Energy, Sustainability and Society

RESEARCH

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Public support and willingness to pay for a carbon tax in Hungary: can revenue recycling make a difference?

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Abstract

Background To curb human-made carbon-dioxide emissions, the European Union will introduce carbon pricing for buildings and transport in 2027. Central and East European (CEE) countries are pressured to embark on ambitious decarbonization pathways leading to carbon-neutral economies by 2050. This paper is the first to investigate the public acceptance of and the willingness to pay (WTP) for a carbon tax in a CEE country, Hungary. It analyzes the support-increasing effects of five revenue-recycling mechanisms (tax cuts, green spending, support for poor households, funding for health care and education, and debt reduction), a wider range than covered in previous studies. A national face-to-face survey of 3013 adults on public attitudes to climate change, conducted in summer 2022, is the main method of data collection. This is combined with secondary analysis of related statistics and documentary analysis of relevant materials.

Results The results show low public acceptance, with only a modest increase from 20.3% to 27.3% due to revenue recycling. This is accompanied by low WTP values and WTP increases. All these are lower than those found in Western surveys. A novel empirical result is the relative popularity of public health care and education in revenue recycling, though differences in revenue-recycling preferences are apparent between those who accept a carbon tax even without a redistribution mechanism and those who are willing to pay only if redistribution is included. Green spending also performed relatively well, while supporting the poor fared less well, albeit with relatively high WTP values. Reducing taxes and public debt were the least likely to instigate carbon-tax acceptance.

Conclusions The results highlight the importance of carefully assessing the distributional impact of implementing carbon pricing mechanisms and thoroughly integrating social considerations into climate policy. Based on this, as well as the analysis of the social conditions and political economy of climate policy development in Hungary, policies—such as a gradually increasing carbon tax, social cushioning, legal earmarking of carbon-tax revenues, and policy bundling—are proposed to make carbon pricing socially tolerable and politically acceptable. The findings and conclusions might also be relevant for other parts of the CEE region.

Keywords Carbon tax, Green transition, Hungary, Public acceptance, Revenue recycling, Willingness to pay

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Background

Reducing human-made (anthropogenic) greenhouse-gas emissions to mitigate climate change is an imperative, and carbon pricing policies have been lauded for their potential to do this in a cost-effective manner [1]. By putting an explicit price tag on emissions—either through emissions-trading systems (ETS) or carbon

taxes—economic actors and consumers are incentivized to desist from polluting activities and invest in low-carbon technologies [2]. However, public and business support for these policies is limited, which renders the implementation of stringent carbon prices a formidable task for policymakers. The low level of public acceptance can be largely explained by the potentially adverse (regressive) distributional impact of carbon pricing (which negatively affects public perception on fairness) and the general skepticism toward the environmental effectiveness of these policies [3]. However, recent findings suggest that certain approaches to allocating these revenues (i.e., revenue recycling) may increase public acceptance and, thus, help dissolve the political impasse around ambitious carbon pricing [4, 5]. For example, there is a symbiotic relationship between the progressive distributional impact of carbon pricing—achieved through different compensation strategies, such as increasing welfare transfers to low-income households—and enhanced public acceptance due to changes in public perception of fairness of the policy [6, 7].

As part of its increasing climate change mitigation efforts to reduce greenhouse-gas emissions to at least 55% below 1990 levels by 2030, the European Union will extend the EU Emissions Trading System (EU ETS) to the building and transportation sectors in 2027 (EU ETS2). This will directly affect citizens' well-being due to the price increase of such basic commodities as heating and motor fuels [8]. Through a large representative survey in a Central and East European (CEE) country and EU member, Hungary, this paper analyzes the public acceptability of and willingness to pay (WTP) for carbon pricing, and determines whether and what revenue recycling engenders a higher level of support and WTP for these policies. More specifically, respondents first are asked how much they would be willing to pay for a hypothetical carbon tax, if at all. Then it is investigated how revenue-recycling mechanisms shape people's acceptance and WTP. Based on previous theoretical and empirical research explicating the relationship between different spending options and increased public acceptance (e.g., [3, 6]), five revenue-recycling mechanisms are distinguished: (1) reducing existing labor and corporate taxes, (2) financing environmental projects (i.e., green spending for energy efficiency programs, renewable deployment or public transport development), (3) supporting poor households, (4) improving the public education and health care, and (5) reducing public debt. The methodology offers valuable insights about two general respondent types: those who are initially reluctant to pay and those who are willing but may favor one recycling measure over another to pay more for a carbon tax. This study analyzes the support-increasing effects of a wider range of revenue-recycling mechanisms than covered in previous studies, which mainly focused on green spending and compensating low-income households. In this article, the terms "acceptability", "acceptance" and "support" refer to a binary "yes" or "no" for the measure, while "WTP" refers to a certain amount of money. For the sake of simplicity (i.e., to make the questions easier for respondents to understand), the term "carbon tax" is used instead of an ETS. In terms of impact, the EU ETS2 will be very similar to a carbon tax. (The survey questions can be found in Additional file 1).

The survey used for this analysis is the first of its kind in the post-socialist CEE region. Currently, the literature focuses on Western countries. A meta-analysis of 43 studies finds that 40 of these were undertaken in the United States, Australia and West European countries, and none in the CEE region [6]. Indeed, few studies are related to Central and Eastern Europe. These include the discrete choice experiment by Alberini et al. [9], which provides comparable results. In this, they estimate the WTP in Italy and Czechia to avoid one ton of carbon dioxide using different climate mitigation measures, one of which was a tax on fossil fuels. Based on the results of the 2016 European Social Survey, Pohjolainen et al. [10] examined the attitudes of the general public toward increasing taxes on fossil fuels in European countries, including seven CEE countries. Partly based on the same survey, Halman et al. [11] showed the proportion of people in European countries who would be prepared to donate part of their income to prevent environmental pollution.

The political economic dynamics guiding climate policy development in the CEE region are markedly different from those in Western countries due to lower disposable income of households, higher dependence on fossil fuels in the energy mix, and climate change being a socially less salient issue, which creates a more constrained environment for policy interventions [12–15]. (See Hribar et al. [16] for the contextual background for energy transition in Southeastern Europe). As the questions on a carbon tax and revenue recycling are embedded in a large-scale survey—specifically designed to understand the attitudes, perceptions and behavior of the population toward climate change in Hungary—a wider context is available to explain the empirical results concerning carbon taxation.

Since CEE societies are similar to each other in terms of levels of public environmental awareness, as well as other social values and preferences related to well-being [17], the findings of the paper might be relevant for the whole CEE. The CEE region lacks experience with carbon taxes, making this research a theoretically interesting trial to gauge how the public would react to the introduction

of such policy initiatives. It has become highly relevant and pressing from a policy perspective to understand the general acceptance of a carbon tax and discover which mechanisms might be most effective in garnering public support in a relatively constrained socioeconomic environment. An increasingly ambitious climate policy framework can only be successfully implemented in the EU if less affluent member states get on board politically, and for this, social support is needed. The policy recommendations contribute to pivotal discussions on how these policies should be designed to make them environmentally effective, socially tolerable and politically palatable for the CEE region.

