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Is the problem or the solution riskier? Predictors of carbon tax policy support

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Abstract

Climate change is posing significant threats to human societies and developmental prospects. Governments continue to design and propose comprehensive climate policies aimed at tackling the climate crisis but often fail to successfully implement them. One reason is that securing public support for such policy instruments has proven to be challenging. While public opinion research has often documented a positive correlation between beliefs in climate change and policy support, it has also become clear that the presence of such beliefs is in many situations not enough for policy support. This is the starting point of our study in which we delve deeper into the link between climate change beliefs and policy support by specifically integrating risk perceptions related to climate change but also related to policy solutions. Empirically, we leverage survey data from the United States and Switzerland and employ the random forest technique to further explore the mechanisms that link climate change beliefs, risk perceptions, and policy support. We use the case of carbon taxation, which is considered a particularly effective instrument by ecological economists but seems to be particularly unpopular politically. The results of this study suggest that beliefs and risk perceptions are very important predictors of support for carbon tax policies. Furthermore, they unveil the strongest predictors and specific patterns that generate the highest support in the United States and Switzerland.

Introduction

Climate change is a serious and persistent threat to human civilizations and the global economy over the long run (Lee *et al* 2015, Swiss Re Institute 2021). The recent decades of the escalating climate crisis have failed to produce the essential transformative policy adjustments needed to keep the crisis under control (Crawley *et al* 2020, Rossa-Roccor *et al* 2021). In 2015, at the Paris Climate Meeting, government representatives of 196 parties pledged to keep global warming below 2 °C, 'preferably to 1.5 °C' above pre-industrial levels (UNFCCC 2015). Though, considering the existing mitigation measures of most countries, it is highly likely that global warming will exceed 1.5 °C (Roelfsema *et al* 2020, Bumann 2021). We now observe an urgency for government action as the delays in dealing with this serious issue entail significant future consequences.

Carbon pricing is one of the instruments that has dominated the political debates on climate change in recent decades, and which has proven to be a better performer than emissions trading schemes (ETSs) (Green 2021). While ecological economists consider carbon taxes 'a key instrument [...] to achieve future de-carbonization targets' (EAERE 2019, p.1), these instruments are among the ones for which the lack of public backing has shown to be a crucial barrier to their implementation (Harrison 2010, Williams III 2016, Rhodes *et al* 2017, Lachapelle and Kiss 2019, Dermont and Stadelmann-Steffen 2020, Levi 2021). In fact, climate policy instruments usually require public support to be implemented, either and most obviously because in some contexts citizens can vote on them (Stadelmann-Steffen and Dermont 2018, Carattini *et al* 2019, Stadelmann-

Steffen and Thalmann 2021), but also because politicians who need to win elections are not likely to implement unpopular instruments (Harrison 2012, Lachapelle and Kiss 2019).

It has been constantly shown that strong climate change beliefs are related to higher climate policy support (Stoutenborough *et al* 2014, Ziegler 2017, Leiserowitz 2019). However, at the same time, climate change concerns and beliefs do not always mean policy support, but more typically there is a gap between environmental attitudes and individual willingness to accept concrete policy measures (Blake 1999, Dermont *et al* 2017). This is the starting point of our study, in which we delve deeper into the link between climate change beliefs and policy support by specifically focusing on three critical dimensions: beliefs, risk perceptions, and policy support (Crawley *et al* 2020, 2022). Recent evidence suggests that, at an individual level, the three dimensions of climate opinion often intersect with one another. Therefore, it raises the question of how climate policy support may be influenced by interactive mechanisms related to beliefs and risk perceptions (Crawley *et al* 2020). To the best of our knowledge, to date, there are a handful of studies that concretely assesses this intersection. Goldberg *et al* (2020) confirm that climate beliefs and risk perceptions are important predictors of climate policy support, using survey data for the United States. In accordance with this study, we assume a predictive approach and argue that by exploring the predictive patterns behind policy support, we can gain new insights into how climate change mitigation shall be approached in the public debate.

However, we go beyond existing research by considering not only beliefs and risk perceptions related to the problem, namely climate change, but also risk perceptions related to the policy instruments. In so doing, this study aims at contributing to the existing theoretical and empirical findings in three specific steps. First, theoretically, we argue that in order to better understand the predictive patterns between climate change beliefs and policy support, we not only need to consider beliefs and risk perceptions related to the problem, i.e., climate change, but also need to integrate risk perceptions related to potential solutions, e.g., negative effects on the economy or energy security. If individuals evaluate the latter as riskier than the risks directly related to climate change, they might oppose climate change policy despite high levels of climate change beliefs and strong risk perceptions. Second, empirically, we use a unique climate opinion survey dataset for the United States and Switzerland capturing carbon tax policy support, risk perceptions, beliefs, and socio-demographic indicators, and construct a policy support index for carbon taxation based on a conjoint analysis, which includes and therefore controls for varying policy designs. This should enable us to investigate rather general predictive patterns, considering the multidimensional nature of carbon tax policies (Dermont and Stadelmann-Steffen 2018). Predictive patterns of policy support are likely to differ between nations (Taylor *et al* 2014); hence, our two-country data may offer more detailed insights on this matter and the rationale behind such variations. Third, we use a mix of methods such as OLS regressions and random forest technique, to produce novel insights on the predictive patterns behind policy support.

