Is prioritization possible? Experts' perceptions of obstacles and responses to staying below 2°C

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The global community has acknowledged the goal of mitigating anthropogenic climate change to well below 2°C (1)**, but the required ambition is still lacking** (2; 3)**. While the growing academic literature** (4) **analyzes this problem and informs about potential solutions, problem perception seems to differ widely** (5; 6)**, making prioritization and agreement on a way forward difficult. We present quantitative evidence on how experts from the IPCC and UNFCCC perceive the importance of obstacles and responses for climate change mitigation. While confirming that on an individual level importance ratings differ substantially, our survey also finds that the majority of experts perceive a wide range of obstacles and responses as important, supporting an agenda (for research and policy) that is inclusive in terms of issue coverage. Concerning prioritization, technological R&D is seen as the most important response and opposition from special interest groups as the most important obstacle on average. However, we also find average importance ratings to be partly influenced by an underrepresentation of experts from the Global South, stressing that equal representation is key. Using an ordered logit regression, expert's judgment seems to be most influenced by their academic training, local experience and cultural background, while surprisingly little difference occurs between experts from the IPCC and the UNFCCC.**

Despite the growing academic literature on climate change mitigation, policy advice has not converged towards one single most effective response to achieve ambitious emission reductions. Instead, mitigation seems to face multiple case-specific synergies and trade-offs. Under capacity constraints, prioritizing seems important, but competing understandings of climate change and its mitigation impede consensus (5; 6). To quantitatively assess whether prioritization is possible, we conducted a survey among experts from the IPCC and UNFCCC to rate the importance of a wide range of obstacles and responses to keeping the temperature increase below 2°C. We take as a starting point the null hypothesis that no obstacle or response will be rated as significantly more or less important than the average. This hypothesis would call for an all-encompassing approach to climate research and policy that does not prioritize across issues.

Table 1: Basic characteristics of sample

	IPCC	UNFCCC
Contacted	3013	2236
Response rate	28%	11%
Respondents identified as [a]	683	158
		Both: 76
Gender [b]		
Male	74%	64%
Female	25%	36%
Region of home country [b]		
Africa	4%	20%
Asia	9%	16%
Europe	48%	35%
Latin America	6%	18%
North America	23%	3%
Oceania	9%	4%
Age		
< 36	9%	24%
36-49	35%	39%
50-63	41%	32%
64-75	15%	5%

[a] The numbers are lower than the response rate as we excluded non-IPCC/UNFCCC respondents.
[b] Percentages do not add up to 100% because not all respondents indicated the specific item.

Survey design and sample

We contacted 3013 IPCC authors, contributors, or reviewers of the fifth assessment report and 2236 UNFCCC country delegates from COP 19, 20 and 21. We received 917 responses (see Table 1). Respondents were first asked to state some background information (IPCC/UNFCCC and their function therein, gender, home country, academic background, age). Second, two separate lists of obstacles and responses were presented and respondents were asked to: "Please indicate – in your opinion – how important the following obstacles (responses) are to keeping global average temperature increase below 2°C." Table 2 states the 13 obstacles and 13 responses (see Methods on selection of items). Experts could choose from a Likert scale ranging from "Not important" to

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Table 2: List of 13 obstacles and 13 responses in order of appearance in the survey

Obstacles	Responses
(1) **Uncertainty** about climate change **impacts or costs** of mitigation	(1) **More research** on climate-change impacts or mitigation costs
(2) Lack of public **awareness** about the magnitude of climate change impacts	(2) Intensified **communication** and education to build public support
(3) **Different costs and benefits** of mitigation across countries	(3) Financial and technological **transfers between countries**
(4) **Time lag** between costs and benefits of mitigation	(4) **Compensation to special interest** groups (for example, emission-intensive industries)
(5) Different understandings of **fairness** and responsibility	(5) Policies addressing **intergenerational conflict** (for example, appropriate discounting)
(6) Concerns over high mitigation costs slowing **economic development**	(6) **Research and development** for low-carbon technologies
(7) **Uncertainty** and risks about low-carbon **technologies**	(7) **Subsidies and standards** to deploy low-carbon technologies
(8) Negative GHG **emission externality** from economic activity	(8) **Carbon pricing**
(9) **Consumerism** in society	(9) **Change lifestyles** and behaviors within society
(10) Lack of **administrative capacity** for climate policy	(10) **Strengthening** domestic administrative **capacity** for climate policy
(11) Opposition from **special interest** groups (for example emission-intensive industries)	(11) Measures to en**force international** emissions reductions (for example, trade sanctions)
(12) Global public-good nature of mitigation and **free-riding** incentives	(12) Applying concepts for human development **other than growth of GDP**
(13) Multitude and **complexity** of obstacles	(13) Coherent and multi-objective **policy packages**

"Somewhat important", "Moderately important", "Very important", and "Extremely important", or indicate "Don't know" or choose not to answer.

Importance ratings differ substantially between individuals and vary across issue items; on average, almost all items are at least moderately important

We find that individual variation in rating the items was substantial: every obstacle and every response was rated from not important to extremely important at least once (Figure 1). Comparing the histograms, we can clearly reject the hypothesis that all obstacles and responses are perceived as equally important among the whole sample: for each obstacle/response, the relative frequencies of Likert scale ratings differ significantly – based on a Chi-Squared test – from the relative frequencies across all obstacles/responses (see Methods).

This would suggest that prioritization is possible, but we find limited scope for it because the distribution of average ratings is relatively flat and most items are perceived as at least moderately important. To allow comparison beyond the histograms of importance ratings, Figure 1 shows the Average Likert Scale as a quantitative measure.