Carbon pricing theory suggests that essential alterations to current production practices and consumer habits to mitigate climate change can effectively be facilitated by imposing costs on emissions [18]. Explicit carbon pricing mechanisms are endorsed by economists who argue that an economy-wide carbon price is the most efficient way to reduce carbon-dioxide emissions because it internalizes the social costs of pollution. Climate policy practitioners also see these policies as indispensable for domestic and international abatement efforts to keep dangerous global warming below a socially tolerable level, as envisaged in the landmark 2015 Paris Agreement [2, 19].

However, public support for ambitious carbon pricing policies appears to be limited, which makes the implementation and reform of these policies politically challenging [20, 21]. The public acceptability of climate policies is chiefly determined by people's perception of policy fairness and effectiveness [22]. With regards to carbon pricing, public perception on fairness is largely influenced by the potential regressive distributional impact of the policy [6], imposing a relatively higher burden on low-income households, exacerbating energy poverty, and widening existing social inequalities [23, 24]. In some countries, such as Italy and France, the distributional impact is progressive [25, 26], but carbon pricing nevertheless affects certain socioeconomic groups more negatively than others in the same income percentile. For instance, it adversely affects rural households that lack access to low-carbon heating and transportation, or other vulnerable groups, such as the elderly and big families [27]. Another political obstacle is that stringent carbon pricing increases the prices of basic commodities, which entails a considerable short-term reduction in private welfare for most households. The imposed costs are perceived to be too high by those affected, a problem further exacerbated by focusing on short-term costs and neglecting substantial (environmental) benefits (e.g., cleaner air or jobs created in low-carbon sectors) in public debates about carbon pricing implementation [21, 28]. Furthermore, distaste for the relatively high cost is conjoined with a general skepticism about the environmental effectiveness of carbon pricing (e.g., [29, 30]), because people do not necessarily consider this climate policy to be an effective tool to discourage carbon-emitting behavior due to the inelasticity of demand for basic commodities (here heating and motor fuels) and the high investment costs of low-carbon alternatives, such as heat pumps and electric vehicles [3]. Lastly, the public may believe that the primary aim of introducing a carbon tax is not to protect the environment, but to raise revenue for the state, as a backdoor mechanism in "green" disguise [29]. Despite this backdrop, carbon pricing is a unique climate policy measure. In contrast to different forms of command-and-control regulation, such as technology- and performance-based standards, it generates a significant amount of revenue [1], which can be utilized in various ways to improve economic, social and environmental conditions in a jurisdiction. For instance, carbon pricing proceeds can be used to further climate change mitigation efforts by green spending, increasing the positive environmental effects of the policy. Revenue can also be channeled toward the reduction of existing taxes on labor and infrastructure development, such as digitalization and high-speed rail development. These measures make domestic economies more competitive, an argument put forth in different strands of the "double dividend" literature (e.g., [31–33]). More recently, Köppler and Schratzenstaller [34] have provided a comprehensive overview of the available empirical evidence on various aspects of a carbon tax, including its environmental effectiveness and the double dividend argument.

Crucially, certain allocations of revenue may not only improve the socioeconomic conditions of a jurisdiction (here, a country) but can also lead to higher political acceptability by delivering direct and salient benefits to the public, which ultimately facilitates the implementation of higher carbon prices [4]. Empirically, the relationship between revenue recycling and an elevated level of public support is confirmed by the meta-analyses of Carattini et al. [3] and Maestre-Andrés et al. [6], both arriving at the conclusion that green spending is the most popular form of revenue recycling for increasing public acceptance. In some cases, the increase can be quite substantial. For example, a survey by Amdur et al. [35] found that public support for a hypothetical carbon tax was as low as 28% in the United States but increased to 60% when revenue was committed toward clean energy development. In a similar fashion, albeit with a considerably smaller increase, Baranzini and Carattini [36] found that public acceptance in Switzerland increased by 15% points (from 49 to 64%) when preferred revenue-recycling measures were implemented—this meant that

spending was earmarked for environmental causes. Public preference toward green spending might be explained by the ability of these investments to directly address people's skepticism over the environmental effectiveness of carbon pricing. Green projects create a positive perception of the environmental effectiveness of this policy due to the visible results, possibly coupled with a reduction in personal costs via cheaper and more easily commercially available low-carbon alternatives (e.g., it becomes cheaper to install solar photovoltaic panels) [3]. Empirical evidence also confirms that increasing public knowledge about the environmental effectiveness of carbon pricing and its possible co-benefits (e.g., cleaner air) is associated with elevated level of public support for this policy [4, 37, 38].

Other empirical works suggest that compensating negatively affected social groups can also be a constructive way to secure public support behind more stringent carbon pricing policy [7]. Lump sum or targeted transfers to low-income households or other vulnerable groups may eliminate the possible regressive qualities of carbon pricing (partly offsetting negative effects at the level of the individual) and have an overall positive impact on the well-being of most citizens, favorably changing the public perception on policy fairness [39]. Furthermore, Bergquist et al. [40] show that "policy bundling"—which entails linking climate action to other social and economic projects, such as housing and wage reform—also increases support for a carbon tax.

Literature is also emerging that advocates for the hybrid use of revenue by combining and integrating different spending options [4, 41, 42]. These authors suggest that the more social benefit is derived from the redistribution of carbon funds across the political spectrum and various socioeconomic groups, the more political support can then be gathered.

Despite the potential role of revenue recycling in heightening public acceptance, it should be noted that it is not a silver bullet. Some revenue-recycling measures are very appealing, but others may increase public support only modestly, not at all, or may work in a highly context-specific manner [43, 44]. For example, survey experiments show that comparable revenue-recycling mechanisms proposed in the United States and Sweden can have opposite outcomes. One scheme increased policy support in the United States, but reduced it in Sweden [45, 46]. Also, Beiser-McGrath and Bernauer's [5] experiment involving the United States and Germany demonstrated that infrastructure development supportive of renewable deployment and low-income programs financed from carbon pricing proceeds increased WTP for carbon taxation, and the support-increasing effect of revenue recycling was significantly and consistently higher in the United States than in Germany. The same study shows that reducing public debt and corporate taxes enhanced public support. This is why it is crucial to test various revenue-recycling alternatives to ascertain which ones are effective in enhancing public support in different environments.

The rest of the article is structured as follows. The "Methods" section describes the research methods and design. The "Results" section presents the results of the survey. Here, quantitative research methods, such as descriptive statistics as well as regression and association analysis, are used to analyze the data. The "Discussion" section discusses the social context in which the individual decisions were made and provides explanations on the public acceptance and WTP results in Hungary and why certain revenue-recycling mechanisms were preferred. In this section, secondary analysis of related official statistics is combined with documentary analysis of relevant materials. Finally, conclusions and policy implications are offered in the "Conclusion" section.

