lowest declared levels of trust in European national institutions, regardless of income (Eurofound, 2022). In our sample, about 35% of respondents declared low levels of trust. We observed a clear pattern separating our sample into three groups based on their age, economic, and political views. The first group identified themselves as "social-right" and showed doubt in the negative consequences of climate change in Poland. They demonstrated relatively high trust and were represented among the three age groups we considered. The second group was a substantial group of leftist respondents who had low trust and low consciousness of climate change, mainly among those aged 55 or older (8%). The third group consisted of liberal respondents (mostly centrist and aged 35-54; 8% of the population) with low trust and higher awareness of the adverse effects of climate change (Figure 3).

Figure 3. Levels of trust and climate change consciousness among respondents with different political and economic views



Note: plot size is representative of the relative size of a given group in the total population. Levels of trust and climate change consciousness were calculated based on a ten-point scale.
Source: own calculations using data gathered for the experiment (2022).

Below is a presentation of the descriptive results of the five attributes outlined in Table 1: (1) a carbon tax with a revenue recycling mechanism; (2) climate change impacts; (3) air quality impacts; (4) Russian fuel imports; and (5) access to energy and private transport. Our study found that all proposed policies were largely rejected by respondents, with approximately 60% preferring the status quo regardless of the redistribution measure that was employed (Table 3).While there were minor differences in preferences between socio-demographic groups, such as men being more likely than women to choose the carbon tax, and older individuals being slightly more inclined than younger ones, these differences were not significant. We also observed slight variations in preferences based on education level (Table 3).

Table 3. Shares of respondents who chose vignettes with particular attributes (%)

	Carbon tax		Climate change impacts		Diseases caused by poor air quality		Purchases of Russian fuels		Access to electricity and individual transport	
Attribute level	Cash benefit	Full Subsidy	Limited	Minimal	Limited by half	Limited to minimum	Limited by half	Limited to zero	Interrupted	Energy rationing
Total sample										
%	43.1	41.6	52.3	53.63	50.6	55.0	50.3	53.9	50.4	46.0
N	11,031	10,737	17,956	18,319	17,421	18,748	17,285	18,511	17,316	15,789
Women										
%	43.0	41.3	52.5	54.2	50.6	55.5	50.7	53.5	50.7	45.6
N	6,011	5,847	9,874	10,107	9,525	10,345	9,587	10,058	9,492	8,630
Men										
%	43.0	42.1	52.1	53.1	50.6	54.3	49.8	54.3	50.2	46.5
N	5,020	4,890	8,082	8,212	7,896	8,403	7,698	8,453	7,824	7,159
Secondary or lower										
%	43.0	41.8	52.3	53.0	50.7	54.5	50.4	53.0	50.1	46.1
N	7,298	7,079	11,810	11,902	11,484	12,285	11,445	11,970	11,365	10,394
Tertiary										
%	43.2	41.3	52.4	54.9	50.5	55.9	50.1	55.6	51.1	45.9
N	3,733	3,658	6,146	6,417	5,937	6,463	5,840	6,541	5,951	5,395
18-34										
%	42.7	41.6	53.2	55.1	51.3	54.3	49.9	52.9	50.8	44.8
N	3,568	3,498	5,959	6,208	5,731	6,008	5,576	5,956	5,749	5,008
35-54										
%	42.8	40.9	52.0	53.6	50.1	55.1	50.8	53.9	50.0	46.8
N	4,210	4,065	6,876	7,042	6,652	7,277	6,733	7,097	6,543	6,175
55 or more										
%	44.0	42.7	51.8	52.1	50.4	55.5	49.9	54.9	50.7	46.3
N	3,253	3,174	5,121	5,069	5,038	5,463	4,976	5,458	5,024	4,606

Note: participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented.

Source: own calculations using data gathered for the experiment.

3. The models

3.1. Stated preferences regarding energy and climate policies

We use logistic regression to estimate the probability that an individual prefers a given alternative for energy and climate policies. The logistic model is specified as follows:

$$\Pr(\mathrm{a}_j = 1) = F(\beta_0 + \beta_1\tau_i + \beta_2 c_i + \beta_3 s_i + \beta_4 r_i + \beta_5 u_i + \beta_6 D_i + \beta_7 Q_i + \beta_8 \lambda_j + \varepsilon_{ijv}) \quad (1)$$

where $\mathrm{F(Z)} = \frac{\mathrm{e^Z}}{1+\mathrm{e^Z}}$, i stands for the individual, j for a choice, and v for the vignette number. The five attributes described in Table 1 are represented by: τ_i for carbon tax, c_i for climate change impacts; s_i for air quality, r_i for Russian fuel imports, u_i for access to energy and individual commuting. D_i is a vector of personal characteristics (a set of indicator variables for gender, age, education, employment status, and income), while Q_i is a set of indicator variables that represent urbanisation (location), building type, year of construction, and main heating source; λ_j is a set of indicator variables that reflects attitudes towards climate change and levels of political and social trust. The error term, ε_{ijv} is clustered at the level of an individual respondent.

To estimate the conditional logistic regression, we assessed the probability of choosing a particular distributional policy (the preferred policy) against the "status quo" option. The model we used is specified as:

$$\Pr(\mathrm{p}_j = 1) = F(\beta_0 + \beta_1 c_i + \beta_2 s_i + \beta_3 r_i + \beta_3 u_i + \beta_5 D_i + \beta_6 Q_i + \beta_7 \lambda_j + \varepsilon_{ijv}) \quad (2)$$

In contrast to model (1), the variable of interest here is the choice of a different policy option rather than choosing a particular alternative.

3.2. Willingness to pay

Next, we estimate the willingness to pay for specific climate change or energy security attributes to better understand the monetary valuation of each attribute. We model participant utility as:

$$U_{ijv} = \alpha_0 + \alpha_1 X_i + \alpha_2 \theta_j + \alpha_3 W_j + \epsilon_{jiv} \quad (3)$$

Where i stands for the individual, j is the alternative, and v is the vignette number. X_i stands for the individual characteristics of a participant i, θ_j represents particular attributes related to climate and energy security, W_j is the relative income difference after introducing detailed policy j compared to the status quo.[6]

Policy j is chosen if it provides a higher expected utility than the status quo k presented in the same vignette v, $U_{jiv} > U_{kiv}$. The indicator variable Y_{ijv} is equal to one if participant i selected policy j presented in a vignette v. Therefore:

$$Pr\left(Y_{ijv} = 1\right) = \Pr\left(U_{ijv} > U_{ikv}\right) \quad (4)$$

[6] We checked whether treating the differences in earnings between the status quo, a carbon tax, and a redistribution measure as a continuous variable, instead of as a set of indicator variables, yielded comparable regression results.

We estimate the parameters using logit models, where $F(U) = \frac{e^U}{1+e^U}$. Standard errors ε_{jiv} are clustered at the level of an individual respondent. We estimate the willingness to pay for a particular attribute as the ratio of point estimates of parameters $WTP(O_j) = -(\frac{\alpha_2}{\alpha_3})$. We then compute the confidence intervals using the Stata *wtp* command with the default delta method (Hole, 2007).

To quantify the heterogeneity in WTP between subgroups, we divide the sample into smaller subsets and estimate the willingness to pay in subgroups based on demographic variables, socio-economic characteristics, energy consumption patterns, and political attitudes.