As a first indication that prioritization is difficult, we find that all items are rated by a majority of experts as "moderately", "very" or "extremely" important (confirming our selection of relevant topics about which experts have been inquired). Second, most items also have an Average Likert Scale of 3 or larger, rating them at or above "moderately important" on average. Third, the Average Likert Scales are relatively close together with less than 0.5 Average Likert Scales difference between the third least-important obstacle and the second-most important obstacle. For the responses, the six items with the highest Average Likert Scales are only 0.3 Average Likert Scales apart.

For the least-important items, the uncertainty obstacles ("Technological" and "Scientific") and the response "Compensation to special interests" were on average not even moderately important and are therefore a lower priority among the experts. We will however see below that this is partly driven by an underrepresentation of experts from the Global South in our sample.

The obstacle "Special interests" stands out as rated "very important" on average and thereby more important than all the other obstacles. However, we find that this result is also partly driven by an underrepresentation of experts from the Global South.

Standing out, 80% of experts rated "Technological R&D" as "very" or "extremely" important, suggesting that this item belongs at the top of the policy agenda. This response was also rated most important on average. However, the difference in average rating compared to second and third most important is only about 0.1 Average Likert Scales.

We observe the surprising pattern that related topics have been rated as less important as an obstacle but particularly important as a response and vice versa. The obstacles with overall highest importance ("Time lag between costs and benefits", "Special interests") are clearly linked to the responses with least importance ratings ("Compensation to special interests", "Intergenerational policies"). On the other hand, the obstacles which were perceived as least important ("Technological" and "Scientific uncertainty") have clear connections to the responses

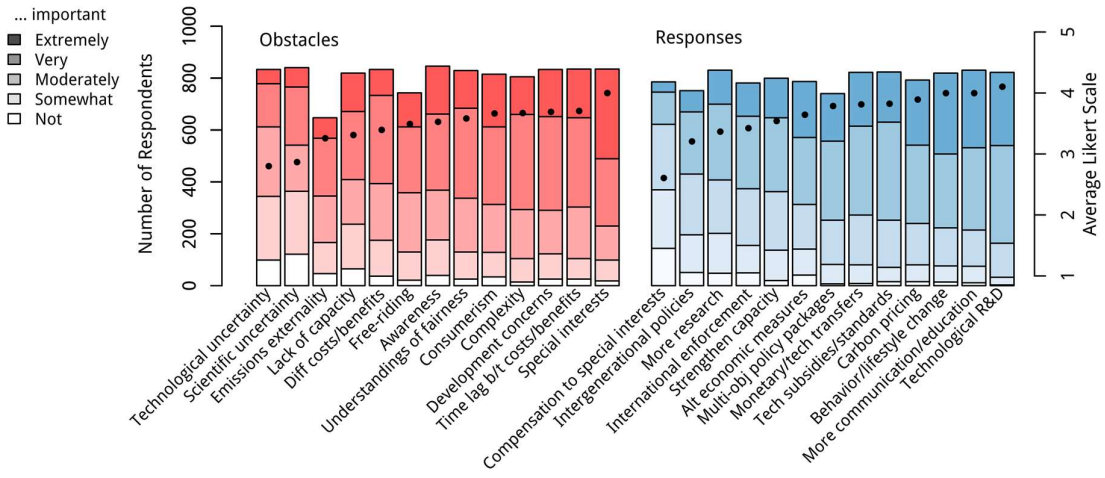

Figure 1: Number of respondents choosing each Likert scale for obstacles (red) and responses (blue), heights in the stacked bars show how many respondents chose one of the importance ratings as opposed to not answering or "Don't Know". For the "Average Likert Scale", importance ratings received a numerical value from 1 (not important) to 5 (extremely important); the average across the sample is reported. Obstacles and responses were abbreviated for presentation.

that were rated highest on average ("More communication/education", "Technological R&D"). One explanation could be that experts tend to discount the importance of obstacles if a solution is already known and highlight the importance of obstacles if they cannot identify an important solution to that particular obstacle. However, we find no quantitative evidence for this hypothesis. Table A.1 reports the coefficient of correlation between importance ratings of obstacles and responses. There is no negative correlation between the least (most) important obstacle and most (least) important response, which would indicate that those experts who found "Technological uncertainty" less important (or "Special interests" more important) perceived "Technological R&D" more important (or "Compensation to special interests" less important).

Perceived response importance does not seem to drive differences in prioritization among obstacles. To investigate other factors that influence perceived importance, the next two sections investigate in how far characteristics of respondents may explain varying importance ratings.

Regional affiliation and academic background influence importance ratings, whereas organizational affiliation and gender don't

Figure 2 compares the "Average Likert Scale" rating across different subgroups in our sample. We find that importance ratings do not differ substantially across affiliation with either the IPPC or the UNFCCC. Moreover, the gender of the respondents does not substantially influence the importance ratings. Male respondents rate both obstacles and responses consistently lower, which is consistent with a higher risk aversion of females (7). However, this effect is small and ranges between 0.1 and 0.3 Average Likert Scales.

The influence of academic training on obstacle and response perceptions varies with the issue discussed. As expected, social scientists tend to see "Free-riding" as a more important obstacle but rate "Consumerism" and "Alternative economic measures" less important than natural scientists. More surprisingly, political scientists tend to discount the importance of "Public awareness", "Different understandings of fairness", and "More communication/education" more than experts from other academic backgrounds. Natural scientists and engineers perceive "More research" to be more important than their colleagues that were trained in social science.

The regional background of the experts influences their assessment more strongly than their academic background. In particular, we find that the clear lower average rating of the uncertainty obstacles and clear higher average rating of the "Special interest" obstacle are driven by an imbalance in our sample. Figure 2 shows that "Scientific" and "Technological uncertainty" were perceived as less important by experts from the global North (North America and Europe), which are the clear majority of respondents, than from experts of the Global South (Africa, Asia, and Latin America), and vice versa for the "Special interest" obstacle. Some other items show a similar North/South divide ("Administrative capacity", "Compensation to special interests", "More research", "Strengthen administrative capacity", "Monetary and technological transfers"). There is a different regional divide between importance ratings for a few other items, perhaps most notably that experts from Latin American countries perceive "Consumerism" and

"Behavioral/Life-style change" to be substantially more important on average.