Methods

The majority of the data used in this analysis is from a national survey involving Hungarian adults. The main objective of the survey was to gather essential information to measure and understand public attitudes toward climate change in Hungary. The survey consists of 42 questions, of which three address public support and WTP for carbon pricing and various revenue-recycling measures. In total, 7000 adults were interviewed in person in their home during the data collection period between June 10 and August 1, 2022. The data analysis is based on a sample of 3013 respondents, which was derived from the baseline sample of 7000 respondents in such a way as to be representative of sex, age, place of residence and level of education (so no weights were needed to correct for over- or under-representation).

As a first step, respondents were provided with a brief description of what a carbon tax is and its likely effects in order to familiarize them with this policy and reduce the number of respondents who might answer "do not know" because they lacked information. Following the description, respondents were simply asked to select from the categories listed how much they would be willing to pay for a carbon tax ("initial WTP"). Then respondents were presented with five revenue-recycling measures and those who initially refused to pay or provided a "do not know" answer were asked if they would be willing to accept the carbon tax in light of the new measures and how much they would be willing to pay in each case, while those who were willing to pay initially were asked if they would be willing to pay more and, if so, how much.

The five revenue-recycling measures are as follows. First, the option to reduce existing labor and corporate taxes is presented, which can offset the individual costs of the policy (the so-called tax-neutrality approach). The second option is financing environmental projects from the revenue, such as energy efficiency programs and public transport development, which can change the perception of the policy effectiveness. The third mechanism supports low-income households to deliver more equitable outcomes, which also supports the perception that the policy is fair. The last two options concern spending on public education and health care (two highly regarded and popular social objectives) or on reducing public debt. For a discussion on the relationship between increased acceptability and tax neutrality, elimination of regressivity and ecological spending, see Carattini et al. [3]; for the relationship between increased acceptability and spending on social objectives, presented through case studies such as the Ghanaian education reform, see World Bank [47].

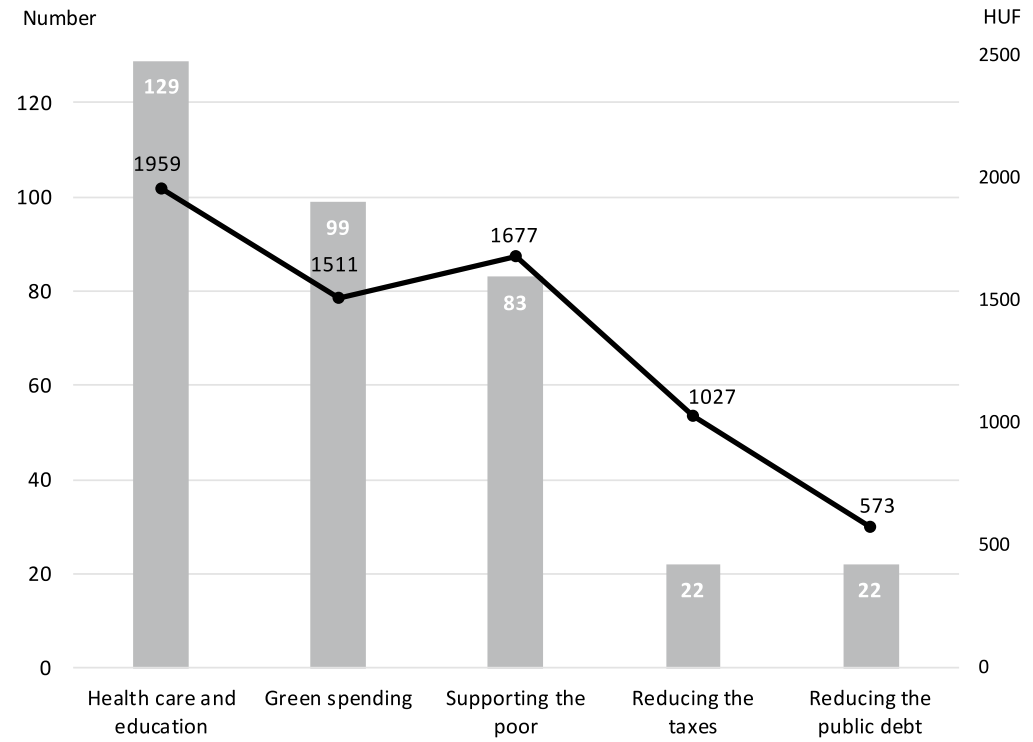
In the results section of the article, quantitative research methods—descriptive statistics, binary logistic regression (logit) models and association analysis—are used to analyze the data along eight steps. First, descriptive statistics are provided to show the initial WTP for a carbon tax. Second, the first logit model analyzes the "initial acceptance" as the outcome variable. To explain the outcome variable, explanatory variables describing the respondents' sociodemographic situation and awareness of energy consumption are included. These variables are dummy variables except for age, which is a continuous variable. (The dummy variables are coded as 0s and 1s.) As the dependent variable is also a binary variable ("support" or "oppose"), we apply binary logistic regression (Columns A of Table 1). Third, based on cross-tables, association analyses are implemented to learn which variables influence the amount of a carbon tax that respondents with initial WTP would be willing to pay (Table S1 in Additional file 2). Fourth, with the help of descriptive statistics, for each of the five cases the paper investigates the number of respondents who initially refused a carbon tax or responded "do not know" and later expressed willingness to pay, along with the amount they would pay (Part A of Fig. 1). Fifth, to find out to what extent the multitude of the respondents who are open to changing their minds in the case of a redistribution differs from those who show initial acceptance, association analysis is performed between these two groups (Table S2 in Additional file 2). Sixth, it is important to see how the redistribution changes the public acceptance of a carbon tax. For this reason, the previous logit model is repeated, but this time, value 1 in the output refers to all respondents who are open to paying for a carbon tax without or only with specific redistributions mechanisms in place ("extended acceptance") (Columns B of Table 1). Seventh, relying on the two logit models, we calculate the odds of the initial and extended acceptance among the social groups that are most open and most reluctant to accept a carbon tax (Fig. 2). Lastly, eighth, the descriptive statistics show the number of those accepting a carbon tax even without a revenue-recycling mechanism that would pay more in each of the cases and by how much (Part B of Fig. 1).

Finally, in the discussion section, a secondary analysis is completed using related quantitative data: official statistics from Eurostat, the Hungarian Central Statistical Office and the Odyssee-Mure project. This is supplemented with further input drawn from the documentary analysis of relevant materials, i.e., government policy documents, research reports, academic articles, newspaper accounts and government websites.