4. Results

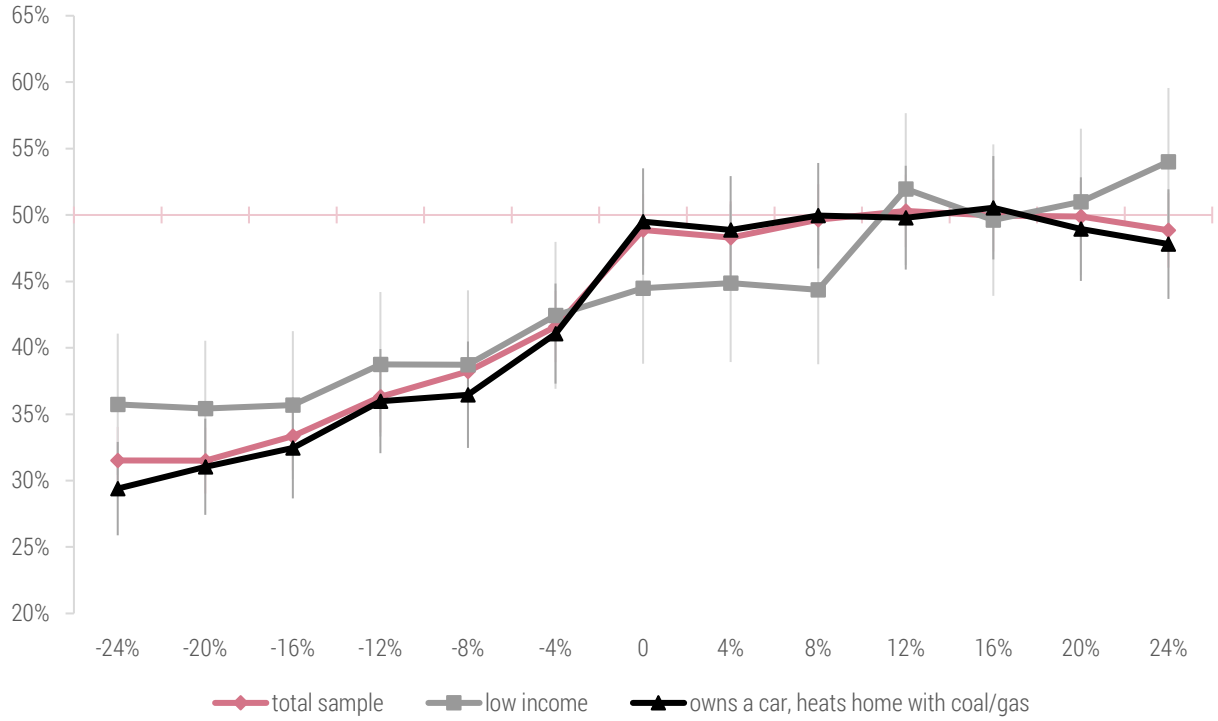
This section is divided into four subsections. The first subsection discusses preferences for a carbon tax, paired with two different redistribution mechanisms: a cash transfer or a subsidy for green investments. The preferences are analysed based on income premium or penalty due to the introduction of a carbon tax. The second subsection analyses the preferences for the effects of the tax, such as climate change mitigation, air quality improvement, reduced purchases of Russian fuels, or uninterrupted access to energy and individual commuting (i.e. the four attributes described in Section 2.2.). In the third subsection, potential areas of socio-ecological conflict that may arise following the implementation of a carbon tax are determined by combining the effects of premiums and penalties with the estimated willingness to pay. The fourth subsection presents our robustness checks.

4.1. Preferences for a carbon tax and redistribution measures

By estimating a logit model (1) on the likelihood of selecting a climate policy, we find that the population in Poland has a strong aversion to the carbon tax. When offered the same income with or without a climate policy, 51% of participants preferred no climate policy when paired with a cash transfer, and 52% were against the tax when the revenues were redistributed as a subsidies for green investments (new heating sources, thermal retrofitting, electric cars). The lower a participant's income after introducing the tax, the lower the predicted probability that they would choose the climate policy.

Meanwhile, premiums and penalties showed to have differing impacts. For each level of income difference, a penalty considerably reduced the preference for a carbon tax, while an equivalent premium did not increase this preference. For example, an income penalty of 8% reduces the probability of choosing a carbon tax paired with a cash transfer by 11pp, while a similar income premium increases the probability by only 1 pp. These results are consistent with similar studies that identified the low effectiveness of redistribution policies in improving the acceptance of a carbon tax (Douenne and Fabre, 2022). Additionally, we find that low-income respondents, as well as those who either own a car or heat their houses with coal or gas, do not differ from the total population in their preferences in this regard (Figure 4).

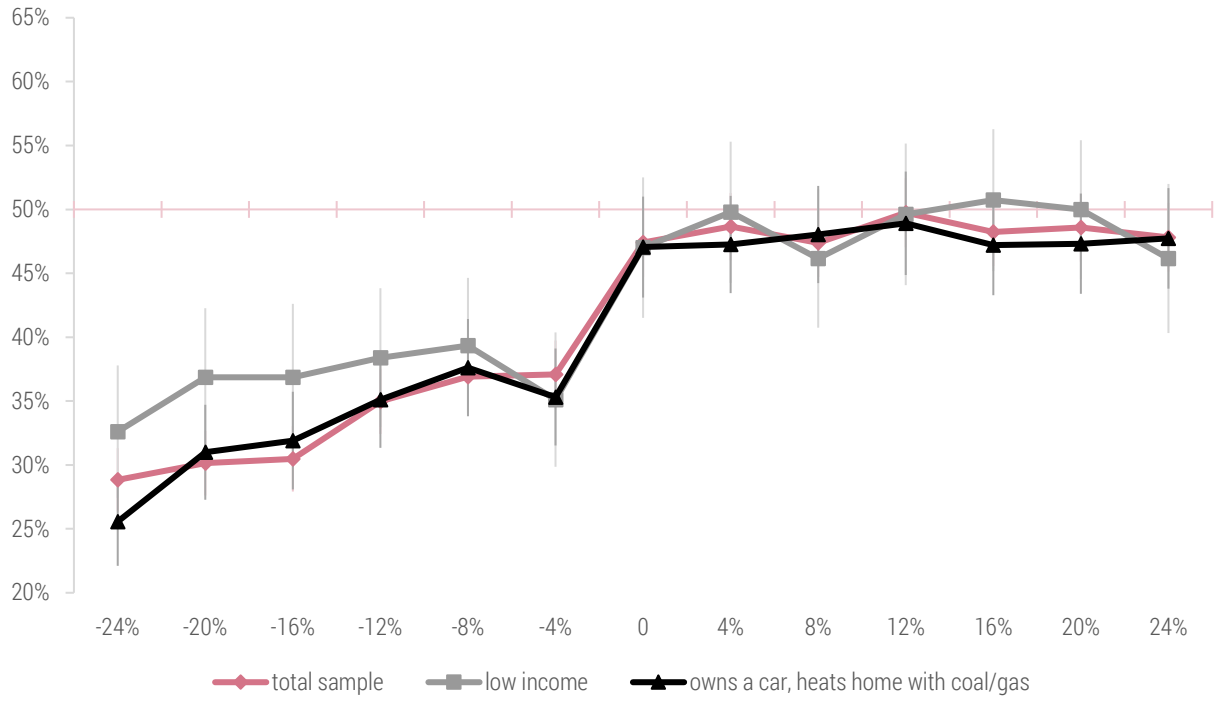
Figure 4. Predicted probabilities of respondents choosing a carbon tax paired with a cash transfer, conditional on differences in income after introducing the policy measure (%)



Note: participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented.
Source: own calculations using data gathered for the experiment.

A carbon tax paired with a full subsidy for green investments is less preferrable than a cash transfer, but the differences are minor (Figure 5). We observed a similar pattern for both redistribution policies. Firstly, income penalties decrease the probability of accepting a carbon tax, while premiums do not serve to increase policy acceptance. Secondly, low-income respondents and those who either own a car or heat their home with coal or gas share a similar level of tax aversion.

Figure 5. Predicted probabilities of respondents choosing a carbon tax paired with an investment subsidy, conditional on differences in income after introducing the policy measure (%)



Note: participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented.
Source: own calculations using data gathered for the experiment.

4.2. Willingness to pay for climate change mitigation and improved energy security

We considered the following variables when analysing people's willingness to pay for climate change mitigation and energy security: (1) incomes and expenditures, (2) energy consumption patterns, (3) levels of trust and consciousness of the effects of climate change, and (4) age, economic and political orientation (Dietz et al., 2007). Incomes and expenditures are significant as they indicate the ability to pay for higher prices caused by climate change mitigation and energy security measures. Energy consumption patterns are also relevant as they provide insight into how people consume energy and what sacrifices they might be willing to make to reduce their carbon footprint. Trust and climate change consciousness are critical factors as they influence people's perception of the issue and how much they are willing to contribute to help tackle it. Finally, age and economic and political orientation can significantly impact people's willingness to pay, as these factors may reflect their values, beliefs, and interests. To this end, we estimate how the model specified in equation (4) interacted with respondents' different characteristics. We tallied the results for each attribute and variable in Appendix B.

Overall, respondents in our study showed a preference for climate change-related attributes over energy-security attributes. On average, respondents were willing to forego 17-18% of their incomes to mitigate the negative impacts of climate change or achieve better air quality, and 11% to reduce imports of Russian fuel. They would also require compensation of 14% of their incomes if their access to energy and individual commuting were to be limited (Figure 6).