If we extrapolate our data and adjust the regional Average Likert Scale ratings with population weights, the difference in importance ratings across obstacles and responses decreases (see dotted line in Figure 2). Among the obstacles, "uncertainty" would still have the lowest importance, albeit with a smaller difference. "Understandings of fairness" and "Development concerns" would have on average the highest perceived importance when extrapolating our data, again with only a small difference. For the responses, "Monetary and technological transfers" and "Behavioral/Life-style change" would be equally important as "Technological R&D".

Extrapolating our sample, we find that a more equal representation of experts increases the importance of items with less Average Likert Scale ratings towards the level of the more important items. A more equal representation of experts may hence make prioritization harder, but also indicates the possibility of agreement on an inclusive agenda for research and policy by a majority of a representative expert group.

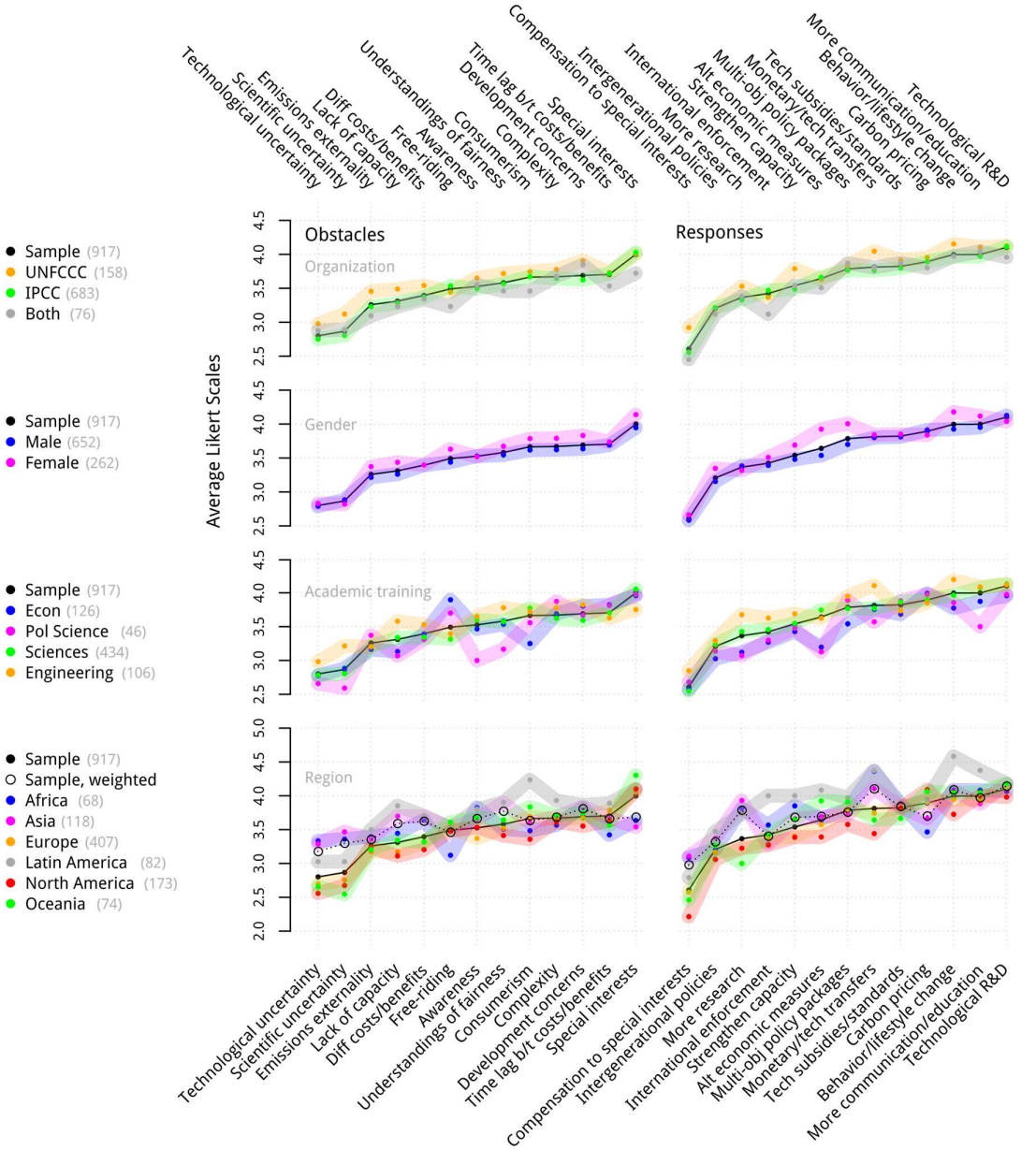

Figure 2: Average Likert Scale ratings across different individual characteristics compared to the sample average: whether respondent is or has been IPCC author, UNFCCC country delegate or both, his or her gender, the respondents academic background and home country region (regions are based on the United Nations geoscheme M49 coding). The "weighted sample" line is the sum of regional means weighted with their population. Obstacles and responses were abbreviated for presentation.

Experiences with political institutions and economic culture are important drivers for individual and regional variation in importance ratings

We conducted a series of ordered logistic regressions to better understand the drivers behind individual and regional variation in importance ratings (Methods). Because our sample is not drawn randomly (Methods), we concentrate on the size of effects and not on statistical significance.