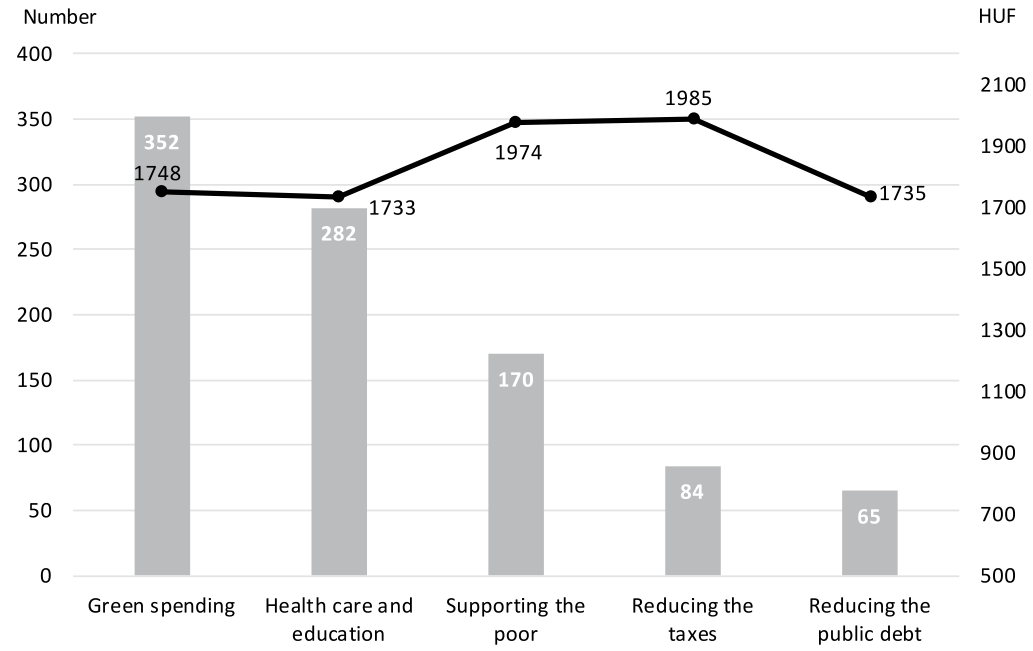
Results

The survey's results show that 70.7% of respondents (2130 out of 3013) objected outright to paying a carbon tax, while 9.0% (272 people) provided a "do not know" response. Overall, 20.3% of respondents (611 people) revealed their WTP, with 13.3% (401 people) of all respondents saying they would pay 1000 Hungarian Forints (HUF) monthly (USD 2.50), 5.3% (159 people) would pay HUF 3000 (USD 7.50), 1.4% (43 people) would pay HUF 6000 (USD 15), and 0.2% (8 people) would pay HUF 12,000 (USD 30). USD figures are calculated using the approximate exchange rate of USD 1 to HUF 400 at the time of data collection, mostly in July 2022. Net median earnings including tax benefits were HUF 279,400 (USD 698.50) in Hungary in July 2022 [48]. In nominal terms, the Hungarian WTP numbers are significantly lower than those recently found in the Western world, such as in Italy (e.g., [28]), but similar to some earlier findings in Western countries, such as Germany (e.g., [49]) and the United States (e.g., [20]). However, the comparability of these amounts is very limited, as they have different purchasing power or real values at different times and in different countries.

Columns A of Table 1 convey the main correlations between initial acceptance and other factors. Respondents living in the capital city of Budapest, in cities classified as county seats or in other cities with county rights (see the first asterisked note to Table 1 for explanations) are more open to accept a carbon tax. The results also show that the initial acceptance is significantly higher among those who completed a grammar/vocational grammar school or have a college/university degree. It does not differ significantly among those who trained in a vocational school, compared to the reference group, which consists of those who only have an eighth-grade



A) Those who initially refused a carbon tax or responded "do not know"



B) Those who accept a carbon tax even without a redistribution mechanism

Fig. 1 WTP for redistribution among those who initially refused a carbon tax or responded "do not know" and those who accept a carbon tax even without a redistribution mechanism (number of supporters and mean WTP value in HUF). Number of respondents: 3013. Source: Own editing based on the survey results

Table 1 Logit model outcome on the initial and extended public acceptance of a carbon tax

	(A) Initial acceptance			(B) Extended acceptance		
	Odds ratio	**Standard error**	**P-value**	**Odds ratio**	**Standard error**	**P-value**
Age	0.996	0.003	0.171	0.995	0.003	0.052
Place of residence						
Other settlements (not Budapest or a city with county rights)[a]	0.672	0.080	0.001	0.620	0.108	0.000
Level of education (reference category: eight grades or less)						
Vocational school	1.078	0.173	0.639	1.212	0.140	0.168
Grammar school and vocational grammar school with or without a technician qualification	1.452	0.211	0.010	1.557	0.129	0.000
College or university diploma	1.895	0.304	0.000	2.084	0.145	0.000
Type of premises (reference category: other type of residential premises—not a prefabricated concrete apartment block or a single-family detached home)						
Prefabricated concrete apartment blocks	0.719	0.139	0.088	0.738	0.178	0.088
Single-family detached home	1.033	0.199	0.865	1.050	0.179	0.786
Awareness of energy consumption (reference category: not monitoring household electricity use)						
Monitoring household electricity use for environmental reasons	4.210	0.558	0.000	3.746	0.126	0.000
Monitoring household electricity use for cost-related reasons	1.261	0.143	0.040	1.285	0.099	0.012
Subjective financial situation[b] (reference category: living poorly)						
Living modestly	2.227	0.603	0.003	1.889	0.213	0.003
Living well	3.653	0.982	0.000	2.778	0.213	0.000
Sex (reference category: male)						
Female	1.046	0.102	0.646	1.011	0.088	0.901
Intercept	0.072	0.026	0.000	0.147	0.296	0.000
Model parameters (using Stata software)	Log likelihood = −1370.0473 Number of obs = 3013 LR Chi^2 (12) = 298.47 Prob > Chi^2 = 0.0000 Pseudo R^2 = 0.0982			Log likelihood = −1613.2082 Number of obs = 3013 LR Chi^2 (12) = 305.07 Prob > Chi^2 = 0.0000 Pseudo R^2 = 0.0864		

[a] Hungary is divided into 19 counties. Cities with county rights include 18 county seats and other seven important cities. The capital of Hungary, Budapest, has a special status, since it is a county seat but is not among the cities with county rights

[b] "Living well" refers to the answers "We live without financial problems" and "We make a good living on our monthly income if we budget our money". "Living modestly" corresponds to the response "Our income just covers our expenses". "Living poorly" combines the answers "We have financial problems from month to month" and "We live in a state of deprivation"