We find that income disparities matter more for the valuation of specific attributes than differences in energy and individual transportation expenditures between respondents.[7] Low-income households are of particular interest when introducing a carbon tax, as they have fewer resources to absorb rising costs and spend a more significant proportion of their income on energy. Therefore, a carbon tax would disproportionately impact low-income households, aggravate economic hardship, and potentially exacerbate existing inequalities. Low-income individuals place less value in reducing climate change impacts and energy security than the general population (by about 2-4 pp). In contrast, those with high incomes value climate change mitigation, air quality improvements and the lowering of fuel imports from Russia by 4-5 pp more than the average respondent.

Figure 6. Willingness to pay for attributes in the total sample and selected interactions (%)

Note: the Y-axis represents how much income an average respondent is willing to forego for a specific attribute. Attribute levels are as follows: Climate change impacts: (1) Major; (2) Limited; (3) Minimal; Diseases caused by poor air quality: (1) No change; (2) Limited by half; (3) Limited to a minimum. Participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented. The "2M" is double the national median. "Below 2M" means spending below this threshold. Source: own calculations using data gathered for the experiment.

[7] We note that two variables related to income also differentiate the valuation of attributes. These are: (i) education (ii) occupation type. Namely, respondents with tertiary education and those working white-collar jobs demonstrated higher valuations across all attributes included in the experiment.

Additionally, we observe that those who spend a large share of their income on energy or individual transportation[8] value the attributes differently from the general population. Firstly, the value of reducing Russian fuels purchases decreases by almost 3 pp among those who spend a high share of their income on energy. Secondly, respondents who spend a high share of income on transportation are less willing to pay for better air quality than the average respondent by 3 pp.

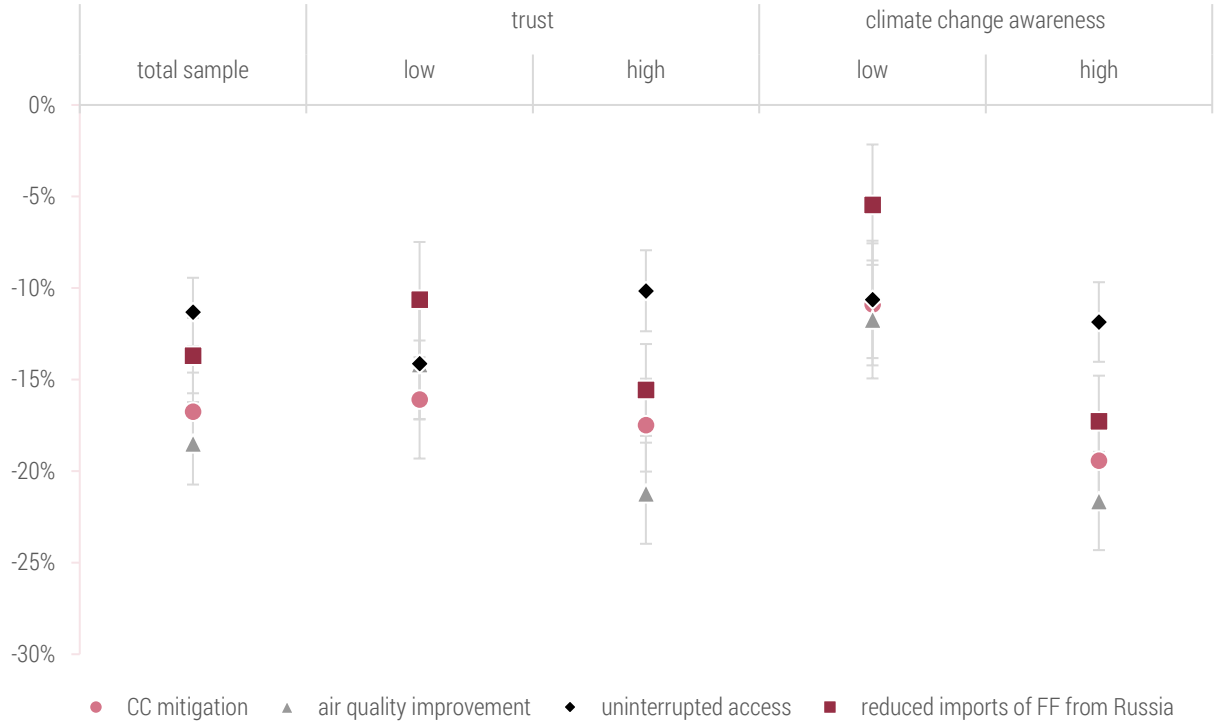
Next, we focus on identifying differences related to characteristics that are difficult to observe but play a critical role in defining attitudes, such as levels of trust and climate change awareness (Mayer and Smith, 2019). Our findings show that people with low trust and low consciousness of the adverse effects of climate change demonstrate a substantially lower willingness to pay for specific attributes in our experiment (Figure 7). For a carbon tax to be effective, it must be seen as a legitimate and necessary policy for addressing the urgent global warming crisis (Chaikumbung, 2023). Our research reveals that individuals with low trust decreased the valuation of improved air quality and reduced fuel imports from Russia by 4 pp. People who do not trust others would also require a higher compensation if their access to energy and transportation were interrupted (by 3 pp). Conversely, people with higher trust are more willing to pay for improved air quality (by 3 pp) and reduced imports (by 2 pp) compared to the general population. Finally, low levels of climate change consciousness substantially decreased the valuation of all attributes (nearly 9 pp for Russian fuel imports, 6 pp in the case of climate change mitigation and air quality improvement).

Descriptively, the share of respondents who showed low trust and low climate change awareness was similar among all income groups. We further examined the interrelatedness of low trust and low awareness of climate change effects across income groups by running logistic regressions (see Appendix B, Table B1) in which low trust and low climate change were dependent variables. We found that both characteristics are correlated with low incomes, and the higher the income, the lower the probability that respondents have low trust or low awareness of climate change effects. For example, the probability of declaring low trust among respondents from the first income quartile is 27 pp higher compared to the fourth quartile. We also investigate the interactions between incomes, trust, and climate change awareness to separate the relationships between these variables and the valuation of particular attributes (see Table 5 in section 4.4., "Robustness," for more details). Our results reveal that the valuation of better air quality and reduced fuel imports from Russia is notably lower for people with both low incomes and low awareness of climate change (6% and 2%, respectively, compared to 14% and 10% among all low-income respondents, and 12% and 5% among all people with low awareness of climate change).

[8] The preferences of car owners and people who heat their homes with coal or gas differ substantially across these groups, and also when compared to the general populace. Respondents' preferences in these two groups are of particular interest as car owners and people who heat their homes with fossil fuels are at a potentially greater risk of exposure to price hikes caused by the introduction of a carbon tax. Car owners value reduced purchases of Russian fuels and uninterrupted access to commuting more than the average respondent by 3 pp and 2 pp, respectively. The valuation of all attributes increases among people who heat their homes with fossil fuels, with the most pronounced rise of valuation for improved air quality (by 3 pp).

These findings have significant implications for understanding willingness to pay. Firstly, differences in attribute valuation influenced by trust levels can be addressed through targeted transfers to low-income respondents to improve their economic position. Secondly, individuals who do not believe in the adverse effects of climate change allotted substantially lower valuations than those with low incomes. Therefore, improving preferences for climate change mitigation and energy security requires direct income transfers coupled with a higher public awareness of climate change and its consequences.

Figure 7. Willingness to pay for attributes in the total sample and selected subgroups (%)