We find that expert's experiences with local political institutions and regulatory cultures influence which obstacles and responses experts perceive to be important. In the next paragraph, we discuss our findings for those obstacles and responses where Figure 2 showed a large regional variation:

- **Lower importance of "Scientific Uncertainty" and "More research" can be partly explained by the size of research conducted in expert's home countries; less so for "Technological uncertainty" (Table A.2, A.4)**: Experts from countries with a larger scientific sector tend to perceive "Scientific uncertainty" 0.1-02 Likert Scales less important and attribute 0.2-0.3 Likert Scales less importance to "More research" as a response compared to countries with a smaller scientific sector. We conclude that expert's perception of scientific certainty is influenced by the scientific community in their home country: if they are from a country with a vibrant research community, scientific certainty is perceived as more advanced than if they are from a country where little scientific output is generated. This partly explains the higher importance attributed to scientific uncertainty by experts from Africa, Asia, and Latin America. Including this country-specific indicator reduces the effect of the regional indicators. However, experts from Africa and Asia still tend to rate scientific uncertainty as an important obstacle 0.34 and 0.57 more Likert Scales higher respectively. The influence of the scientific sector on perceived technological uncertainty is similar but does not significantly reduce the influence of the regional indicators.
- **Higher perceived importance of "Consumerism" and "Behavioral and lifestyle changes" by Latin America persists; experts from more democratic, less affluent, and less carbon-intensive countries tend to perceive both items to be more important (Tables A.2 and A.5):** Experts from more democratic countries tend to perceive consumerism to be a more important obstacle (by 0.24-0.47 Likert scales) than experts from undemocratic countries. Furthermore, experts from wealthier and more carbon-intense countries tend to perceive consumerism to be a less important obstacle (by 0.08 and 0.2 Likert Scales respectively). Grading of lifestyle change as a response is influenced similarly. Controlling for democracy and carbon intensity, experts from Latin America still rate "Consumerism" and "Behavioral/Lifestyle change" 0.5 Likert Scales more important than experts from Europe on average. The level of democracy may be connected to the activity of civil society organizations pushing post-materialist values of which the experts are influenced (8). We also interpret the negative correlation of national income and carbon intensity with rating of consumerism as a manifestation of system justification bias (9). As it is precisely the non-sustainable consumerist culture of wealthy and carbon- intense countries that has caused climate change, people from these countries are hesitant to problematize this due to self-interest.
- **The quality of governance institutions in experts' home countries partly accounts for how much they worry about "Special Interest Groups" (Table A.3)** Experts from countries with effective government institutions tend to perceive "Special interests" to be a less important obstacle (by 0.1-0.32 Likert Scales). We suspect that countries with effective government institutions suffer less from corruption and lobbyism and that experts from those countries are hence less likely to experience special interest influence on government policy. However, even when controlling for government effectiveness, regional tendencies persist: African experts tend to rate special interests to be a less important obstacle, whereas Asian and Oceanic experts perceive it as more problematic.
- **Experts from carbon intense countries with poor governance and mitigation performances tend to discount the importance of "Free-riding" (Table A.3.)** Experts from countries with good government institutions (0.08-0.23 Likert Scales) and strong climate change mitigation policies (0.1-0.23 Likert Scales) tend to perceive "Free- riding" to be a more important obstacle. On the other hand, experts from carbon intense countries perceive "Free- riding" as less important (by 0.06-0.21 Likert Scales). The low attribution of "Free-riding" in African countries disappears when controlling for effective government institutions and strong mitigation policies, where African countries tend to score particularly low. The effect of mitigation performance and carbon intensity may result from system justification and motivated cognition bias (9): problematizing free-riding negatively affects carbon-intense countries

and positively affects countries with a good mitigation performance, which is why experts from countries with strong mitigation policies are more likely and experts from carbon-intense countries are less likely to advocate this idea. Also, countries with a good mitigation performance experience international free-riding first-handedly.

- **Experts from poorer countries tend to rate "Monetary and technological transfers" more important, as so do experts from Africa, Asia and Latin America (Table A.4.)** Experts from wealthier countries tend to perceive "Monetary and technological transfers" to be a less important response (by 0.15 Likert Scales). However, when controlling for regional variables, this effect diminishes and regional influences prevail: African, Asian, and Latin American experts tend to perceive transfers to be more important than their colleagues from Europe North America and Oceania. This regional pattern follows the traditional donor/recipient pattern within the UNFCCC and therefore again represent system justification bias.
- **Experts from countries with low carbon intensity, poor governance institutions, and a culture of market intervention tend to see "Compensation to Special Interest Groups" as more important (Table A.5.)** Experts from carbon-intense countries (0.02-0.21 Likert Scales), from economically liberal countries (0.25-0.31 Likert Scales), and from countries with good governmental institutions (0.42-0.53 Likert Scales) perceive compensation to special interests to be less important on average. This explains much of the regional influences. We suspect these effects are rooted in experts from countries with well working governance institutions having experienced that there are other means to regulate polluters than to pay them off and therefore perceive compensation as less important. Furthermore, experts from countries with less economic regulation may also discount pay-offs because they trust in self-regulating performance of markets. Beyond these variables Asian experts rate compensation more important and North American ones less important

Final remarks

Our data shows that most items are perceived as important, from which we conclude that a global mitigation agenda should be inclusive. We also observe that the rating of items differs significantly in statistical terms but to a small extent quantitatively, from which we conclude that prioritization is possible, but difficult. As regional and country-specific factors are the strongest influences on importance ratings, tailoring mitigation agenda to regional or national needs might be feasible beyond global groups such as the IPCC and UNFCCC.

Methods

Sample

We collected all names of contributors to the IPCC's Fifth Assessment Report from Annex I of the report. Out of the 3562 experts listed (not unique), we distributed the survey to 3013 unique contacts, for which E-mail addresses could be found online. Hence, our contact list is nearly complete for the IPCC scientists.