Predictors of climate policy support

Changes in an individual's behavior are important in reducing carbon dioxide emissions, though, they are far from sufficient. Bold government actions –for example, climate policies– are required to achieve a large-scale impact on emissions reduction. Climate policy formulation and design process might be smooth, but the policy adaptation most of the time requires citizens' approval (Bumann 2021). According to the existing literature, public opinion plays a crucial role in shaping support for public policy, particularly climate policy (Agnone 2007, McCright *et al* 2013, Goldberg *et al* 2020, Stadelmann-Steffen and Eder 2020). In this vein, a series of individual-level factors that directly or indirectly influence climate policy support are identified. Among the most notable ones are climate change beliefs, risk perceptions, socio-demographics, socio-psychological, and party identification (O'connor *et al* 1999, Smith and Leiserowitz 2014, Elgin 2014, Lee *et al* 2015, Drews and Van den Bergh 2016, Knight 2016, Crawley *et al* 2020, Bumann 2021). Studies such as Drews and Van den Bergh (2016) propose a more structured categorization of the factors that influence climate policy support: (1) 'social-psychological factors and climate change perception; (2) the perception of climate policy and its design; and (3) contextual factors'[2] (p.855). In addition to the categorization of major factors, another branch of the literature has also expanded significantly on the climate policy design aspect, which indeed helps to sharpen our theoretical and methodological rationale (Amdur *et al* 2014, Baranzini and Carattini 2017, Rhodes *et al* 2017, Klenert *et al* 2018, Stadelmann-Steffen and Dermont 2018, Beiser-McGrath and Bernauer 2019, Jagers *et al* 2019, Dermont and Stadelmann-Steffen 2020, Dolšak *et al* 2020, Nowlin *et al* 2020). Lastly, Egan and Mullin

[2] (1)'…the positive influences of left-wing political orientation, egalitarian worldviews, environmental and self-transcendent values, climate change knowledge, risk perception, or emotions like interest and hope; (2) the preference of pull over push measures, the positive role of perceived policy effectiveness, the level of policy costs, as well as the positive effect of perceived policy fairness and the recycling of potential policy revenues; (3) the positive influence of social trust, norms and participation, wider economic, political and geographical aspects, or the different effects of specific media events and communications.' (p. 855).

(2017) worked on a study that reviews the results and polling data of Americans' attitudes on climate change over the long term. They find that aggregate opinion is rather stable in this and other issues in contemporary United States politics, mainly driven by partisan and ideological polarization. However, they suggest that 'features of the climate change problem elicit some distinctive determinants of opinion, including individuals' trust in science, risk processing, and personal experience' (p.209).

Considering this claim, we concentrate on climate change beliefs and risk perceptions in the following. Previous research has repeatedly emphasized the relevance of *climate change beliefs* and defined them as the 'Beliefs about timing, human cause, seriousness and threat of climate change…' (McCright *et al* 2013, Perera *et al* 2022, p.2). However, beliefs are often subject to complexities, as the narrative of climate skepticism[3] has been particularly impactful in building social movements of denial and challenge to the community of scientists (Rensburg 2015, Lejano and Nero 2020). More recent studies emphasize that 'just believing' that climate change is happening may not be a strong predictor of an individual's willingness to accept and pay for mitigation measures (Dermont *et al* 2017, Crawley *et al* 2020). Therefore, an individual's belief that climate change is a problem does not necessarily ensure the support for various climate policy measures. If the climate change issue is not prioritized by the government, individual support for explicit measures may still be limited (Stadelmann-Steffen and Thalmann 2021). Hence, this suggests that whether climate change beliefs are translated into the willingness to act hinges on the issue's risk perception. This is corroborated by findings by Bromley-Trujillo and Poe (2020) who show that climate policy adoption is influenced by public risk perception.

The concept of risk is defined by Beck (1992) as 'a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself' (p.21). It is argued that today's risks are a result of modernization and globalization. They are closely linked with the concept of reflexive modernization, which questions the political and economic management of risks in the contemporary area (ibid). In addition, and more specifically, the perception of such risks is defined as the 'subjective judgment of the probability and severity of current or future harm associated with climate change' (Wang *et al* 2021, p.2). Relevant climate policies are more likely to be supported and adopted in the places where climate change is perceived as a problem and where the attention on environmental issues is high. A key condition for climate change to be considered an important issue is the perception that global warming involves some dangers and risks. As risk perceptions have important power for predicting behavioral intentions (O'Connor *et al* 1999), it is likely to assume that individuals who strongly perceive the risks related to climate change are also more willing to support mitigation measures.