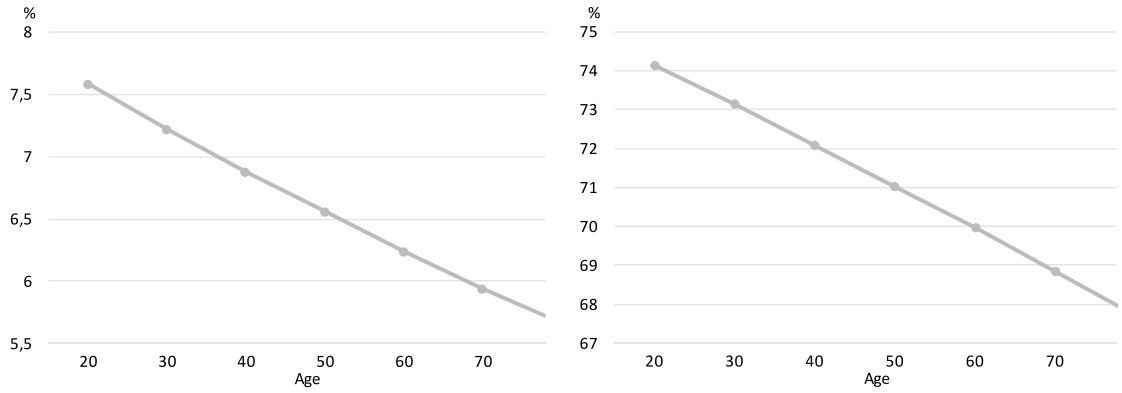
Significant variables are in italics

Source: Own editing based on the survey results

education or less. Those who monitor the electricity consumption of their households for cost-related or environmental reasons are significantly more willing to pay a carbon tax than those that do not. Not surprisingly, those "living well" or "modestly" are more willing to pay for a carbon tax than those "living poorly" (for explanations of these categories, see the second asterisked note to Table 1). Age, sex, and the type of premises where the respondent lives do not correlate with the acceptance of a carbon tax.

The amount of carbon tax that the 611 respondents would pay differs significantly based on educational level, subjective perception of their financial situation, awareness of energy consumption and the place of residence. In other words, these variables influence the amount they would allocate to the matter. In contrast, the sex of the respondents does not significantly influence the amount (Table S1 in Additional file 2).

Analyzing the effects of revenue recycling, the following observations can be made. The acceptance of a carbon tax changes based on what the tax is spent on. However, the total effect of revenue recycling on the decision is modest, since public acceptance increased by only 7% points, from 20.3% (611 people) to 27.3% (822 people). This increment is considerably lower than in Western countries. For instance, revenue-recycling mechanisms



A) The least receptive to a carbon tax B) The most receptive to a carbon tax

Fig. 2 Likelihood of extended public acceptance based on age among those social groups that are the least and most receptive to a carbon tax (%). Source: Own editing based on the survey results

increased support by 15% points in Switzerland [36] and Norway [50] and by 11% points in the Netherlands [51]. The first two of these are from earlier surveys, the last from more recent ones. (For more recent global results, see Dabla-Norris [51].) According to the 2016 European Social Survey, the Hungarian population is slightly more supportive of increasing taxes on fossil fuels than introducing a carbon tax. Around 30% are in favor of raising fossil fuel taxes in Hungary [10], placing the country in the middle of the European ranking, ahead of Belgium, for example. The other CEE countries are even less supportive (in Poland, which ranked in last place, with an acceptance rate half as high as in Hungary), but the country ranking is relatively mixed across regions.

Using carbon funds to reduce the labor or corporate tax result in only a 0.9% point increase in those supportive of the tax scheme, while the same change occurs if the income is spent on public debt. This finding is similar to that of other studies (e.g., [5, 52]). The revenue-recycling options of green spending and compensation for poor households fare better, since 4.1% and 3.5% of them, respectively, changed their minds and agreed to pay. One central finding is that the most effective revenue-recycling measure turned out to be spending on public health care and education. This convinced 5.4% of those who refused to support the measure and those that responded "do not know" initially to change their mind and support the tax. Based on the authors' knowledge, the latter finding is unique in the literature.

The weighted mean level of WTP for those who changed their opinion based on the redistribution measures in place is HUF 1625 (USD 4.10). Financing health care and education is the most popular revenue-recycling measure when considering the mean WTP value (HUF 1959 or USD 4.90), while support for the poor led to the second highest mean (HUF 1677 or USD 4.20) ahead of green spending (HUF 1511 or USD 3.80) (Part A of Fig. 1).

In terms of their education, residence, and sex, those who would be willing to support a carbon tax only if a known redistribution scheme were in place are similar to those that initially supported the tax, but the two groups differ from them in terms of their subjective financial situation and awareness of energy consumption. The share of those who live modestly is larger in the former group than those who live well. Furthermore, the share of those who monitor their household electricity consumption for environmental reasons is smaller within this group. The reason for this might be that most of the environmentally conscious respondents would be willing to pay for a carbon tax even without a specific redistribution mechanism in place. It also means that those who track their electricity use for cost-related reasons may be more affected by the redistribution than those who do so for environmental reasons. Besides these monetary and environmental drivers, this result might also be related to the respondent's subjective financial situation: the more one may receive through redistributive measures, the more one may be willing to pay for a carbon tax (Table S2 in Additional file 2).

When the logit model is repeated with the group that includes all supporters of the carbon tax with or without specific redistributions mechanisms in place ("extended acceptance") (Columns B of Table 1), the overall result does not substantially differ from the first set of results. One of the minor differences is that age becomes an almost significant explanatory variable, while it is not significant at all in the previous model.

Applying a significance level of 10% (instead of 5%), one can surmise that the younger a person is, the higher the probability of support. Another difference is that in the case of the extended group, tracking one's electricity consumption for financial reasons is a stronger explanatory variable.

Based on the two logit models, presented in Table 1, the odds of both initial and extended public acceptance can be calculated for certain social groups. The likelihood of initial public acceptance is the lowest (4.6%) among those who live in a village or a town (not a city with county rights or Budapest), have an eighth-grade education or less, live poorly, and do not monitor household electricity consumption. On the contrary, the likelihood of the initial acceptance is the highest (67.9%) among those who live in Budapest or a city with county rights, have a college or university degree, live well, and track household electricity use for environmental reasons. For extended public acceptance, the lowest and highest likelihoods are found among the same social groups, although the numbers are slightly different: 8.3% is the lowest and 76.1% the highest. Further examining the role of age separately is justified by the second logit model's results (Columns B of Table 1) that indicate a nearly 5% significance level for this continuous independent variable. Figure 2 shows the likelihood of extended public acceptance based on age among those social groups that are the least and most receptive to a carbon tax. The likelihood of acceptance declines with respondent age in both groups.

It is worthwhile carefully assessing the preferred revenue allocation among people who are receptive to a carbon tax and were initially willing to pay, as 451 out of the 611 initial carbon-tax supporters (73.8%) would pay more than initially committed if a revenue-recycling measure is in place. Green spending was their most favored form of resource allocation, with 57.6% of respondents willing to pay more than they initially committed to once this revenue-recycling option was introduced (11.7% of all respondents). This finding resonates with most studies in the literature (e.g., [3, 6]). The second most effective measure was improving public health care and education (46.2%), followed by compensating the poor (27.8%). Tax and public debt reduction were less preferred (13.7% and 10.6%, respectively) than other options.