Contacts for the UNFCCC country delegates were derived from the COP 19, 20 and 21 participant lists. We distributed the survey to 2236 unique contacts, for which E-mail addresses could be found online. The lists of participants encompass 21647 names (not unique) so that our contact list is not complete and may be subject to a bias for experts that provided an E-mail address online.

Notice that since only 28% of IPCC scientists and 11% of UNFCCC experts responded, our results may be influenced by non-response bias.

Detailed survey design

The survey was conducted using Survey Monkey. Respondents were informed on the first page about the scope of the survey and that they were not required to answer all of the questions.

The next two pages asked respondents to indicate:

1. Whether she or he is an (i) IPCC author, contributor, or reviewer (ii) an UNFCCC country delegate (iii) both or (iv) other (participants that clicked other or nothing were excluded from the analysis).
    a. Experts from the IPCC were asked to indicate their working group and their role as (i) Coordinating Lead Author, Lead Author, Review Editor or (ii) Contributing Author.
    b. Experts from the UNFCCC were asked which country delegation they belonged to and their capacity therein (Party, Observer etc.).
2. their home country
3. their educational background, with choices: Physical and Natural Science, Engineering, Mathematics, Geography, Economics, Political Science, Law, Medicine, Arts and Design, History, Humanities, Other
4. their age group, with choices from: 35 or younger, 36-49, 50-63, 64-75, 76 or older

5. their gender as male, female or other

On the next page respondents were asked to take a moment to consider the questions:

1. What – in your opinion – is the most important obstacle to keeping the global average temperature increase below 2°C.
2. What – in your opinion – is the most important response option to keeping the global temperature increase below 2°C.

The next page presented the 13 obstacles, and respondents could choose one of the Likert scales: not – somewhat – moderately – very – extremely important, or "Don't know". Respondents were then asked to choose one of the 13 obstacles as the one they perceived as "most important" or indicate that they do not consider there to be a "most important". Additionally, there was the option to answer whether there is an obstacle that is more important than any of the above but was not included. If respondents chose "yes", they had the chance to name it in their own words. This page also offered the chance to provide additional comments.

The pages described in the last paragraph were repeated for the responses.

Lastly, we asked respondents to indicate how confident they are that the world can keep global average temperature increase below 1.5°C, 2°C and 3°C. They could choose from very low to low, medium, high and very high confidence.

Selection of obstacles and responses

We compiled the list of obstacles and responses based on a survey of existing literature and expert interviews. The initial selection of items was based on an extensive reading of central literature, for example (10; 11; 12) as well as of the fifth assessment report of the IPCC (13). Items were refined through an iteration with selected experts from science, the IPCC and the UNFCCC as well as three test runs of the survey.

The importance of individual items was confirmed by the rating of experts. In order to control whether we left out important obstacles or responses we allowed individual answers on issues that were not included in our list. Table A.6 reports a categorization of the most common answers. It shows that there is a wide range of items that we did not include, which hints at the difficulty of defining a comprehensive list. To illustrate our approach, we had previously incorporated "Lack of political will" in our list of obstacles, which was mentioned by our respondents most often to be lacking. We chose to drop it for brevity and because there is no clear concept of political will so that importance ratings are hard to compare.

Software and statistical methods

The data was analyzed and figures prepared with the R software package (14).

To test the null-hypothesis that no obstacle or response is more or less important than the average, we performed a Chi-Squared test on the relative frequencies derived from the histograms. First, the relative frequencies of Likert scale ratings were calculated for each individual obstacle and response. The Chi-Squared test in R was used to test whether these relative frequencies are significantly different from the average relative frequencies of all obstacles and all responses, respectively. The null-hypothesis was rejected with p-values below 0.001, expect for the obstacle "Awareness" and response "Alternative economic measures", which are very close to the average frequencies.

The Likert scale ratings are estimated with an ordered logistic regression, for which details can be found in (15; 16). The "polr"-package was used in R to estimate the coefficients and intercepts (17). The "ocME"-package calculates the marginal effects at the mean of the sample. For the effect on the numerical Likert scale rating (reported in Tables A.2-A.5), the marginal effect on each Likert scale is multiplied by the numbers 1 to 5 in their respective order and then summed up. The standard errors and p-values are calculated using the Delta-method.

The explanatory variables "Age" and "Confidence in 2 degree" were converted to a numerical scale. For "Age" the 5 groups and for "Confidence in 2 degree" the 5 confidence levels (see previous section) were substituted by a number from 1 to 5 in corresponding order.

For the regressions, the explanatory variables below were scaled in the following way. Over the range of values available over all countries (counting each country one time), the difference between 80% and 20% percentile were used as a normalization of values in our data. For the following variables this is the difference between:

- GNI: Portugal and Pakistan
- Size of Science in Country: Hungary and Bolivia
- Climate Change Mitigation Performance: Switzerland and Thailand
- Carbon Intensity: United States and Singapore
- Economic Freedom: Colombia and Egypt
- Government Effectiveness: Germany and Angola

To select the explanatory variables in Tables A.2-A.5, we followed the following procedure. We estimated

the change in Average Likert Scale ratings both with the ordered regression and an OLS regression on the numerically converted Likert scales. Both methods delivered very similar effects. To choose between the explanatory power of models, we proceeded with the OLS regression. We programmed a script that would automatically fit models with the highest explanatory power in terms of R square. We excluded all model variations with substantial multicollinearity and discussed the model variations proposed by the script and adjusted them if we thought that the effect of some variable might be wrongly attributed or different but related variables could better explain the item. We excluded all variables which did not influence the outcome (threshold 0.1 LS) even when they furthered the R square. To discuss the effects in the main part, the results of the ordered regression are reported.