Based on the extant literature, we thus expect that both climate change beliefs as well as the perception that global warming involves negative consequences are positively related to individual support for mitigation measures (Bromley-Trujillo and Poe 2020). In this study, we focus specifically on examining the explanatory—and most importantly—predictive power of the two climate opinion dimensions, *beliefs and risk perceptions* (problem salience), on influencing climate policy support. Propositions that climate change beliefs and risk perceptions are important predictors of public climate policy support become more relevant with recent findings among United States voters (Goldberg *et al* 2020), where it was argued that prior research has identified some important climate policy support predictors, though, recent work needs to focus more on unveiling the strongest predictors in specific countries (ibid). Hence, we intend to address this specific gap in the literature by including in our analysis the United States and Switzerland.

Furthermore, we argue that the previous literature has neglected another aspect of climate change-related risk perception, namely the *risks related to climate change mitigation measures*. Recently, a growing literature has investigated public support for such measures, especially for carbon taxation policies (e.g., Harrison 2010, Rhodes *et al* 2017, Lachapelle and Kiss 2019, Dermont and Stadelmann-Steffen 2020, Levi 2021). While these studies have focused on the role of policy design, the related discussion documents that policies to mitigate climate change are often characterized by visible and short-term costs, while their benefit—namely successful climate change mitigation—is uncertain and only materializes in the future (Stadelmann-Steffen and Dermont 2018). Hence, from the perspective of individuals, such measures involve risks related to higher economic costs (e.g., for energy prices) and uncertainty (e.g., concerning energy security). Thus, if individuals evaluate policies, i.e., decide on whether they want to support them or not, they may not only consider climate change as risky but also the solution, i.e., the mitigation measures (e.g., negative effects on the economy or energy security). We, therefore, suggest that to understand individual policy support, we also need to include this type of risk perception. Consequently, we contend that individual support is a function of climate change beliefs, risk perceptions of the problem, and risk perceptions related to mitigation measures.

[3] Climate change scepticism is a discourse that refers to a group of arguments and individuals that reject or question the orthodox view of climate issue (Rensburg, 2015).

Data and methods

In this study, we used novel climate opinion data from the United States and Switzerland to determine how individual beliefs and risk perceptions interact and influence the individual's climate policy support. The survey was conducted in both countries in December 2019 and has 1094 (United States) and 968 (Switzerland) final respondents. The rationale for comparing these two countries is straightforward. Both the United States and Switzerland, as two federalist states, are characterized by modern direct democracy that shapes political life, with citizen participation as a central element of their democracies.

Dependent variable

As a dependent variable, we used carbon tax policy support, which is one of the most intensively discussed policy instruments in this context. Policy support is not easy to measure in a survey context. In particular, single-item questions often fail to capture the multidimensionality of these policies and are moreover prone to a social desirability bias (Stadelmann-Steffen and Dermont 2018). The policy acceptance research has therefore seen the increasing popularity of factorial survey designs, especially conjoint analysis, which has been shown to at least partially solve the aforementioned problems (Hainmueller *et al* 2014). Hence, in this study, we used individual responses from a conjoint analysis, in which respondents had to rate four paired policy packages on a scale of 0 to 10. Those packages contain randomly generated measures including various carbon tax policy designs based on the net costs to households, what is taxed, how tax revenues should be used, and possible exemptions for energy-intensive companies. As we are not interested in policy design but in the individual propensity to support this type of policy, our dependent variable reflects the average rating of an individual for the eight policy packages. This policy support index broadly displays the level of readiness and willingness of individuals to support carbon tax policy packages targeted at resolving the climate change challenge, regardless of tax policy micro arrangements or designs.

Independent variables

Table 1 displays the eight independent variables that represent climate opinion dimensions of *beliefs* and *risk perceptions*. We do this variable classification by heavily relying on a similar approach implemented by 'Yale Climate Opinion Maps 2021' (Marlon *et al* 2022). *Beliefs* are related to whether or not a respondent thinks climate change is a problem. *Risk perceptions,* by contrast, capture perceived risks related to climate change but also potential risks related to specific measures. It is essential to note that risk perceptions do not necessarily need to involve potential negative effects, i.e., classical 'risks' but can also be related to potential (but unsure) positive effects, i.e., chances. Hence, we applied a broad conceptualization of risk perceptions, which generally denotes uncertain future outcomes that might be positive or negative. In this vein, we used three indicators that represent the perceived risks and insecurities associated with potential synergies or trade-offs between some critical climate change-related mitigation measures and potential outcomes. First, two indicators—*Renewables risk* and *Transition* capture classical risks related to climate change mitigation, namely the risk that the energy transition towards renewable energy sources involves a trade-off between energy security and energy costs. The other two items, *Money and Jobs* and *Renewables promise*, represent potential but unsecure chances related to the energy transition with respect to the labor market outcomes and investments. Individuals who do not acknowledge this potential (i.e., exhibit low agreement to these items) again interpret the consequences of climate change mitigation as risky rather than as a chance. Lastly, we used education, age, gender, and income as control variables.