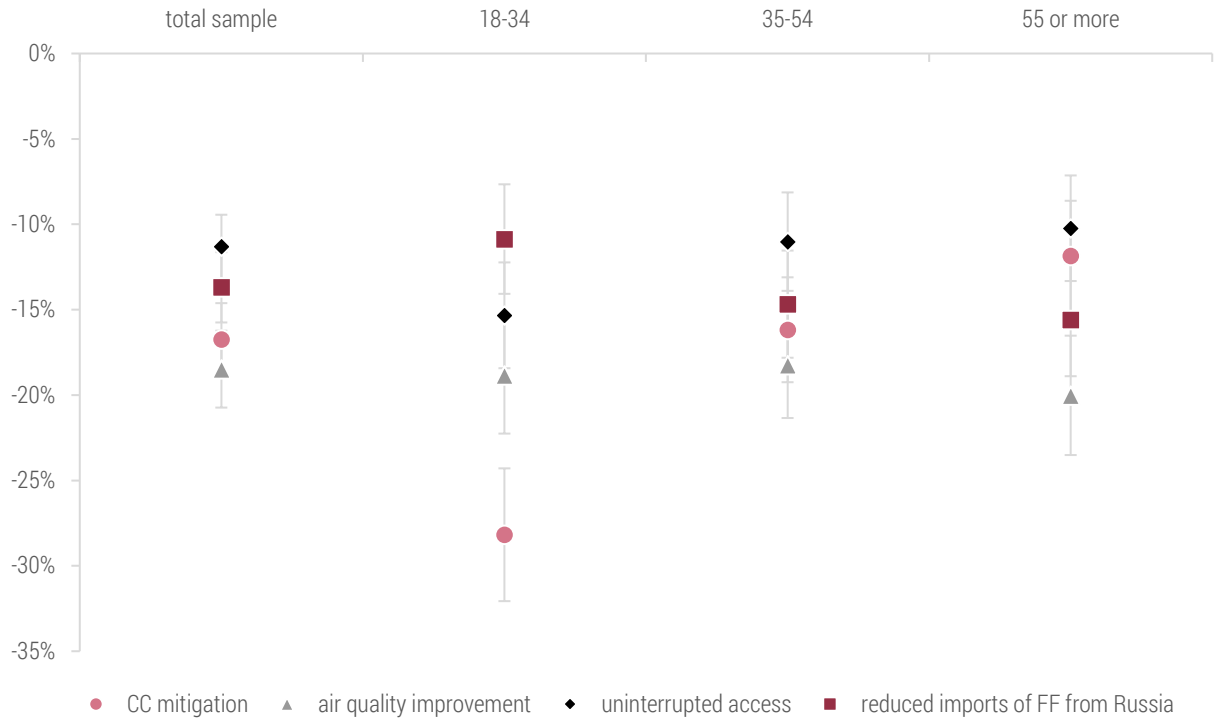


Note: the Y-axis represents how much income an average respondent is willing to forego for a specific attribute. Attribute levels are as follows: Climate change impacts: (1) Major; (2) Limited; (3) Minimal; Diseases caused by poor air quality: (1) No change; (2) Limited by half; (3) Limited to a minimum. Participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented.
Source: own calculations using data gathered for the experiment.

In addition, our research reveals that age and political orientation are critical factors for stated preferences for particular attributes, as shown in Figure 8. Age is a socio-demographic factor consistently related to attitudes towards climate change, as previous studies have found (Syropoulos and Markowitz, 2022). On average, the younger the respondent, the more willing they are to forego income to mitigate climate change (28% willingness to pay among the youngest, compared to 12% among the oldest respondents, Figure 8). The result is consistent with previous research that identified age as one of the best predictors of attitudes towards climate change (Douenne and Fabre, 2020). This result is intuitive, as younger people are more likely to experience the consequences of climate change and therefore have a greater stake in addressing the problem. Conversely, older people prioritise more immediate issues that affect their living conditions, such as diseases caused by poor air quality.

An interesting tension is also reflected in the willingness to pay to reduce imports of fossil fuels from Russia, with young respondents showing a significantly lower willingness (11%) compared to older respondents (16%). This difference might be the result of various life experiences, as younger people in Poland have not experienced Russian control over the state or shortages in energy supplies. On the other hand, older generations who remember these times feel a greater solidarity with Ukraine and are more willing to allocate money to weaken Russian capacities to finance the war.

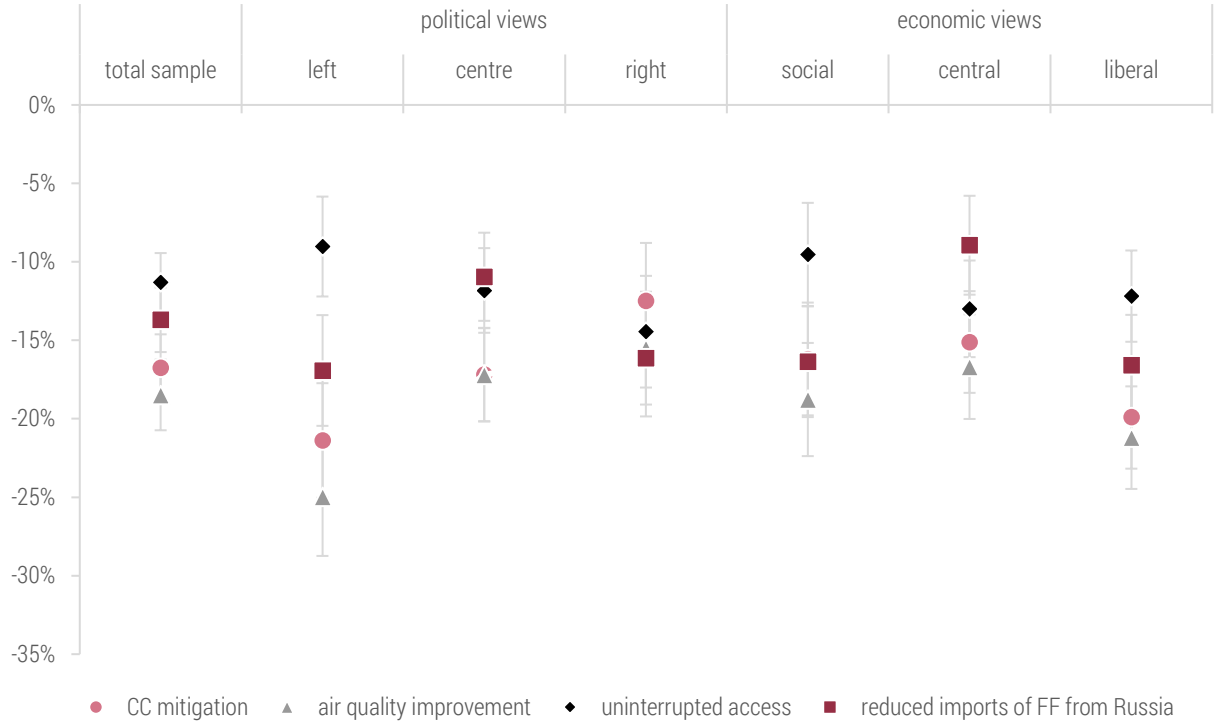
Figure 8. Willingness to pay for attributes in the total sample and selected subgroups (%)



Note: the Y-axis represents how much income an average respondent is willing to forego for a specific attribute. Attribute levels are as follows: Climate change impacts: (1) Major; (2) Limited; (3) Minimal; Diseases caused by poor air quality: (1) No change; (2) Limited by half; (3) Limited to a minimum. Participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented.
Source: own calculations using data gathered for the experiment.

Political orientation is also a significant factor that consistently shapes attitudes towards carbon taxes (Levi, 2021). Right-leaning individuals are generally less willing to pay to mitigate climate change impacts and improve air quality (by 5 pp% and 3 pp, respectively; Figure 9). In contrast, left-leaning individuals have a higher willingness to pay (by 4 pp and 7 pp, respectively). Interestingly, people who consider themselves centrist are less willing to pay to reduce Russian fuel imports than both left- and right-leaning respondents (11%, compared to 17% and 16%, respectively). Preferences for reducing dependence on Russian fuels differ significantly among heterogenous groups in Polish society. Young-aged respondents, those with low trust, and low-skilled workers showed a substantial decrease in attribute valuation (about 10%).

Figure 9. Willingness to pay for attributes in the total sample and selected subgroups (%)



Note: the Y-axis represents how much income an average respondent is willing to forego for a specific attribute. Attribute levels are as follows: Climate change impacts: (1) Major; (2) Limited; (3) Minimal; Diseases caused by poor air quality: (1) No change; (2) Limited by half; (3) Limited to a minimum. Participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented.
Source: own calculations using data gathered for the experiment.