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Appendix

Table A.1: Coefficient of correlation between numerically converted Likert scales (scale 1 to 5) of obstacles and responses (results were confirmed by using the Goodman-Kruskal Gamma-measure for categorical data)

Response / Obstacle	Compensation to special interests	Intergenerational policies	More research	International enforcement	Strengthen capacity	Alt economic measures	Multi-obj policy packages	Monetary/tech transfers	Tech subsidies/standards	Carbon pricing	Behavior/lifestyle change	More communication/education	Technological R&D
Technological uncertainty	0.2	0.18	0.23	0.06	0.14	0.1	0.15	0.18	0.06	-0.04	0.09	0.12	0.17
Scientific uncertainty	0.2	0.1	0.41	0.02	0.11	0.03	0.04	0.12	-0.02	-0.07	0.04	0.12	0.08
Emissions externality	0.1	0.2	0.11	0.16	0.15	0.19	0.21	0.22	0.16	0.1	0.09	0.16	0.14
Lack of capacity	0.15	0.28	0.26	0.26	0.64	0.31	0.26	0.28	0.13	0.09	0.28	0.29	0.1
Diff costs/benefits	0.17	0.18	0.26	0.13	0.18	0.12	0.18	0.26	0.07	0.06	0.16	0.18	0.14
Free-riding	0.11	0.28	0.04	0.21	0.13	0.1	0.2	0.13	0.12	0.17	0.11	0.13	0.05
Awareness	0.1	0.2	0.27	0.16	0.27	0.27	0.14	0.18	0.09	0.08	0.27	0.55	0.12
Understandings of fairness	0.15	0.29	0.19	0.22	0.25	0.22	0.2	0.28	0.12	0.04	0.28	0.28	0.12
Consumerism	0.05	0.24	0.05	0.22	0.34	0.37	0.25	0.22	0.12	0.1	0.56	0.26	0.04
Complexity	0.19	0.24	0.12	0.14	0.22	0.19	0.33	0.21	0.15	0.14	0.15	0.15	0.13
Development concerns	0.22	0.17	0.17	0.13	0.08	0.1	0.16	0.17	0.14	0.12	0.16	0.14	0.14
Time lag b/t costs/benefits	0.16	0.27	0.1	0.08	0.1	0.14	0.24	0.17	0.14	0.15	0.09	0.16	0.13
Special interests	0.12	0.18	0.01	0.31	0.26	0.26	0.23	0.15	0.24	0.24	0.15	0.26	0.03

Tables A.2-A.4: Ordered Logit Regression for explaining variation in rating obstacles and responses, reported numbers are the effect of changing the respected variable on the expected numerical Likert scale rating (see Methods)

Table A.2

	Scientific uncertainty			Technological uncertainty			Consumerism		
	1	2	3	1	2	3	1	2	3
UNFCCC	0.17 (0.13)	0.16 (0.13)	0.22. (0.12)	0.01 (0.11)	0 (0.11)	0.09 (0.11)			
Political Science	-0.28 (0.19)	-0.28 (0.19)	-0.29 (0.19)	-0.1 (0.16)	-0.1 (0.16)	-0.11 (0.17)	-0.09 (0.18)	-0.11 (0.18)	-0.14 (0.19)
Economists							-0.42** (0.13)	-0.38** (0.13)	-0.38** (0.13)
Nat Sciences							0.1 (0.09)	0.11 (0.09)	0.11 (0.09)
Male	0.06 (0.09)	0.06 (0.09)	0.09 (0.09)	-0.06 (0.08)	-0.06 (0.08)	-0.02 (0.08)	-0.17* (0.08)	-0.13 (0.08)	-0.16. (0.08)
Confidence in 2 degree	-0.04 (0.04)	-0.03 (0.04)	-0.04 (0.04)	-0.09** (0.03)	-0.08** (0.03)	-0.08** (0.03)	0.02 (0.03)	0.02 (0.03)	0.03 (0.03)
Age							0.03 (0.04)	0.03 (0.04)	0.05 (0.04)
GNI								-0.05 (0.06)	-0.08. (0.05)
Democracy								0.24 (0.18)	0.47** (0.15)
Size of Science in Country		-0.09 (0.08)	-0.2*** (0.04)		-0.03 (0.07)	-0.18*** (0.04)			
Carbon Intensity								-0.21. (0.12)	-0.21** (0.06)
Africa	0.54** (0.16)	0.34 (0.23)		0.64*** (0.15)	0.57** (0.21)		-0.18 (0.15)	-0.38 (0.26)	
Asia	0.72*** (0.14)	0.57** (0.19)		0.59*** (0.13)	0.56** (0.17)		-0.1 (0.13)	-0.08 (0.19)	
Latin America	0.21 (0.16)	0.03 (0.22)		0.29* (0.14)	0.23 (0.2)		0.68*** (0.12)	0.5** (0.17)	
North America	-0.09 (0.11)	-0.11 (0.12)		-0.17. (0.1)	-0.17. (0.1)		-0.34** (0.11)	-0.06 (0.19)	
Oceania	-0.19 (0.15)	-0.14 (0.16)		-0.04 (0.14)	-0.02 (0.14)		0.05 (0.14)	0.24 (0.17)	