Initially, we used the *mice* package in R— with the random forest option—to impute the very few missing values in the survey data after we excluded the respondents that submitted incomplete surveys (Buuren and Groothuis-Oudshoorn 2011). We then conducted a two-step empirical analysis—the first for explanatory purposes, and the second and most importantly, for prediction purposes. Firstly, we intended to estimate the relationship between our dependent variable, Carbon Tax Policy Support, and all of the independent variables listed in table 1 using the Ordinary Least Squares (OLS) model. The main aim of this analysis is to generate reference results with which the findings of the second step can be compared. Secondly, we proceeded with the random forest technique, a powerful machine learning approach that solves complex regression, prediction, and classification problems using randomized recursive partitioning, particularly exemplified by the non-randomized partitioning tree model (Levi 2021). 'Random forests fit a high number of single partitioning tree models and inject elements of randomization in each of them…' (ibid, p.8), which substantially increases the model's predictive performance. According to Levi (2021), random forests have two significant advantages over

Table 1. Details about the independent variables.

Name	Survey Question	Operationalization
Beliefs		
Happening	Recently, you may have noticed that global warming has been getting some attention in the news. Global warming refers to the idea that the world's average temperature has been increasing over the past 150 years, may be increasing more in the future. *What do you think: Do you think that global warming is happening?*	Yes=1 No=2 Don't know=3
Consensus	To the best of your knowledge, what percentage of climate scientists think that human-caused global warming is happening?	Ranking presented in percentage, from the lowest to the highest values.
Risk perception: problem		
Personal	How much do you agree with the following statement: 'I have personally experienced the effects of global warming'.	Strongly agree (1) Somewhat agree (2) Neither agree nor disagree (3) Somewhat disagree (4) Strongly disagree (5)
Energy dependence	Do you agree or disagree with the following statement? *US and Swiss version:* 'In the long-term, the United States/Switzerland needs to have an energy	Agree (1) Somewhat agree (2)

Table 1. (Continued.)

Name	Survey Question	Operationalization
	system that does not depend on fossil fuels'.	
		Don't know (3)
		Somewhat disagree (4)
		Disagree (5)
Risk perception: solution		
Money and Jobs	Do you agree or disagree with the following statement?	Agree (1)
	US version: 'Investing in local, renewable energy keeps money and jobs here in the United States.'	Somewhat agree (2)
	Swiss version: 'With domestic, renewable energies, the money and work stay here. With the Energy Strategy 2050, we, therefore, keep the value creation in Switzerland. '	Don't know (3)
		Somewhat disagree (4)
		Disagree (5)
Renewables promise	Do you agree or disagree with the following statement?	Agree (1)
	US version: 'Investing in renewable energy is an investment in the future.'	Somewhat agree (2)
	Swiss version: 'Investments in renewable energy sources are investments in the future. The Energy Strategy 2050 takes responsibility for this.'	Don't know (3)
		Somewhat disagree (4)
		Disagree (5)
Renewables risk	Do you agree or disagree with the following statement?	Agree (1)

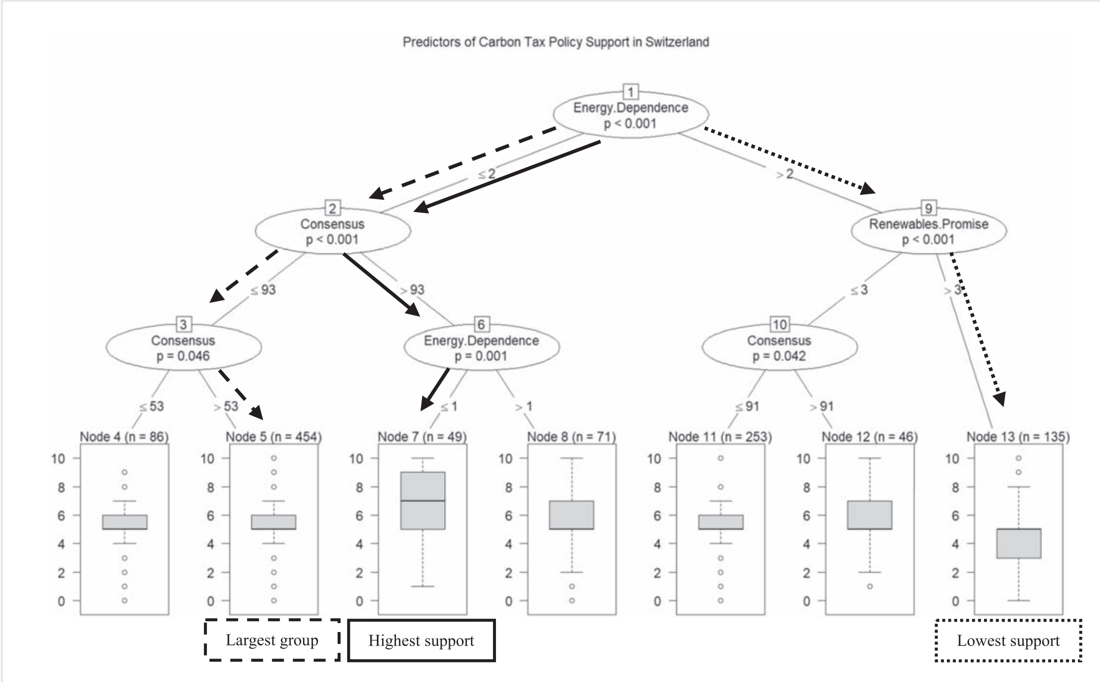
Table 1. (Continued.)