4.3. Minimising carbon tax aversion with redistribution measures

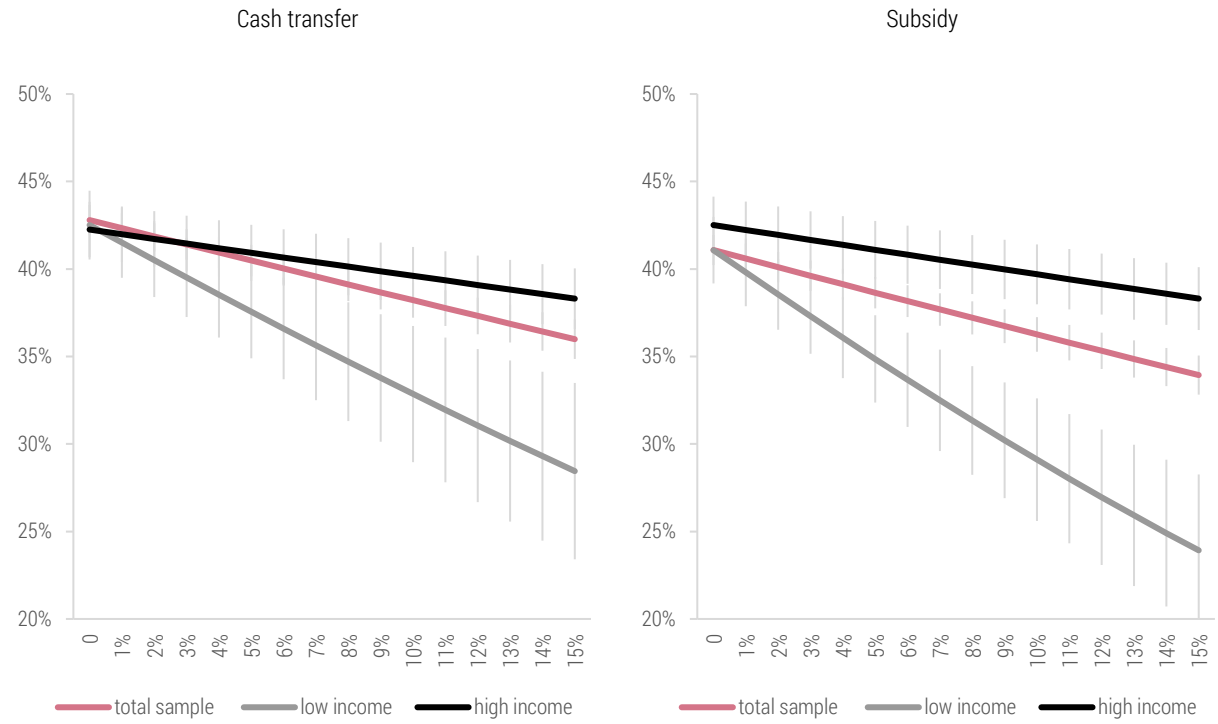
The goal of this study is to identify the redistribution measures that can help reduce the tensions associated with introducing a carbon tax. Although redistribution measures do not substantially increase the acceptance of a carbon tax, they can be used to minimise carbon tax aversion, which was only made worse by income penalties (Section 4.1.). If a particular group has a substantially higher carbon tax aversion than the average population, redistribution measures could be helpful in closing this gap and diffusing any tensions that may arise among this particular category.

To achieve this goal, we use the estimated probability of accepting a carbon tax (equation 1) paired with a redistribution measure and willingness-to-pay data to identify which groups are more likely to protest the introduction of the tax, and how tensions can be eased through the adoption of redistribution measures. Our methodology was based on the following steps. First, we set the level of carbon tax between zero and 15 percent, i.e. the estimated average value of willingness to pay to achieve the climate effects (climate change mitigation, improved air quality, uninterrupted access to energy and individual commuting). Second, we estimated the probability of acceptance of a carbon tax between zero and 15 percent. Third, we calculated the gap in acceptance

between low-income respondents (those in the first income distribution quartile), the average probability of tax acceptance in the population, and high-income respondents (those in the fourth income distribution quartile).

We found that preferences for different redistribution measures vary significantly between low- and high-income households when mitigating carbon tax aversion. Low-income households prefer cash transfers as a redistribution measure, whereas high-income households prefer subsidies for investments in green technologies (Figure 10). Low-income households also display a greater aversion to carbon taxes, even at low rates such as 5 percent (when paired with a subsidy) and 8 percent (when paired with a cash transfer). Therefore, a carbon tax paired with a cash transfer is the most effective and progressive revenue recycling scheme, as it minimises tax aversion more effectively than redistributing revenues through subsidies. High-income households have a lower carbon tax aversion than the general populace. For this particular group, subsidies for green investments would work better in minimising their tax aversion – contrary to the case of low-income respondents.

Figure 10. Predicted probabilities of respondents choosing a carbon tax paired with a cash transfer or subsidy, conditional on differences in income after introducing the policy measure (%)



Note: the figure shows predicted acceptance probabilities for a carbon tax coupled with a cash benefit (left) and a carbon tax coupled with a full investment subsidy (right). Participants had to choose between introducing a carbon tax and a status quo. Among the vignettes with a carbon tax, 50% contained a carbon tax paired with an unconditional cash transfer, while the other 50% were paired with a full subsidy for investments in a new heating source, a PV installation, or an electric car. Sample sizes refer to the total number of vignettes presented.
Source: own calculations using data gathered for the experiment.

We identified low-income respondents as being at particular risk of protesting a carbon tax as it will directly lower their disposable incomes. Therefore, a redistribution mechanism targeted at these households is needed, even if the carbon tax rate levels are low. Finally, we find that car owners and people who heat their homes with coal or gas have a similar aversion to a carbon tax to the general population, and therefore, a means-tested approach is more effective than policies targeted at owners of particular heating technologies or vehicles.

Overall, our findings are consistent with previous studies that examined the differences in carbon tax aversion between low- and high-income households (Sommer et al., 2022). The results also align with macro-microeconomic modelling simulations for Poland, which suggest supporting households directly as the most effective and progressive revenue recycling scheme (Antosiewicz et al., 2022a).

4.4. Robustness

In this section, we present the results of several robustness tests we conducted to assess the reliability and consistency of our findings.

First, we estimated the model described in equation (2) for particular subpopulations rather than interacting it with the variables of interest (Table 4)[9], and the differences we observed confirmed that our approach – focused on interactions rather than subpopulations – is correct (Table 4). We found that the intuitive differences in attribute valuation among respondents with low and high incomes disappear when we focus on subpopulations. In some cases, this result could lead to an impression that low-income respondents value some attributes more than the general populace or high-income respondents. In other cases, our results were robust and consistent across all subgroups.

Table 4. Willingness to pay in selected subpopulations (continued in Appendix B, Table B2)

subpopulation	Climate change impacts	Diseases caused by poor air quality	Access to electricity and individual transport	Purchases of Russian fuels
high income	-19.2 (-25.6; -12.8)	-18.3 (-24.8; -11.9)	-9.6 (-4.4; -14.7)	-12.7 (-18.4; -7)
low income	-18.2 (-21.7; -14.7)	-19.5 (-23.1; -15.9)	-8 (-5.1; -10.9)	-15.5 (-18.9; -12.1)
high consciousness of climate change	-18.6 (-21.1; -16.1)	-20.7 (-23.4; -18)	-11.4 (-9.2; -13.5)	-16.6 (-19.1; -14.1)
low consciousness of climate change	-11.5 (-15.3; -7.7)	-12.5 (-16.4; -8.7)	-11.2 (-7.4; -15)	-5.5 (-9.1; -1.9)
18-34	-23.7 (-27.4; -19.9)	-15.8 (-18.9; -12.7)	-12.9 (-10.1; -15.7)	-9.1 (-11.9; -6.3)
35-54	-14.3 (-17.3; -11.4)	-16.3 (-19.3; -13.2)	-9.7 (-7.1; -12.4)	-13.1 (-16.2; -10.1)
55 or more	-13.8 (-18; -9.7)	-23.3 (-28.7; -17.8)	-12 (-8; -16)	-18.2 (-22.9; -13.5)
left	-20.8 (-24.9; -16.6)	-24 (-28.6; -19.5)	-8.5 (-5.4; -11.7)	-16.4 (-20.3; -12.5)
centre	-16.4 (-19.4; -13.3)	-16.2 (-19.3; -13.1)	-11.1 (-8.4; -13.9)	-10.4 (-13.2; -7.6)

[9] The mean marginal effects are reported in Appendix B, Table B1.

right	-13 (-17.2; -8.8)	-16.5 (-21; -12)	-14.9 (-10.7; -19.2)	-16.7 (-21.3; -12.1)
social	-16 (-20.1; -11.9)	-18.9 (-23.3; -14.4)	-9.6 (-6.1; -13.1)	-16.3 (-20.5; -12.1)
central	-16.2 (-20.2; -12.2)	-18.2 (-22.6; -13.9)	-14.3 (-10.5; -18.1)	-9.9 (-13.6; -6.2)
liberal	-17.4 (-20.5; -14.3)	-18.5 (-21.7; -15.3)	-10.4 (-7.8; -13)	-14.5 (-17.5; -11.6)

Source: own calculations using data gathered for the experiment.

Second, we conducted tests to examine the robustness of our results by exploring the interaction between two sets of variables: (i) trust and income, (ii) awareness of climate change effects and income (Table 5). The purpose of examining these interactions was to separate the relationship between income, trust, climate change awareness, and the valuation of particular attributes, and how sensitive the latter is to interactions between these variables, knowing that the three former characteristics are correlated.