Table A.3

	Special interests				Free-riding				
	1	2	3	4	1	2	3	4	5
UNFCCC	0.01 (0.1)	0.18. (0.1)	0.13 (0.1)	0.07 (0.11)	-0.1 (0.11)	-0.29* (0.14)	-0.27* (0.14)	-0.16 (0.11)	-0.2. (0.11)
Political Science					0.17 (0.17)	0.25 (0.19)	0.23 (0.19)	0.19 (0.17)	0.2 (0.17)
Economists					0.44*** (0.11)	0.41** (0.12)	0.39** (0.12)	0.45*** (0.11)	0.44*** (0.11)
Nat Sciences					-0.19* (0.08)	-0.15 (0.09)	-0.16. (0.09)	-0.16. (0.08)	-0.17* (0.08)
Male	-0.22** (0.08)	-0.23** (0.08)	-0.23** (0.08)	-0.26** (0.08)	-0.15. (0.08)	-0.15. (0.09)	-0.16. (0.09)	-0.16. (0.08)	-0.18* (0.08)
Age	0.08. (0.04)	0.08. (0.04)	0.08. (0.04)	0.09* (0.04)	-0.08. (0.04)	-0.1* (0.05)	-0.09. (0.05)	-0.08. (0.04)	-0.08. (0.04)
GNI		-0.04 (0.06)	0.03 (0.07)	0.12. (0.06)					
Climate Change Mitigation Performance						0.23** (0.09)	0.08 (0.06)		
Carbon Intensity								-0.21* (0.1)	-0.06 (0.05)
Economic Freedom		-0.07 (0.13)							
Government Effectiveness			-0.32. (0.18)	-0.1 (0.16)		0.23 (0.18)	0.1 (0.12)		
Africa		-0.54* (0.25)	-0.77** (0.26)		-0.29. (0.15)	0.11 (0.41)		-0.36. (0.19)	
Asia		-0.57** (0.2)	-0.65*** (0.18)		0.04 (0.12)	0.38* (0.17)		0.02 (0.12)	
Latin America		-0.15 (0.18)	-0.2 (0.19)		0.03 (0.14)	0.27 (0.24)		-0.06 (0.14)	
North America		0.07 (0.1)	0.04 (0.1)		-0.04 (0.1)	0.09 (0.12)		0.23 (0.16)	
Oceania		0.29* (0.14)	0.25* (0.12)		0.13 (0.14)	0.41* (0.18)		0.3* (0.15)	

Table A.4

	More research			Monetary/tech transfers		
	1	2	3	1	2	3
UNFCCC	-0.02 (0.11)	-0.05 (0.11)	-0.03 (0.11)	0.09 (0.1)	0.1 (0.1)	0.21* (0.1)
Political Science	-0.23 (0.18)	-0.23 (0.18)	-0.24 (0.18)	-0.29. (0.16)	-0.32* (0.16)	-0.34* (0.16)
Nat Sciences	0.18* (0.08)	0.19* (0.08)	0.17* (0.08)			
GNI					0 (0.05)	-0.15*** (0.04)
Size of Science in Country		-0.2** (0.07)	-0.29*** (0.04)			
Africa	0.65*** (0.14)	0.21 (0.2)		0.62*** (0.1)	0.6*** (0.16)	
Asia	0.78*** (0.11)	0.44** (0.16)		0.4*** (0.1)	0.3* (0.14)	
Latin America	0.52*** (0.13)	0.1 (0.2)		0.68*** (0.1)	0.58*** (0.13)	
North America	-0.03 (0.1)	-0.07 (0.1)		-0.26** (0.09)	-0.26** (0.09)	
Oceania	-0.23 (0.14)	-0.11 (0.15)		-0.1 (0.12)	-0.15 (0.12)	

Table A.5

	Compensation to special interests					Behavior/lifestyle change			
	1	2	3	4	5	1	2	3	4
Political Science	0.13 (0.18)	0.14 (0.18)	0.12 (0.18)	0.14 (0.18)	0.12 (0.18)	-0.22 (0.16)	-0.18 (0.16)	-0.16 (0.16)	-0.18 (0.16)
Male	-0.15. (0.09)	-0.17. (0.09)	-0.13 (0.09)	-0.18* (0.09)	-0.15 (0.09)	-0.23** (0.07)	-0.24** (0.07)	-0.24** (0.08)	-0.26** (0.08)
Age	0.11* (0.05)	0.12* (0.05)	0.09* (0.05)	0.12* (0.05)	0.11* (0.05)				
GNI								-0.06 (0.06)	-0.12** (0.05)
Democracy								0.04 (0.17)	0.22 (0.15)
Carbon Intensity		-0.02 (0.11)	-0.2** (0.06)	-0.08 (0.1)	-0.21** (0.06)			-0.16 (0.1)	-0.13* (0.06)
Economic Freedom				-0.25* (0.11)	-0.31** (0.09)		-0.02 (0.1)		
Government Effectivness		-0.53** (0.16)	-0.42*** (0.1)						
Africa	0.51** (0.15)	0.08 (0.24)		0.41* (0.2)		0.12 (0.13)	0.04 (0.17)	-0.17 (0.22)	
Asia	0.52*** (0.13)	0.22 (0.16)		0.36* (0.15)		0.15 (0.11)	0.12 (0.13)	0.02 (0.16)	
Latin America	0.13 (0.14)	-0.32. (0.18)		-0.1 (0.16)		0.69*** (0.1)	0.68*** (0.11)	0.57*** (0.13)	
North America	-0.42*** (0.1)	-0.38* (0.17)		-0.26 (0.17)		-0.2* (0.1)	-0.2* (0.1)	0.03 (0.16)	
Oceania	-0.17 (0.14)	-0.13 (0.17)		-0.01 (0.18)		0.14 (0.12)	0.12 (0.14)	0.29* (0.14)	

Operationalization and Data Sources

Variable: GNI

Source: World Bank (https://data.worldbank.org/indicator/NY.GNP.PCAP.CD)

Details: Gross National Income per capita 2015 in US Dollar (version 21.05.2018).
GNI per capita (formerly GNP per capita) is the gross national income, converted to U.S. dollars using the World Bank Atlas method, divided by the midyear population. GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad. GNI, calculated in national currency, is usually converted to U.S. dollars at official exchange rates for comparisons across economies, although an alternative rate is used when the official exchange rate is judged to diverge by an exceptionally large margin from the rate actually applied in international transactions. To smooth fluctuations in prices and exchange rates, a special Atlas method of conversion is used by the World Bank. This applies a conversion factor that averages the exchange rate for a given year and the two preceding years, adjusted for differences in rates of inflation between the country, and through 2000, the G-5 countries (France, Germany, Japan, the United Kingdom, and the United States). From 2001, these countries include the Euro area, Japan, the United Kingdom, and the United States.