Name	Survey Question	Operationalization
	US and Swiss version: 'Renewable energy will not be able to provide enough safe and cheap energy to replace nuclear energy for the foreseeable future.'	Somewhat agree (2)
		Don't know (3)
		Somewhat disagree (4)
		Disagree (5)
Transition	Do you agree or disagree with the following statement?	Agree (1)
	US version: 'The energy transition will destroy our existing energy supply system and will make energy much more expensive.'	Somewhat agree (2)
	Swiss version: 'The Energy Strategy 2050 destroys our proven energy supply and makes energy massively more expensive. '	Don't know (3)
		Somewhat disagree (4)
		Disagree (5)
Controls: socio-demographic		
Income	*US version:* What was your household income before taxes during the past 12 months?	Less than $40,000 (1)
	SWISS version: What was your monthly net household income?	$40,000 to $59,999 (2)
		$60,000 to $89,999 (3)
		$90,000 to 139,999 (4)
		$140,000 or more (5)
		Less than 5000 Fr. (1)
		5001 to 7000 Fr. (2)
		7001 to 9000 Fr. (3)
		9001 to 13,000 Fr. (4)

Table 1. (Continued.)

Name	Survey Question	Operationalization
		13,001 or more Fr. (5)
Gender	What is your gender?	Female(1) Male(2) Other(3) No answer(4)
Education	What is the highest education level you have completed?	Ranking from the lowest to the highest level of education (starting from primary, professional, and tertiary education).
Age	How old are you?	18 to 24 (1) 25 to 34 (2) 35 to 44 (3) 45 to 54 (4) 55 to 64 (5) 65 to 74 (6) 75 + (7) No answer (8)

Note: 'neither agree nor disagree' in the '*Personal*' indicator is not an option in the Swiss survey. Thus, the ranking for this indicator in the Swiss version is 1 to 4.



Consensus: To the best of your knowledge, what percentage of climate scientists think that human-caused global warming is happening? *Belief.*	Response in %: from lowest to highest.
Energy Dependence: In the long-term, Switzerland needs to have an energy system that does not depend on fossil fuels. *Risk perception (problem).*	Agree (1) Somewhat agree (2) Don't know (3) Somewhat disagree (4) Disagree (5)
Renewables' Promise: Renewable energy will not be able to provide enough safe and cheap energy to replace nuclear energy for the foreseeable future. *Risk perception (solution).*	

Figure 1. (a): Predictors of the carbon tax policy support in Switzerland. Note: The circles are inner nodes on which splitting decisions are made, whereas the p-value represents the significance level of the splitting decision. The box plots at the bottom are called terminal nodes and show the level of carbon tax policy support.

conventional regression techniques. First, random forests have excellent compatibility with various relationships or types of data[4]. Second, they may 'inductively' find relationships by simply estimating the manner in which dependent and independent variables relate to one another, without needing any prior assumptions (ibid, p.8).

Specifically, we used the *VSURF* package in R to identify and rank the most important variables and remove those which are not strongly related to the response variable. The package does this by first generating a subset of important variables relevant for interpretation[5], and then by generating a smaller subset that avoids redundancy and focuses more on the prediction[6] objective (Genuer *et al* 2015). Furthermore, using the *ctree* function in the *partykit* package in R, we constructed conditional inference classification trees for Switzerland and the United States, using the variable indicators derived from the *VSURF* approach (Genuer *et al* 2015, Hothorn and Zeileis 2015) (see figures 1(a), 2(a) and appendix 3, figures 1(c)–(e), 2(c)–(e) for details).

Results and discussion

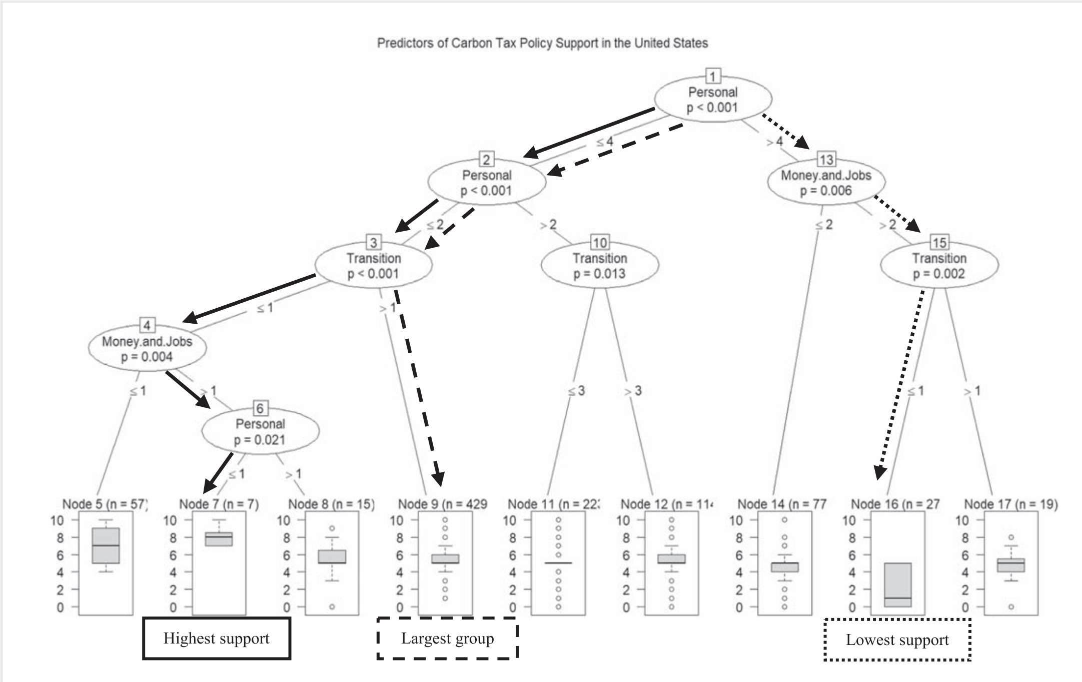
Random forests—classification description