Our analysis revealed that the interaction between these variables does not significantly change the valuation of particular attributes, as our estimates remain robust and consistent regardless of the interactions between these variables. Furthermore, examining these interactions allowed us to separate the relationship between income and the valuation of particular attributes from trust and climate change awareness.

Table 5. Willingness to pay in selected subpopulations (continued in Appendix B, Table B3)

interaction	Climate change impacts	Diseases caused by poor air quality	Access to electricity and individual transport	Purchases of Russian fuels
Low income x low trust	-17.3 (-23.7; -10.8)	-11.9 (-17.9; -5.8)	-12.6 (-6.5; -18.7)	-4.8 (-11.6; 2.0)
low income x high trust	-13.6 (-18.9; -8.3)	-15.9 (-21.0; -10.7)	-5.5 (-0.5; -10.4)	-14.1 (-19.3; -9.0)
Low income x low awareness of climate change	-9.6 (-15.9; -3.4)	-6.3 (-12.3; -0.4)	-8.0 (-2.0; -14.1)	-2.0 (-8.7; 4.7)
Low income x high awareness of climate change	-18.3 (-23.7; -12.9)	-18.9 (-24.1; -13.6)	-8.6 (-3.7; -13.6)	-15.1 (-20.4; -9.9)
High income x low trust	-16.7 (-22.6; -10.9)	-18.2 (-23.8; -12.7)	-13.6 (-7.5; -19.6)	-15.3 (-21.1; -9.5)
High income x high trust	-24.6 (-29.1; -20.1)	-26.3 (-30.8; -21.8)	-7.8 (-3.9; -11.7)	-19.9 (-24.2; -15.6)
High income x low awareness of climate change	-17.2 (-23.8; -10.7)	-19.8 (-25.8; -13.8)	-8.2 (-1.9; -14.5)	-7.2 (-13.5; -1.0)
High income x high awareness of climate change	-23.6 (-27.8; -19.3)	-24.6 (-28.9; -20.4)	-10.3 (-6.5; -14.2)	-22.2 (-26.4; -18.0)

Source: own calculations using data gathered for the experiment.

Finally, we examined the results of interactions separated into dummy variables representing each attribute level (Table 6). In all cases, our results remained robust and reliable, providing valuable insights into the willingness to pay for particular policy objectives (e.g. limiting Russian fuel imports by half or completely).

Table 6. Willingness to pay interacted with particular attribute levels (continued in Appendix B, Table B4)

Interaction	Attribute level	Climate change impacts	Diseases caused by poor air quality	Access to electricity and individual transport	Purchases of Russian fuels
high income	1	-8.2 (-11.3; -5.1)	-4 (-6.9; -1.1)	3.4 (6.4; 0.4)	-1.4 (-4.5; 1.7)
	2	-13.8 (-17.1; -10.4)	-18.8 (-22.3; -15.2)	-12.9 (-9.6; -16.3)	-16.5 (-20; -12.9)
low income	1	-6.6 (-10.3; -2.9)	0.2 (-3.4; 3.9)	-1.1 (2.6; -4.8)	-1.1 (-5; 2.8)
	2	-8.9 (-12.8; -5)	-14.3 (-18.4; -10.2)	-7.3 (-3.3; -11.3)	-9.2 (-13.3; -5.2)
high awareness of climate change	1	-7.1 (-9.1; -5.1)	-2.6 (-4.5; -0.7)	1.3 (3.2; -0.6)	-1.1 (-3.1; 0.9)
	2	-12.9 (-15.2; -10.7)	-18.9 (-21.5; -16.4)	-13 (-10.7; -15.2)	-16.4 (-18.8; -14)
low awareness of climate change	1	-5.5 (-8.6; -2.3)	-1 (-4; 2)	-0.2 (2.8; -3.2)	-1.3 (-4.5; 1.8)
	2	-5.7 (-8.7; -2.6)	-10.8 (-14.1; -7.5)	-10.8 (-7.5; -14)	-3.8 (-7.2; -0.5)
18-34	1	-10.6 (-13.5; -7.6)	-4.4 (-7.2; -1.6)	3 (5.8; 0.3)	-1.4 (-4.3; 1.4)
	2	-16.9 (-20.2; -13.6)	-14.2 (-17.4; -11)	-18.4 (-15; -21.7)	-9 (-12.1; -5.9)
35-54	1	-4.9 (-7.5; -2.3)	-0.6 (-3.2; 2.1)	-1.6 (1; -4.3)	-2.2 (-4.9; 0.5)
	2	-11.7 (-14.5; -8.9)	-17.5 (-20.6; -14.5)	-9.2 (-6.4; -12)	-12.4 (-15.4; -9.5)
55 or more	1	-5.9 (-8.9; -2.9)	-2.2 (-5.1; 0.6)	1.8 (4.6; -1)	-0.2 (-3.1; 2.8)
	2	-6.5 (-9.6; -3.4)	-17.6 (-21.1; -14.1)	-11.9 (-8.7; -15.1)	-15.6 (-19; -12.2)
left	1	-9.4 (-12.6; -6.3)	-3.9 (-6.9; -0.8)	0.9 (3.8; -2.1)	-1.5 (-4.6; 1.5)
	2	-12.5 (-15.7; -9.2)	-20.7 (-24.2; -17.2)	-9.8 (-6.6; -12.9)	-15.2 (-18.6; -11.7)

centre	1	-5.7 (-8.1; -3.2)	0 (-2.4; 2.5)	2 (4.5; -0.4)	-0.3 (-2.8; 2.2)
	2	-11.6 (-14.3; -8.9)	-17 (-20; -14)	-14.2 (-11.3; -17)	-10.9 (-13.6; -8.1)
right	1	-4.9 (-8.3; -1.4)	-3.8 (-7; -0.7)	-1.5 (1.8; -4.7)	-2.4 (-5.7; 0.9)
	2	-7.9 (-11.3; -4.4)	-11.6 (-15.1; -8.1)	-12.8 (-9.2; -16.4)	-13.6 (-17.3; -9.9)
social	1	-6.1 (-9.3; -2.9)	-3 (-6; 0)	1.4 (4.4; -1.6)	-0.1 (-3.2; 3.1)
	2	-10.8 (-14.1; -7.5)	-15.2 (-18.6; -11.7)	-10.9 (-7.6; -14.2)	-16.5 (-20.1; -12.9)
central	1	-5.3 (-8.2; -2.4)	-1 (-3.8; 1.9)	-1.2 (1.7; -4)	0.3 (-2.6; 3.3)
	2	-9.7 (-12.7; -6.7)	-15.7 (-19; -12.4)	-12 (-8.7; -15.3)	-9.2 (-12.3; -6)
liberal	1	-8.2 (-10.9; -5.4)	-2.5 (-5.1; 0.1)	2.2 (4.9; -0.4)	-3.4 (-6.1; -0.7)
	2	-12 (-14.9; -9.1)	-18.9 (-22.1; -15.7)	-14.1 (-11.2; -17)	-13.2 (-16.2; -10.1)

Source: own calculations using data gathered for the experiment.

As demonstrated above, our results are robust and reliable and provide valuable insights into the relationships between the variables of interest. Our analyses indicate that our findings are not dependent on any particular combination of variables or subgroups and hold across various populations.

5. Conclusions and discussion

In this study, we examined the preferences of Polish society towards the implementation of a carbon tax, a crucial policy instrument for climate change mitigation. Poland is a country characterised by low levels of social and political trust, deep social divisions, and low policy priority for climate change mitigation. Our analysis revealed that there is a strong aversion to carbon taxes in Poland, and implementing such policies may exacerbate social tensions and trigger anti-establishment movements similar to the Yellow Vests in France. Such movements can, in turn, effectively oppose carbon tax adoption and deflect climate policy goals in other European countries. To this end, we diagnosed and calculated the willingness to pay for climate change mitigation and improving energy security in particular groups of Polish society. We found that income plays a crucial role in shaping preferences regarding climate and energy policies, with the general population valuing climate change and energy security more than those with low incomes (a 2-4 pp difference in the share of income people were willing to forego to achieve climate goals).

Our study is the first to identify the preferences for climate change mitigation and energy security improvement of a society highly impacted by the Russian invasion of Ukraine and the energy market shocks that followed. These events have highlighted the importance of energy security and climate change mitigation for Poland, a nation heavily dependent on Russia for its energy supply. With this knowledge, policymakers can consider society's preferences regarding climate and energy policies to avoid a further worsening of social tensions.