Variable: Climate Change Mitigation Performance

Source: Germanwatch (https://germanwatch.org/en/download/13626.pdf)

Details: Climate Change Performance Indicator 2016 - On the basis of standardised criteria, the index evaluates and compares the climate protection performance of 56 countries and the EU. 80 percent of the evaluation is based on objective indicators of emissions, renewable energy and energy use. 20 percent of the index results are built upon national and international climate policy assessments by about 300 experts from the respective countries.

Variable: Democracy

Source: Center for Systemic Peace (http://www.systemicpeace.org/polityproject.html)

Details: For measuring the level of democracy, we have used the PolityIV Score. The PolityIV Score is published by the Center for Systemic Peace's. The Polity IV Dataset covers all countries (also termed polities) with a population greater than 500,000 in the previous year of data collection, currently providing data on 167 polities between 1800 and 2015. For each year and polity, a score is calculated on a sliding 21 point range from -10 (hereditary monarchy) to +10 (consolidated democracy). This score can then be converted into separate regime categories with -10 to -6 referring to autocracies, -5 to +10 corresponding to anocracies and 6 and upwards denoting democracies. The Polity data series is compiled of six component measures trying to capture key qualities of executive recruitment, constraints on executive authority and political competition.

The Polity scheme consists of six component measures that record key qualities of executive recruitment, constraints on executive authority and political competition. It also records changes in the institutionalized qualities of governing authority. The level of democracy (0 to +10) is conceptualized and measured with three essential, interdependent elements: (1) presence of institutions and procedures through which citizens can express effective preferences about alternative policies and leaders, (2) the existence of institutionalized constraints on the exercise of power by the executive, and (3) the guarantee of civil liberties to all citizens in their daily lives and in acts of political participation. The level of autocracy on the other hand (-10 to 10) is defined in terms of the presence of a distinctive set of political characteristics. In mature form, autocracies sharply restrict or suppress competitive political participation. Their chief executives are chosen in a regularized process of selection within the political elite, and once in office they exercise power with few institutional constraints.
The POLITY score itself is a combination of democracy and autocracy index values in a unitary score by subtracting the AUTOC score from the DEMOC score. In this study, we used the revised combined polity score POLITY2. The difference between the POLITY and POLITY2 variable lies in their respective coding. For the POLITY2 variable, standardised authority scores are converted to conventional polity scores within the range of -10 to +10, which then make time series analyses possible.

Variable: Size of Science in Country

Source: World Bank (https://data.worldbank.org/indicator/IP.JRN.ARTC.SC?view=chart)

Details: Scientific and technical journal articles per Capita in 2015. Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences. We divided the number of articles by the total population of a country and multiplied the indicator by 1 million.

Variable: Carbon Intensity

Source: Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States., provided by the World Bank (https://data.worldbank.org/indicator/EN.ATM.CO2E.PC)

Details: CO2 emissions (metric tons per capita) in 2011. Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

Variable: Economic Freedom

Source: World Heritage Foundation (https://www.heritage.org/index/)

Details: The Index of Economic Freedom is an annual index and ranking created by The Heritage Foundation and The Wall Street Journal in 1995 to measure the degree of economic freedom in each country. It covers 186 countries and is compiled based on 12 quantitative and qualitative factors grouped into four categories.

Rule of Law	**Government Size**	**Regulation**	**Open Markets**
property rights	Government Spending	Liberalization of Enterprise	Trade Barriers
government integrity	Tax Level	Liberalization of Labor	Liberalization of investment activities
judicial effectiveness	Fiscal Spending	Liberalization of monetary System	Liberalization of money markets

Each indicator is ranked on a 0-100 scale and the country's overall score is built as an average of all 12 indicators.

Variable: Government Effectiveness

Source: World Bank (http://info.worldbank.org/governance/WGI/#home)

Details: For the Governance Effectiveness we used the World Governance Indicators (WGI) from the year 2016. They are also published by the World Bank and have been conceptualized by Daniel Kaufmann and two of his colleagues.

They understand Governance as the tradition and institutions how authority is exercised in a particular country. "This includes (1) processes by which governments are selected, monitored, held accountable, and replaced; (2) the capacity to manage resources efficiently, and formulate, implement, and enforce sound policies and regulations, and (3) the respect of the citizen and the state for the institutions that govern social and economic interactions among them." The data is generated through combination of hundreds indicators that mainly summarize information collected by household and company surveys but also include subjective assessments from business information providers, NGOs, multinational organizations, and other public-sector bodies. (D., Kraay, A., & Zoido-lobatón, P. (1999). Governance Matters. World Bank Working Paper. https://doi.org/10.2139/ssrn.188568)

Table A.6: Categories of individual answers to whether there was a more important obstacle/response that was not included in the list and the number of times it was mentioned

Obstacles (261 individual answers)	Number of mentions	Responses (110 individual answers)	Number of mentions
lack of political will/commitment/leadership	44	change of economic system	6
scale of the problem/transformation too large	14	adaptation	5
capitalism/neoliberalism/growth as the core of the economic system	14	more social science research (transformation)	5
ideology/polarisation plays large role in decision making	12	geoengineering	5
myopia in decision making	11	binding international commitments	4
human/social/behavioral decisions not rational	9	polycentric approach to climate governance	3
any obstacles related to adaptation	8	cultural change	3
lack of finance	7	fossil fuel subsidy phase out	2
misinformation	6		
Trump	6		
climate change action is not priority	5		