The weighted mean level of WTP of those that were initially willing to support a carbon tax increased to HUF 1804 (USD 4.50) after they learnt how their taxes would be spent. In this group, the mean levels of WTP for the different revenue-recycling measures are very similar to each other, but they are a bit higher for those mechanisms which were chosen by fewer people, i.e., in the case of tax reduction (HUF 1985 or USD 5), support for low-income households (HUF 1974 or USD 4.90) and public debt reduction (HUF 1735 or USD 4.30) (Part B of Fig. 1).

Discussion

The low acceptance of and willingness to pay for a carbon tax in Hungary may be explained by both common CEE and Hungary-specific characteristics. The evidence presented in this section suggests that five factors are crucial in explaining public attitudes toward a carbon tax in Hungary. The first is a deficiency in the culture of environmentally conscious thinking and acting in Hungary despite public awareness of global climate change. The second links to the level of economic development and the state of the Hungarian economy at the time of the survey, which influence whether Hungarians can afford the extra expenditure. The third is the perception of Hungary's role in causing climate change. The fourth is the fact that Hungary has an individualistic society with low social capital and trust, facing issues linked to solidarity and corruption. Finally, the fifth is the government's policies, politics in general and narratives pertinent to energy prices.

Environmental protection, including climate action, is under-represented in the Hungarian political and civil space. Hungary does not have a strong green party or movement (a small green party, LMP, has been in the parliament since 2010), even though it will be severely affected by climate change [53]. Green policy does not have an established tradition or a significant representative voice, despite a handful of environment-related events playing an influential role historically. Such is the issue of the Gabčíkovo–Nagymaros Dam on the Danube River between Slovakia and Hungary, which became a symbol of regime change from socialist dictatorship to capitalist democracy in 1989. Hungarian government policy to combat climate challenges has been limited to the promotion of nuclear and solar energy, biomass heating, and e-vehicle battery manufacturing. Climate policy is more of an external constraint imposed by Hungary's EU membership as opposed to something the government pursues on ethical grounds or that is driven by domestic politics [54]. The broader public is nonetheless aware of environmental and climate issues. There has been a strong reaction to deforestation, the unjustified destruction of nature and environmentally harmful industrial projects. Although the vast majority of Hungarians consider climate change to be a serious problem and are concerned about it, they do not rank it among the most threatening socioeconomic issues. Specifically, in the survey, 86.4% of respondents perceives climate change to be a "rather serious" or "extremely serious" problem and 82.0% of respondents report that they are

"rather concerned" or "extremely concerned". In an effort to identify the highest threats, respondents were asked to select three out of 12 options. Health care (1414) and consumer-price inflation (1342) were the most frequently selected challenges, followed by poverty/hunger (1191), communicable diseases (1069) and armed conflicts (932). Climate change (740) came in sixth, lagging well behind the above. Few Hungarians (366) see education as a major problem, with unemployment (530) and migration (406) ranked as higher priority issues.

Climate-change denial and uncertainty—threats posed by misinformation and disinformation (e.g., through social networks)—could also work against the introduction of a carbon tax, but this survey suggests that the relatively low public acceptance of a carbon tax in Hungary cannot be explained by climate skepticism. Only 1.6% of respondents believe that human activity does not contribute to climate change, compared to more than 80% of respondents answering either "to a large extent" or "fully" (showing a highly asymmetric bell curve distribution). According to the 2016 European Social Survey, Hungary is in the middle of the pack in terms of climate-change denial and uncertainty. The survey attempted to measure climate-change disbelief through different questions from those used in the current study, and found that levels of denial are low, but uncertainty is quite strong in Hungary and across Europe [55].

A significant portion of Hungarians may feel they cannot afford to pay extra to support climate action. Hungary's GDP per capita expressed in purchasing power standard is still well below the EU average, despite growing from 66% of the EU average in 2010 to 75% by 2021 [56]. Standard indicators of employment/unemployment, income, consumption, poverty and consequently energy poverty were showing improvement in Hungary before the COVID-19 crisis hit, although social inequalities have increased since then. However, several such indicators still suggest that Hungary is worse off than most EU or even other Visegrád states (Czechia, Poland and Slovakia) [57]. Between 2022 and 2023, the Hungarian population faced massive consumer-price inflation, which may be an important factor in explaining survey responses. Inflation began to rise in 2021 and accelerated year-on-year to 11.7% in June 2022 and 13.7% in July 2022 [58], which overlaps with the survey period (June 10 to August 1, 2022). Food prices saw a surge of 22.1% and 27.0% during these periods, which had an especially strong effect on households' ability to consume and plan additional expenditures. In the survey, 1.0% of respondents reported that they lived in material deprivation, 6.8% were struggling financially each month, and 38.3% said that their income barely covered their monthly expenses. Only 6.8% of respondents said that they lived without financial problems, and this group was willing to pay for a carbon tax. Other questions included in the survey also confirm that material considerations prevail over environmental concerns in the Hungarian society. For example, 37.9% reported that the main consideration when deciding to purchase a new refrigerator was price, 29.9% said the energy consumption of the product to save on operational costs, and only 18.3% were driven by energy consumption for environmental reasons. Therefore, helping the most vulnerable during the climate transition will be essential to protect them from potential adverse impacts and to avoid an escalation of public discontent. This is an explicit policy objective at the EU level, which was embodied in the tangible policy package of the Social Climate Fund within the framework of the EU ETS 2 [59].

Individuals in the CEE region may not think that they should be responsible for paying for climate action, since the problem was largely caused by wealthier nations and multinational companies. This sentiment is supported by the fact that 50.9% and 49.4% of respondents identified the European Union and economic actors, respectively, as having "key" responsibility in the fight against climate change, compared to only 35.1% in the case of individuals. For this question, the responsibility of each actor was asked. On a four-point Likert scale, the category marked "key" referred to the highest responsibility.

It is important to note that Hungary is among the most individualistic societies in the world. However, compared to, for example, the individualistic society of the Netherlands, Hungary has low social capital, i.e., there are fundamental issues linked to social trust, reciprocity, caring for others and compliance with rules and corruption [60]. Trust also defines the link between climate concern and a sense of individual responsibility. Countries with high levels of trust have a higher sense of personal responsibility, while low-trust countries tend to have a lower sense of personal responsibility. Trust plays an important role in whether climate concerns translate into individual action [61]. Klenert et al. [4], Ewald et al. [62] and Khan and Johansson [63] show that trust in institutions and politicians is a strong predictor of climate policy and particularly of carbon pricing acceptance and stringency. Since the perceived level of corruption in Hungary is the highest in the EU [64], people may be reluctant to make financial sacrifices to mitigate climate change because they do not trust the government to handle revenue responsibly.