The regression models have shown that beliefs and risk perceptions are significantly related to policy support while displaying some level of country-specific variation (Appendix 1). The results so far suggest that policy

[4] 'In particular, they can estimate the effect of a large number of mixed type predictors, can operate comfortably under non-parametric distributions, and are able to capture complex non-linear relationships, even under the presence of high-dimensional interactions among co-variates and multi-level clustered data…'(Levi, 2021, p.8).

[5] '*For interpretation*: construct the nested collection of RF models involving the k first variables, for k = 1 to *m* and select the variables involved in the model leading to the smallest OOB error' (Genuer *et al* 2015, p.22).

[6] '*For prediction:* starting with the ordered variables retained for interpretation, construct an ascending sequence of RF models, by invoking and testing the variables in a stepwise way. The variables of the last model are selected' (Genuer *et al* 2015, p.22).



Personal: I have personally experienced the effects of global warming. *Risk perception (problem).*	Agree (1) Somewhat agree (2) Don't know (3)* Somewhat disagree (4) Disagree (5)
Transition: The energy transition will destroy our existing energy supply system and will make energy much more expensive. *Risk perception (solution).*	
Money and Jobs: Investing in local, renewable energy keeps money and jobs here in the United States." *Risk perception (solution).*	

Figure 2. (a): Predictors of carbon tax policy support in the United States. Note: the circles are inner nodes on which splitting decisions are made, whereas p-values represent the significance level of the splitting decision. The box plots at the bottom are called terminal nodes and show the level of carbon tax policy support. *Personal* variable's response 3 is 'Neither agree nor disagree (3)'.

support in Switzerland is mostly driven by climate change beliefs and risk perceptions related to the problem, whereas in the United States, the strongest variable is the experience with the problem. In the second step of our empirical analyses, we use the random forest model to delve deeper into the predictive power of climate change beliefs and the various risk perceptions, to identify which factors and in what combination are strongest in predicting policy support. The results are presented in figures 1(a) and 2(a) (supporting information (available online at stacks.iop.org/ERC/4/105001/mmedia) related to these figures can be found in appendix 3). Using the R package *VSURF*, random forest models for Switzerland and the United States[7] are generated. The decision tree, as a central unit of random forest classifiers, is a hierarchical structure created based on the independent variables in the data set (Suthaharan 2016). This approach (1) firstly drops all the irrelevant variables from the model, (2) then moves with a selection of variables for *interpretation* purposes, and (3) finally refines the selection process of the variables, keeping part of the *prediction* process just a few most important ones (Genuer *et al* 2015, p.22).

The circles in the conditional inference (CI) classification trees (figures 1(a) and 2(a)) are called 'inner nodes' on which splitting decisions are made, i.e., denoting different paths that need to be followed to reach the highest or lowest predicted carbon tax policy support outcome presented in boxplot format called 'terminal nodes'. Such a classification helps us to extract at least three important pieces of information. First and foremost, from inner nodes we understand which are the selected indicators with the highest predictive power to unveil high or low policy support for each country. Second, it helps to map the pathways to the highest or lowest policy support patterns—values presented in terminal nodes. Third, it helps to identify the pathway that leads to the existing majority pattern or the largest group, and its current level of policy support. This group is used to extract key insights into the potential trade-offs between the existing problem (the majority not pursuing the highest policy support path) and the solution (pursuing the path that leads to the highest policy support).

The random forest model, using ***Switzerland*** data, reveals the three most important selected variables as *Energy dependence* (risk perception of the problem), *Renewables promise* (risk perception of the solution), and

[7] Both models generate classification accuracy rates of 43.0 and 46.3 percent, respectively.

Consensus (belief), for both interpretation and prediction purposes. These are the variables of the model leading to the smallest out-of-bag (OOB) error (See appendix 3, figure 1(e)). We use these most important predictor variables in the conditional inference (CI) classification tree for predicting carbon tax policy support. The classification tree shows that the splitting decision begins with the *Energy Dependence* indicator, implying that this is the most important predictor variable out of the three selected (figure 1(a)).