Our analysis demonstrated that redistributive policies may help mitigate the risks of social tensions associated with the introduction of carbon taxes. However, they are unlikely to increase the acceptance of new taxes. Policymakers should, therefore, focus on introducing targeted measures to alleviate the burden of an additional tax on low-income households, as these can significantly improve public acceptability and support of climate policies (Baranzini et al., 2017). However, using carbon tax revenues to compensate lower-income households may not be the preferred option (Büchs et al., 2011), and households with higher income may be the primary driver of using carbon tax revenues as subsidies for green investments. Policymakers must consider public preferences and distributional effects when designing carbon pricing policies (Bureau, 2011), as effective policy design can improve public acceptability and support, ultimately leading to the successful implementation of carbon taxes and a reduction in carbon emissions.

Furthermore, our study highlights the importance of difficult-to-observe factors, such as attitudes and trust, in shaping preferences for climate change mitigation and energy security. Specifically, varying levels of awareness of the effects of climate change among parts of the population was related to differences in their valuation of particular potential outcomes of a carbon tax. People who were more aware of the effects of changing climate were willing to forego more income to mitigate these effects (19% vs. 11%) and decrease fossil fuel imports from Russia (17% vs. 5%). We found that increasing social capital and awareness of climate change may help build the acceptance of new policy measures. Additionally, we identified the heterogeneity of preferences among respondents of different age groups – climate change mitigation was more important for younger respondents, while older respondents preferred improvements in air quality.

Policymakers should frame the effects of a carbon tax based on these principles, as public acceptability and support for carbon pricing policies are essential for the successful implementation of carbon taxes (Köppl and Schratzenstaller, 2022). Furthermore, the design of these policies should go beyond technical parameters, as they must include measures that address distributional consequences (Jagers et al., 2019).

Finally, our study underscores the need for policymakers to be transparent and engage in dialogue with the public to build trust and foster cooperation. The energy crisis caused by Russia's invasion of Ukraine has exerted additional pressure on the energy and climate policy agenda. Therefore, policymakers should ensure that the public is adequately informed about the causes and implications of the energy crisis, the importance of climate change mitigation, and the distributional consequences of climate policy instruments to build understanding, trust, and support for climate policies. Overall, our study suggests that policymakers should adopt a socially just approach to climate policies that balance the immediate needs of vulnerable groups with long-term climate goals while considering the heterogeneity of preferences regarding climate and energy policies.

While our study provides valuable insights into social preferences for mitigating climate change and improving energy security, we acknowledge that it has its limitations. First, it is limited in its generalisability to other countries as it focuses on the context of society in Poland. Nevertheless, our findings are valid for other Central and Eastern European countries and societies affected by the 2022 energy crisis.

Second, our study relied on a survey-based approach which may be prone to biases. Aware of this fact, we used a representative sample and applied rigorous survey methods to mitigate these limitations. Third, our study is limited in capturing the complexity of social tensions and their impacts on climate policy adoption. While we refer to the Yellow Vest movement in France as an illustrative example, we did not fully capture the complexity of the social and political dynamics that could lead to new anti-systemic and anti-elitist movements. Finally, our study did not explore the potential trade-offs between climate change mitigation and other policy objectives such as economic growth, employment and social welfare. Future research could explore these trade-offs to better inform policy design and help strike a balance between multiple policy goals.

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Appendix A: Methodological details

Table A1. Information on interpreting each attribute (translated)

Attribute	Definition
Climate change impacts	Permanent changes and climate properties that affect the intensity and frequency of weather events such as droughts, floods, heavy and intense rainfall, storms, heatwaves and changes in the scale and structure of agricultural crops
Air quality	Air quality assessed by analysing the presence and concentration of substances harmful to health
Purchases of Russian fuels	Natural gas and oil imported to Poland from Russia This gas and oil is used by households (heating, cooking, refuelling cars) and industry
Access to electricity and individual transport	Access to electricity and car usage Interruptions in access: a power outage once a week for 1 hour and a ban on using cars on two Sundays a month Energy rationing means no electricity for 1 hour a day and a ban on using cars on Sundays
Climate and energy policy	Government actions designed to limit climate change by reducing the use of coal, oil and gas for energy production. As part of the climate and energy policy, the government may, for example, introduce environmental fees, i.e. a tax on the use of coal, oil and gas. Tax revenues to the state budget can then finance: 1. cash transfers – a monthly amount paid unconditionally by the government to all households in Poland, 2. full subsidies for green investments – (heat pumps, photovoltaic panels), building insulation, electric car.

Source: own elaboration.

Table A2. Confidence among study participants regarding their choices

	Mean	SD	Min	Max	Q1	Median	Q3
Confidence level (points on a scale from 0-100)	69.0	21.0	0.0	100.0	56.0	71.0	85.0

Source: own calculations using data gathered for the experiment.

Appendix B: Additional results

Table B1. Marginal effects from logistic regressions

	Climate change impacts	Diseases caused by poor air quality	Access to electricity and individual transport	Purchases of Russian fuels	Climate change impacts
high income	0.441***	0.473***	-0.195***	0.370***	2.020***
	(0.034)	(0.033)	(0.033)	(0.033)	(0.088)
low income	0.304***	0.287***	-0.165***	0.210***	2.005***
	(0.041)	(0.039)	(0.039)	(0.041)	(0.087)

Above 2M energy spending[10]	0.340***	0.313***	-0.258***	0.228***	2.016***
	(0.039)	(0.036)	(0.035)	(0.037)	(0.088)
Above 2M transport spending	0.329***	0.298***	-0.213***	0.263***	2.005***
	(0.040)	(0.042)	(0.039)	(0.041)	(0.087)
Below 2M energy spending	0.352***	0.410***	-0.228***	0.305***	2.060***
	(0.021)	(0.021)	(0.020)	(0.021)	(0.089)
Below 2M transport spending	0.354***	0.406***	-0.242***	0.290***	2.072***
	(0.021)	(0.020)	(0.020)	(0.020)	(0.089)
car owners	0.359***	0.372***	-0.264***	0.336***	2.011***
	(0.034)	(0.033)	(0.035)	(0.035)	(0.087)
coal/gas heating	0.361***	0.421***	-0.221***	0.298***	2.014***
	(0.052)	(0.050)	(0.048)	(0.051)	(0.087)
without a car or coal/gas heating	0.336***	0.406***	-0.188***	0.258***	2.002***
	(0.051)	(0.050)	(0.046)	(0.048)	(0.087)
low trust	0.325***	0.285***	-0.285***	0.214***	2.017***
	(0.031)	(0.028)	(0.029)	(0.031)	(0.087)
high trust	0.361***	0.438***	-0.209***	0.321***	2.064***
	(0.023)	(0.023)	(0.022)	(0.022)	(0.089)
high consciousness of climate change	0.406***	0.452***	-0.248***	0.361***	2.090***
	(0.022)	(0.022)	(0.021)	(0.022)	(0.090)
low consciousness of climate change	0.218***	0.234***	-0.212***	0.109***	1.998***
	(0.033)	(0.031)	(0.031)	(0.033)	(0.087)
18-34	0.572***	0.382***	-0.311***	0.220***	2.028***
	(0.033)	(0.032)	(0.029)	(0.032)	(0.088)
34-54	0.326***	0.367***	-0.222***	0.296***	2.016***
	(0.029)	(0.028)	(0.028)	(0.029)	(0.088)
55 or more	0.240***	0.406***	-0.207***	0.316***	2.028***
	(0.032)	(0.032)	(0.031)	(0.032)	(0.088)
left	0.435***	0.508***	-0.184***	0.344***	2.035***
	(0.034)	(0.033)	(0.032)	(0.034)	(0.088)
centre	0.347***	0.347***	-0.239***	0.221***	2.018***
	(0.028)	(0.027)	(0.026)	(0.027)	(0.088)
right	0.252***	0.313***	-0.292***	0.326***	2.018***
	(0.037)	(0.034)	(0.035)	(0.036)	(0.087)
social	0.327***	0.379***	-0.192***	0.331***	2.020***
	(0.035)	(0.034)	(0.033)	(0.034)	(0.088)
central	0.304***	0.336***	-0.262***	0.180***	2.014***
	(0.032)	(0.031)	(0.030)	(0.031)	(0.088)
liberal	0.404***	0.431***	-0.248***	0.337***	2.032***

[10] The share of actual energy expenditures is higher than twice the median of this value in the sample.