The Orbán governments, holding a constitutional majority since 2010, have a crucial influence on narratives in public discourse. Carbon pricing is framed as a threat to levels of economic well-being and economic competitiveness. The government tends to underscore that it is the responsibility of other countries and big

polluting companies to pay these costs. Since 2010, perhaps the most persistent narrative has emphasized the price reductions of residential energy prices (the so-called "utility cost reduction"), as a part of which regulated energy prices were decreased by a quarter in 2013–2014. Regulated prices play an important role in residential heating, constituting the largest item in residential energy expenditure. The utility cost reduction program reduced the ratio of energy expenditure to total household expenditure, which was much higher in the Visegrád countries than in Western Europe or compared to the EU average [57]. Maintaining utility cost reductions was heavily emphasized by the government in 2021 and 2022, when energy prices soared. The government was ultimately forced to increase prices above certain levels of consumption on July 13, 2022, as subsidizing the state-owned energy group MVM put an unsustainable strain on the budget. This change was announced during the data collection period of the survey, but it is likely to have had only a marginal effect on the results as just a fraction of all interviews took place after the announcement (38 on July 13 and 105 after July 13).

In accordance with the above, the Hungarian government opposes EU initiatives that could result in higher energy prices for household consumers. It initially opposed the 2050 carbon-neutrality target, a Carbon Border Adjustment Mechanism (CBAM) on carbon-intensive products (cement, aluminum, fertilizers, electricity, iron and steel) and carbon pricing for buildings and transport, before finally agreeing to these. Hungarian politicians suggest that big polluting companies, and not Hungarian families, should pay the costs of climate protection [65]. They are concerned that the EU is deliberately raising prices by imposing these carbon taxes [66]. However, it is unclear how much this campaign contributed to the high level of opposition to the hypothetical carbon tax. Similarly, there is uncertainty about the impact—either negative or positive—of the war in Ukraine on public support for climate policy, but the growing importance of security considerations for sustainable development is recognized [67].

A novel finding of this research is the willingness of respondents to support a carbon tax if the revenue is recycled into health care and education-related causes; these expenditures rank among the most important causes for those who accept a carbon tax even without a revenue-recycling mechanism. These findings are not particularly surprising given the weak state of public education and health services in Hungary, and because 2022 brought discussions on the future of both, including a wave of strikes in schools, as schoolteachers' salaries in Hungary were among the lowest in Europe [68]. Of the two categories, however, health care was in all likelihood the more attractive option, because survey respondents saw this as the most pressing issue, while the state of education was chosen by substantially fewer respondents. The 2022 research of the Hungarian think tank Policy Solutions led to similar findings in these two areas [69].

Insulating buildings and the development of public transport, the two examples of green spending presented in the survey, have also gained popularity in revenue recycling. It is reasonable to assume that insulating buildings may have played a particularly important role in these decisions because the energy efficiency of the country's housing stock is poor in an EU comparison [70]. But as the survey was largely carried out before the government overhauled the utility cost program, higher energy prices have not played a role in selecting green spending. Buildings were responsible for 45% of final energy consumption in 2018 and 23% of carbon-dioxide emissions from fuel combustion. According to an estimate, retrofitting all residential and public buildings would save 16% of total final energy consumption [71]. Another source calculates that retrofitting existing buildings can reduce emissions by more than 60% in the building sector [72].

Survey respondents consider poverty/hunger to be the third highest threat (after health care issues and inflation) that those in Hungary face, but the option of providing support for the poor is ranked only third among those that are willing to pay a carbon tax with or without knowledge about recycling mechanisms in place. This stands in contrast to international surveys where respondents would typically direct revenues to lower-income households and environmental initiatives. This is not only a combined result of the positive socioeconomic trends of the mid- and late 2010s, the COVID-19 pandemic and the inflation crisis that became evident in 2022. Public attitudes toward the poor is an important consideration, as Hungarian society would prefer to deprive both the rich of their incomes and the poor of state benefits [73]. Hungary is also among the EU countries that spend the least on social protection as a percentage of GDP (16.3% in 2019). It has one of the lowest ratios of unemployment benefits to total social protection benefits expenditure (1.9% in 2019), while the duration of unemployment benefit is the shortest in the EU at a maximum of three months—something the government considers a part of the "work-based economy".

Need-based social redistribution may be lacking, but the government has conveyed itself as "family-friendly". The share of family benefits as a portion of total social protection benefits expenditure is among the higher rates in the EU at 11.3% in 2019 [74]. Social transfers are not distributed in proportion to need, since they are significantly higher for households with

a higher income. The child benefit system favors families with a secure, predictable income and provides less for those in need [75]. Similarly, social justice issues are encoded in the utility cost reduction program, which subsidized energy irrespective of demand until 2022 and without taking income into consideration. Among initial supporters of a carbon tax, relatively high WTP values are found for the support for low-income households, as well. These respondents may include socially minded people with high incomes for whom redistribution is important.

Finally, reducing taxes and public debt were the options least likely to instigate carbon-tax acceptance among the survey respondents, which is consistent with previous research. At the end of 2021, Hungary's government debt-to-GDP ratio stood at 76.8%, the second highest among EU members in the CEE region [76], but it is not surprising that the respondents did not favor public debt reduction, as it does not have a tangible positive effect on individuals.

Reducing the tax burden would have been a more straightforward choice, given that the respondents reported inflation and poverty/hunger to be among the top three problems. The 2022 Policy Solutions survey cited above also supports this by identifying high living costs and low wages as the most important problems in the country [69] (In that survey, health care was lower on the list of problems than in the survey reported on here). The tax wedge on labor costs was 43.2% in Hungary in 2021, one of the highest in the EU, and Hungary's value-added tax is also the highest in the EU at 27%. Therefore, the low flat-rate income tax of 15% and tax relief to families with children do not show the entire picture on the fairness of redistribution. Similarly, Hungary boasts the lowest corporate income tax in the EU (9%), but other taxes (local business tax, various special taxes, etc.) are also imposed on businesses. At the same time as a part of redesigning the utility cost reduction program, the government generally increased taxes for small businesses. But, with a few exceptions, the survey was carried out before the announcement of these decisions. Among the initial supporters of a carbon tax, the mean WTP value for tax reductions is as high as for the poor, which may be because economic competitiveness is presumably an important consideration for these respondents.

Overall, the results of the survey point to the need for measures that combine socioeconomic and environmental policy considerations. These measures would be in line with the recommendation of Filipović et al. [77], who argue that a greater infusion of social considerations into climate policy development is necessary to move forward both with the objectives of the United Nations' Sustainable Development Goals of 2015 and the EU's Green Deal of 2019.