Firstly, the results on the center-left side of the conditional inference classification tree unveil the pathway that leads to terminal node 7, which represents the group of individuals with the highest declared carbon tax policy support (7.1, on a scale of 1 to 10). Hence, if we want to know in more depth the key characteristics of these individuals, we have to analyze the details that exist in the path from inner nodes 1 to 2, 2 to 6, and 6 to 7, using the information below the figure 1(a) (See appendix 3, figure 1(c) for more details). Based on these results, we could predict that the individuals who are most likely to vote for carbon tax policy packages are the ones who are highly aware of what most scientists think about human-caused global warming, and who strongly agree that in the long-term, Switzerland needs to have an energy system that does not depend on fossil fuels. As a result, in the case of Switzerland, it could be argued that specific indicators representing an individual's stronger belief and risk perception (problem) do translate into higher climate policy support, while for these individuals negative risk perceptions related to the solution, e.g., the fear that climate change mitigation hurts the economy or challenges energy security, do not feature among the most important variables.

Secondly, the results on the right side of the conditional inference classification tree unveil the pathway that leads to terminal node 13, which represents the group of individuals with the lowest declared carbon tax policy support (4.3, on a scale of 1 to 10). Primarily, these individuals are characterized by the fact that they do not acknowledge the need to move to a fossil-free energy system. Hence, this is the absence of a strong risk perception related to the problem. Interestingly, for this group, risks related to the solution also matter: they are skeptical that investments in renewable energy sources are investments in the future, i.e., they do not accept the fundamental solution to the problem. Interestingly, figure 1(a) reveals, however, that even if individuals do not see the need for the energy transition (*Energy Dependence*) and do not perceive the chances of investing in renewable energy sources (*Renewables Promise)*, there is still a path to rather high policy support. This can be seen looking at the group of individuals in node 12. Despite their skepticism with respect to the problem and the solution, their strong belief in scientific consensus leads to rather strong policy support.

Thirdly, the results on the left of the conditional inference classification tree unveil the pathway that leads to terminal node 5, which represents the majority pattern or the largest group of individuals with a declared carbon tax policy support of 5.5 (on a scale of 1 to 10). Comparing the paths of the high support group with this largest group is insightful. While the two groups follow the same path to note 2, the main difference between the two groups is that the largest group is less convinced about the scientific consensus regarding climate change. The results imply that this somewhat lower *belief* is highly relevant as it is associated with a support gap of 1.6 points compared to the highest declared support of 7.1., which is to raise the awareness of the public about the percentage of climate scientists who think that human-caused global warming is happening.

The random forest model, using the ***United States*** data, unveils that the three most important selected variables are *Personal (risk perception of the problem),* as well as the two indicators capturing risk perceptions of the solution, *Money and Jobs,* and *Transition.* These are the variables of the model leading to the smallest out-of-bag (OOB) error (See appendix 3, figure 2(e)). The classification tree shows that the *Personal* indicator is used to begin the splitting decision (figure 2(a)).

Firstly, the results on the left side of the conditional inference classification tree unveil the pathway that leads to terminal node 7, which represents the group of individuals with the highest declared carbon tax policy support (8.0, on a scale of 1 to 10). Hence, if we want to know in more depth the key characteristics of these individuals, we have to analyze the details that exist in the path from inner nodes 1 to 2, 2 to 3, 3 to 4, 4 to 6, and 6 to 7, using the information below the figure 1(b) (See appendix 3, figure 2(c) for more details). As a result, in the case of the United States, it could be argued that the predictive pattern of strong policy support is dominated by the risk perception of the problem, namely by exposure to the negative effects of global warming. In fact, the chain of nodes 1 to 7 representing the path leading to the highest policy support, uses the *Personal* indicator three times for splitting decisions and ending with the group of people who '*strongly agree*' that they have personally experienced the effects of global warming. The strong exposure, in these cases, seems to compensate for the fact that the solutions are perceived as a risk rather than a chance. We need to keep in mind that this finding could also partly be the result of the fact that our dependent variable focuses specifically on carbon taxation, while the risk perceptions related to the solution—which are crucial in this model— mostly concern renewable energy production.

Secondly, the results on the right side of the conditional inference classification tree unveil the pathway that leads to terminal node 16, which represents the group of individuals with the lowest declared carbon tax policy support (2.1, on a scale of 1 to 10). The chain of nodes 1–16 representing the path that leads to the lowest policy support includes only the individuals that '*strongly disagree*' that they have personally experienced the effects of global warming, while climate change beliefs—namely climate change concern– are not correlated with policy support in a relevant way. Moreover, as node 15 suggests, this group thinks that the energy transition will destroy our existing energy supply and will make energy much more expensive, i.e., strongly perceives the risk for the economy and energy supply. Hence, this pattern suggests that the combination of a lacking problem perception and a strong perception of risks related to climate change policy go hand in hand with particular low policy support.

Thirdly, the results on the center-left of the conditional inference classification tree unveil the pathway that leads to terminal node 9, which represents the majority pattern or the largest group of individuals with a declared carbon tax policy support of 5.7 (on a scale of 1 to 10). The comparison with the high support group reveals that this largest group's risk perception related to the solution is even less dominated by the fear of energy security and trigger of higher energy prices. However, in contrast to the individuals with the highest policy support, the path of the largest group does not include strong personal experience with negative climate change effects. The findings suggest that these different experiences of the climate change-related risks are associated with a support gap of 2.3 points compared to the highest declared support of 8.0.