	(0.030)	(0.029)	(0.029)	(0.030)	(0.088)
N			87,736		

Source: own calculations using data gathered for the experiment.

Table B2. Willingness to pay interacted with particular socio-economic characteristics (continued from Table 4)

interaction	Climate change impacts	Diseases caused by poor air quality	Access to electricity and individual transport	Purchases of Russian fuels
women	-19.4 (-22.2 ; -16.6)	-19.7 (-22.5 ; -16.9)	-12.0 (-9.5 ; -14.4)	-13.0 (-15.5 ; -10.4)
men	-14.4 (-17.3 ; -11.6)	-17.9 (-20.9 ; -14.9)	-11.1 (-8.4 ; -13.8)	-15.1 (-18.1 ; -12.2)
rural	-18.0 (-21.5 ; -14.6)	-19.1 (-22.5 ; -15.7)	-9.8 (-6.8 ; -12.9)	-12.4 (-15.7 ; -9.1)
urban	-16.6 (-19 ; -14.1)	-18.7 (-21.2 ; -16.1)	-12.3 (-10.1 ; -14.5)	-14.6 (-17 ; -12.2)
Multifamily	-18.1 (-21 ; -15.1)	-19.0 (-22 ; -16)	-11.9 (-9.1 ; -14.6)	-12.0 (-14.9 ; -9.2)
Detached	-16.4 (-19.1 ; -13.7)	-18.8 (-21.5 ; -16)	-11.3 (-8.9 ; -13.7)	-15.4 (-18 ; -12.7)
Buildings built until 1980	-17.4 (-20.2 ; -14.6)	-18.9 (-21.9 ; -16)	-11.4 (-8.8 ; -13.9)	-13.5 (-16.2 ; -10.8)
Buildings built after 1981	-16.7 (-19.4 ; -14)	-18.8 (-21.5 ; -16.1)	-11.8 (-9.4 ; -14.2)	-14.7 (-17.3 ; -12.1)
employed	-20.1 (-22.7 ; -17.5)	-18.4 (-21 ; -15.8)	-12.5 (-10.1 ; -14.8)	-13.7 (-16.1 ; -11.2)
Unemployed	-12.6 (-15.8 ; -9.4)	-19.6 (-22.9 ; -16.2)	-10.2 (-7.3 ; -13.1)	-14.5 (-17.7 ; -11.3)
Primary, secondary education	-18.2 (-20.5 ; -15.9)	-18.3 (-20.6 ; -16.1)	-11.2 (-9.3 ; -13.2)	-15.0 (-17.1 ; -12.8)
Tertiary education	-24.3 (-27.8 ; -20.8)	-21.2 (-24.6 ; -17.8)	-10.0 (-7.1 ; -13)	-20.6 (-24 ; -17.2)
Blue-collar occupations	-13.3 (-18.1 ; -8.5)	-15.1 (-20 ; -10.3)	-13.9 (-8.9 ; -18.9)	-8.7 (-13.6 ; -3.9)
White-collar occupations	-22.5 (-26.3 ; -18.7)	-21.6 (-25.3 ; -17.9)	-10.7 (-7.2 ; -14.1)	-19.0 (-22.8 ; -15.2)

Source: own calculations using data gathered for the experiment.

Table B3. Willingness to pay for attributes of selected subgroups (continued from Table 5)

subpopulation	Climate change impacts	Diseases caused by poor air quality	Access to electricity and individual transport	Purchases of Russian fuels
Above 2M energy spending	-20.1 (-26.1; -14.2)	-19.1 (-24.9; -13.2)	-15.3 (-10; -20.6)	-13.4 (-18.6; -8.2)
Above 2M transport spending	-20.2 (-26.7; -13.6)	-18.4 (-24.8; -12.1)	-13.4 (-7.8; -18.9)	-16.5 (-22.5; -10.5)
Below 2M energy spending	-15.8 (-18; -13.6)	-18.4 (-20.8; -16)	-10.3 (-8.3; -12.3)	-13.7 (-15.9; -11.5)
Below 2M transport spending	-16.1 (-18.3; -13.9)	-18.4 (-20.8; -16)	-11.1 (-9.1; -13)	-13.3 (-15.5; -11.1)
car owners	-16.2 (-19.9; -12.6)	-16.6 (-20.4; -12.8)	-11.7 (-8.3; -15.1)	-15.3 (-19.1; -11.5)
coal/gas heating	-20 (-27.9; -12.1)	-24.6 (-33.1; -16)	-12.4 (-6.1; -18.6)	-17.5 (-25.1; -9.8)
without a car or coal/gas heating	-16.7 (-22.6; -10.9)	-19.9 (-26.3; -13.4)	-9.2 (-4.4; -14)	-13.3 (-18.7; -7.8)
low trust	-15.3 (-18.7; -11.9)	-13.6 (-16.8; -10.4)	-13.7 (-10.5; -17)	-10.1 (-13.2; -6.9)
high trust	-17.4 (-20; -14.7)	-21.2 (-24.2; -18.2)	-10 (-7.8; -12.3)	-15.4 (-18.1; -12.8)

Source: own calculations using data gathered for the experiment.

Table B4. Willingness to pay interacted with particular attribute levels (continued from Table 6)

Interaction	Attribute level	Climate change impacts	Diseases caused by poor air quality	Access to electricity and individual transport	Purchases of Russian fuels
Above 2M energy spending	1	-4 (-7.5; -0.5)	0.2 (-3.1; 3.6)	-0.6 (2.8; -4)	-1.3 (-4.8; 2.3)
	2	-13.5 (-17.3; -9.8)	-16.3 (-20.1; -12.5)	-12.8 (-9.1; -16.6)	-10.1 (-13.7; -6.4)
Above 2M transport spending	1	-6.2 (-10; -2.4)	-0.2 (-3.8; 3.4)	1.1 (4.8; -2.5)	0.1 (-3.7; 3.9)
	2	-10.9 (-14.9; -6.8)	-14.9 (-19; -10.9)	-12.3 (-8.2; -16.4)	-12.9 (-17; -8.8)
Below 2M energy spending	1	-7.5 (-9.5; -5.5)	-2.9 (-4.8; -1.1)	1.3 (3.1; -0.6)	-1.2 (-3; 0.7)
	2	-9.9 (-12; -7.9)	-16.7 (-19.1; -14.3)	-12.2 (-10.1; -14.4)	-13.6 (-15.9; -11.3)

Below 2M transport spending	1	-6.7 (-8.6; -4.8)	-2.6 (-4.4; -0.8)	0.8 (2.6; -1.1)	-1.5 (-3.3; 0.4)
	2	-10.8 (-12.8; -8.7)	-16.9 (-19.3; -14.6)	-12.3 (-10.2; -14.4)	-12.7 (-14.9; -10.5)
car owners	1	-6.9 (-10; -3.8)	-1.9 (-5; 1.3)	-0.1 (3; -3.1)	-1.4 (-4.6; 1.8)
	2	-10.6 (-14; -7.1)	-16 (-19.6; -12.4)	-12.7 (-9.2; -16.2)	-15.4 (-19; -11.8)
coal/gas heating	1	-6.7 (-11.3; -2)	-2.3 (-6.8; 2.2)	1.7 (6.5; -3.2)	-2.8 (-7.5; 1.9)
	2	-11.7 (-16.6; -6.9)	-18.8 (-23.8; -13.7)	-12.3 (-7.4; -17.2)	-12.5 (-17.7; -7.4)
without a car or coal/gas heating	1	-6.4 (-10.8; -2.1)	-2.7 (-7.1; 1.6)	0.8 (5.1; -3.5)	0.4 (-3.8; 4.7)
	2	-10.8 (-15.5; -6.1)	-17.1 (-21.9; -12.2)	-10.6 (-6; -15.1)	-12.8 (-17.4; -8.2)
low trust	1	-4.3 (-7.1; -1.5)	-1 (-3.7; 1.8)	-0.8 (2; -3.6)	-1.4 (-4.2; 1.5)
	2	-12 (-15.1; -9)	-13.2 (-16.3; -10.2)	-13.3 (-10.2; -16.4)	-9 (-12.3; -5.8)
high trust	1	-7.8 (-10; -5.7)	-2.8 (-4.8; -0.7)	1.7 (3.7; -0.3)	-1.1 (-3.1; 1)
	2	-10.1 (-12.3; -7.9)	-18.3 (-20.9; -15.7)	-11.9 (-9.6; -14.2)	-14.6 (-17; -12.2)

Source: own calculations using data gathered for the experiment.

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