Conclusions

This paper shows that there is low acceptance of a carbon tax in Hungary, which could be increased by revenue-recycle mechanisms but not to a significant extent. This is also true for WTP values. All of these absolute and relative numbers are lower than those found in Western surveys. However, these low acceptance rates may also reflect that the present survey focused on a tax that is specifically related to households, as suggested by the comparison with the results of the 2016 European Social Survey.

The challenge the Hungarian government faces is to convince the people to support a carbon tax given the general need and push to take climate action. The results of this research can help with this task. Among the results, the most notable is the unexpected popularity of public health care and education in revenue recycling. In line with the expectations informed by research findings in Western countries, green spending performed relatively well among respondents. Meanwhile, supporting the poor—also popular in Western surveys—fared less well, although with relatively high WTP values. The current results highlight the importance of carefully assessing the distributional impact of implementing carbon pricing mechanisms and thoroughly integrating social considerations into climate policy.

Building on these results, the Hungarian government can decide what to focus on. The findings of this paper suggest that those who would support a carbon tax with the knowledge of how it would be recycled are those that would be worth targeting with revenue-recycling options. Specifically, such a target group would be those who monitor household electricity consumption for economic reasons. Since this group is environmentally more conscious, as demonstrated by the survey results, but their financial capacities are limited, a promising political strategy to earn their support would be a revenue recycling measure that combines compensation and green spending. An example for such a program would be providing grants for lower-income households for the installation of rooftop solar panels or the insulation of homes. This would have positive environmental and financial effects because households' energy expenditure would decline.

The government should seek to dampen the negative impact a tax would have on consumer goods and provide support for those in need. Hungarian households tend to be sensitive to price changes and may thus react dismissively to any interventions that drive the prices for energy

up and thus the prices of basic commodities. A solution could be to introduce a relatively low carbon tax and ramp it up gradually to avoid price shocks and any drop in living standards that this may induce. Social cushioning—through a comprehensive compensation package that supports different groups who are vulnerable to detrimental distributional impacts—also appears crucial for keeping negative social effects at bay. For example, lump-sum transfers to vulnerable households would not only make the distributional impact of carbon pricing progressive, but it can improve the perception of fairness and thus provide higher support for such a policy. Alternately, reducing existing taxes on energy in parallel to implementing carbon pricing would not change prices considerably but could incentivize lower fossil-fuel usage, hence reducing carbon pollution. By applying this revenue-neutral strategy, the government would prevent citizens from considering carbon pricing as a backdoor mechanism to raise revenue. Crucially, the funds earmarked for Hungary from the EU's Social Climate Fund for the period between 2026 and 2032 will not only be able to mitigate the negative effects of carbon pricing but will also have the potential to positively influence the public acceptance of the ETS 2. The design of the projects will be the responsibility of the EU member states and it is crucial that the above two priorities be met through the efficient use of resources. Therefore, the research community should carry out surveys and analyses along these lines in the coming years.

A further recommendation concerns the legal earmarking of carbon-tax revenues. The implementation of legal earmarking could mitigate the general distrust in the government's responsible use of carbon funds, a problem which is accentuated in the CEE region due to the high perception of corruption. The findings of this paper demonstrate that a combination of using these funds on climate action and social projects that are in obvious need of funding and service-quality enhancement might be a good way to increase political acceptability. Specifically, a large-scale energy efficiency program—partly financed by carbon revenue—would enormously benefit the state, households and private companies in Hungary. Such a program would decrease fossil-fuel consumption significantly, increasing productivity, reducing energy import dependence, allowing households to save money, and would also support new jobs. This could be paired with financing wage increases for school teachers and/or developing the health care system, which can also be a socially and politically appealing way to spend revenue.

Finally, the impact of educating the public about climate change (e.g., how present experiences such as droughts or the disappearance of snow relate to climate change), the co-benefits of climate policy (e.g., cleaner air) as well as the effectiveness and key design elements of carbon pricing (e.g., revenue use) cannot be stressed enough. Raising social awareness is essential to facilitate environmentally friendly behavior, especially in CEE countries where climate change is currently of less concern compared to their West European counterparts. In this respect, Hungary is in a controversial position, because the government does not support carbon pricing. External EU pressure is a possible narrative through which the government can legitimize the carbon-tax-induced higher costs, but maintaining this narrative would not be useful, since it undermines the social legitimacy of taking climate action.

This research could encourage other CEE countries to undertake similar assessments, which are essential to tailor climate policies to local social, political and economic conditions. Replication of the study in other CEE countries would reveal whether the trends identified in this research are generally true of the region. The literature would also benefit from widening the scope of such analyses to include EU accession countries, thus carrying out similar research in the Western Balkans region, as the structural conditions—such as the underdeveloped institutional environment, the likely negative impact of the CBAM on the competitiveness of industries in the EU market and the limited EU funds—make the energy transition even more economically and politically challenging than in the EU-member CEE region. The results of this type of research provide essential information not only for domestic policymakers about public attitudes to climate policy, but also for the EU on how to design these policies to make them both environmentally effective and socially tolerable in Central and East European countries.

Abbreviations

CEE	Central and Eastern Europe
ETS	Emissions-trading systems
EU	European Union
EU ETS	EU Emissions Trading System
EU ETS2	EU Emissions Trading System 2
WTP	Willingness to pay

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13705-024-00463-2.

Additional file 1: Survey questions about a carbon tax.

Additional file 2: Supplementary tables: Table S1. Association between the initial WTP and the level of education, subjective financial situation, energy consumption awareness, place of residence, and sex. Table S2. Association between the acceptance of a carbon tax and the level of education, subjective financial situation, energy consumption awareness, place of residence, and sex.

Acknowledgements
First of all, the authors wish to acknowledge András Deák and two anonymous reviewers for helpful comments on this paper. Special thanks also go to Florian Weiler, Ákos Bodor, Viktor Varjú, Ádám Páthy and Bálint Koós for their suggestions. The first version of the article was proofread by John Szabo, Institute of World Economics, HUN-REN Centre for Economic and Regional Studies, Hungary. The proofreading of the final version was done by Robin Lee Nagano, University of Miskolc, Hungary.

Author contributions
DM conceptualized the research idea, determined the research method and design used in this study, and managed the data curation. CW contributed to the visualization of data into tables and figures, edited and supervised the manuscript, and managed the submission and resubmission process. CL processed and interpreted the data gathered, and also contributed to the visualization of data. All authors were involved in the formal analysis of data and in the writing and reviewing of the original draft—DM conducted the Literature review, CW wrote the Discussion, while other parts of the paper were prepared by all authors. All of them read and approved the final manuscript.

Funding
Open access funding provided by HUN-REN Centre for Economic and Regional Studies. This research project entitled "The potential for climate adaptation in Hungary" was supported by the HUN-REN Hungarian Research Network, Hungary.

Availability of data and materials
The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Received: 11 January 2024 Accepted: 29 May 2024
Published online: 06 June 2024

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