Country comparisons

From a comparative perspective, the results from the random forests—the method that ultimately selected the most important predictor indicators—highlight some important similarities and differences between the United States and Switzerland.

In regards to similarities, first, in both country models, it was found that the beliefs and/or risk perceptions are the most important predictor indicators that could influence the level of support for the carbon tax policy packages, while none of the models suggest that any socio-demographic indicator is an exceptionally important predictor. This corroborates the relevance of more closely looking at beliefs and risk perceptions to better understand public support for ecological taxes. Second, both countries' results reveal that there could be different paths towards reaching high carbon tax policy support. Third, for both the United States and Switzerland, the most important predictors that are used to begin the splitting are risk perceptions related to the problem. In both countries, risk perceptions related to the solution, i.e., the negative economic or supply effects of climate change mitigation, are detrimental to low policy support only if they are accompanied by a lack of problem-related risk perception.

Meanwhile, some major variations in the results also deserve attention. First, the type of problem-related risk perception, i.e., the salience of the problem, is different in nature. For the United States, *Personal* experience of the effects of global warming, i.e., the problem, is crucial whereas, for Switzerland, it is the *Energy Dependence*, emphasizing the need for climate change mitigation, namely the need to have an energy system that does not depend on fossil fuels. Second, climate change beliefs—in accordance with the regression models—are not among the most important predictors for the United States case. This is different in Switzerland, where the conditional inference classification tree contains one *belief* measure, *Consensus.* Third, the gap in carbon tax policy support between the group with the *highest support* pattern and the *largest group* is higher in the United States than in Switzerland.

Conclusion

Climate policy support in the twenty-first century has the potential to significantly influence the future of human civilization. Numerous climate change policy packages in countries throughout the globe need public support, and policy instruments such as carbon taxes—which are often at the heart of such plans—are not always readily endorsed and implemented. As such, the primary goal of our study is to identify potential pathways that might help in better understanding and predicting support for climate policies. In accordance with previous research, we assume that climate change-related beliefs and risk perceptions are strong predictors of climate policy support. We thereby emphasize that not only risk perceptions related to the problem, i.e., climate change, but also related to the solutions, e.g., negative effects of mitigation measures on the economy or energy security, should be considered in order to better understand individual policy support.

Our main findings and conclusions can be summarized as follows. First, it was found that an individual's climate change-related beliefs and risk perceptions are indeed very important predictors of the level of carbon tax policy support, and are stronger than socio-demographic variables. For policymakers and advocates, these findings suggest that building support for climate policies is highly influenced by these two dimensions. These results are in line with the existing theory and the recent empirical findings (Goldberg *et al* 2020, Crawley *et al* 2020, 2021). Second, the most important selected indicators deriving from random forest analysis vary between the United States and Switzerland. While the belief in the scientific consensus is a crucial explanatory factor for policy support in Switzerland, policy support seems to be more strongly and more exclusively shaped by risk perceptions in the United States. Interestingly, in both countries, the main difference between the group with the highest policy support and the largest group can actually be found in these two respective variables. Thereby, the majority group does not exhibit a very low level on these indicators but just a little less conviction about the scientific consensus and a little bit less personal experiences with the negative consequences of climate change. This implies that information or sensitization measures to increase climate change beliefs and the visibility of climate change-related risks have the potential to considerably enlargen the group with high support.

The observed heterogeneity in predictor importance in the two countries shows that each country has its unique set of beliefs and risk perceptions that have a significant influence on the level of carbon tax policy support. Nevertheless, we also found major commonalities. Most important, risk perceptions related to the problem are crucial predictors of policy support in both countries. Moreover, risk perceptions related to the solution are also among the most important predictors in both countries. In particular, the perception that mitigation measures are risky leads to lower policy support if this view is combined with a lacking problem perception. Conversely, especially the findings from the United States context imply that if the problem, i.e. climate change, is strongly perceived, even some risks related to the solution can be compensated for. Third, in the public debate, it has been often argued that economic arguments, mostly framed as costs in the context of climate change mitigation, are crucial. Overall, our results suggest that these arguments may be overcome by a stronger emphasis placed on the problem rather than on the risks related to the solution.

Climate policy encompasses a huge range of policy instruments beyond carbon taxes, and it is of vital importance to help shape the understanding of whether the beliefs and risk perceptions could be useful predictors of the support for various other policy instruments. In our analyses, we focused on carbon taxation policies, which are among the most disputed and unpopular policies. We cannot, however, exclude the possibility that our results are to a certain degree driven by this specific instrument but also by specific solution-related risks included in our survey. Our findings thus pave the way for further research examining how far the predictive patterns of climate change beliefs, problem-related and solution-related risk perceptions vary when looking at support for other climate change instruments or when including different framings of risks and chances related to climate change policy.

Data availability statement

The data generated and/or analysed during the current study are not publicly available for legal/ethical reasons but are available from the corresponding author on reasonable request.

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