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Designing Carbon Pricing Policies Across the Globe

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Abstract

This study presents a large-scale, multi-country assessment of expert recommendations on key policy design options for implementing carbon pricing schemes at a country level, for which there is no consensus in the literature. Based on a survey of more than 400 academic experts on carbon pricing across the globe, we find that almost twice as many favor a carbon tax over a cap-and-trade scheme for unilateral carbon pricing than vice versa, and three-quarters strongly recommend using border carbon adjustment to address competitiveness concerns. By contrast, guidance on the use of revenue from carbon pricing is much more nuanced, with considerably lower support for lump-sum transfers to households than reflected in academic and policy discussions. Furthermore, recommendations on instrument choice and revenue use vary considerably with country and expert characteristics, such as GDP per capita and academic discipline. Our findings can guide the search for suitable public policy approaches that combine environmental effectiveness with economic efficiency and fairness considerations.

Keywords Carbon pricing · Expert survey · Instrument choice · Border carbon adjustment · Revenue recycling

JEL classification Q54, H43

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1 Introduction

There is a broad consensus among economists that carbon pricing is a key building block of an effective climate policy mix. Carbon pricing has become more widespread and more stringent in recent decades, partly via diffusion between neighboring countries (Linsenmeier et al. 2023). By the year 2024, more than 50 national jurisdictions had implemented carbon pricing schemes that collectively covered around a quarter of global greenhouse gas emissions (World Bank 2025). These existing schemes exhibit considerable heterogeneity in terms of instrument choice, stringency, as well as the use of revenues. Recent debates regarding implementation have been informed by surveys of the population (e.g., Carattini et al. 2019; Douenne and Fabre 2022; Dechezleprêtre et al. 2025) and distilled in panels of and petitions by general economists in North America (e.g., IGM 2018; Wall Street Journal 2019) and in Europe (EAERE 2019, 2022). With three-quarters of emissions still being unregulated by explicit carbon pricing (World Bank 2025), it is crucial to obtain a better understanding of how to best design carbon pricing to guide policy initiatives.

The question of whether a carbon price should be implemented as a carbon tax, via a cap-and-trade scheme, or some mix of instruments has occupied scholars for decades (Weitzman 1974; Karp and Traeger 2024; Stavins 2022). Furthermore, the benefits and drawbacks of border carbon adjustment (BCA) as a means to protect the competitiveness of domestic industries under unilateral carbon pricing have been intensely debated in recent years.¹ Similarly, the use of revenues from carbon pricing is subject to intensive debate, not least due to its potential effects on public acceptance of carbon pricing and its political feasibility (Carattini et al. 2019; Klenert et al. 2018; Douenne and Fabre 2022). There are also a number of disciplinary differences in views on the role of carbon pricing, as illustrated by a recent debate between economists and other climate policy experts (Rosenbloom et al. 2020a, 2020b; Van den Bergh and Botzen 2020). So far, no consensus view has emerged on any of these key policy design issues, nor do we know how recommendations differ across countries.

The goal of this paper is two-fold. First, by presenting the results of the largest survey among experts on carbon pricing around the globe at the time, we offer a more representative account of experts' views on these crucial but controversial issues than previously available. Second, by using additional data on characteristics of the experts and on their countries, we shed light on some of the drivers of the heterogeneity in their recommendations. Our research question can thus be summarized as: "What do experts around the globe recommend on key policy design options for implementing carbon pricing schemes, and how do experts' recommendations differ across country and expert characteristics?"

Expert surveys and elicitations have gained prominence in the past few years as a way to inform different stakeholders about complex issues in climate science and economics.² Our study targets a broad population of academics sourced as (potential) experts on carbon

¹ While BCA has been discussed as a potential barrier to trade (e.g., Böhringer et al. 2022; Cosbey et al. 2019), it may be amenable to establishing effective carbon prices unilaterally in a non-cooperative world (e.g., Böhringer et al. 2022), or for fostering cooperation (Helm and Schmidt 2015; Al Khourdjie and Finus 2020), and has gained substantial prominence, as exemplified by the EU's planned Carbon Border Adjustment Mechanism – CBAM (European Commission 2021).

² Examples of recent expert surveys and elicitations in climate science and economics include, among others, Andre et al. (2022); Boumans et al. (2024); Christensen et al. (2018); Dannenberg et al. (2017); Dannenberg and Zitzelsberger (2019); DellaVigna et al. (2019); Drews et al. (2024); Drupp et al. (2018, 2024); Gollier et

pricing by virtue of their pertinent and cited publications. Our systematic search process revealed 2106 authors on this topic around the globe. More than 500 authors responded to our survey and 467 experts provided responses on climate policy design, which we report in this paper. The survey combined two thematic parts: one part focusing on key policy design questions for which there is no consensus in the literature, and another part where experts provide carbon price recommendations. Results from the policy design part are presented and analyzed in this paper, whereas experts' carbon price recommendations are scrutinized in a companion paper (Drupp et al. 2024). The survey closed with a question on potential determinants of experts' recommendations and an open field where experts could provide further remarks. In addition to the survey data, we draw on country-level data (e.g., GDP per capita), and on observable expert characteristics, such as experts' publication record or gender, or whether an expert has published in economics journals, to shed light on possible determinants of recommendations.

We first document experts' recommendations on aggregate for each of our key policy design questions, and then split the recommendations by the countries for which experts chose to provide their recommendations (Sect. 4.1). Subsequently, we analyze possible drivers of experts' recommendations (Sect. 4.2). Among our key findings is that almost twice as many experts favor a carbon tax over a cap-and-trade scheme for unilateral carbon pricing than vice versa. However, there is substantial variation across continents and countries. For example, a carbon tax is most strongly preferred in North America, while experts from Germany and Spain recommend cap-and-trade more often than experts from other European countries. Three-quarters of all experts *strongly* recommend using BCA to address competitiveness concerns, with little heterogeneity across continents and countries. By contrast, guidance on revenue use from carbon pricing is much more nuanced. For example, when allowing respondents to recommend multiple options, we find strongest support for "green R&D" (59% of experts chose this option among others), followed by "transfers to particularly affected households" (56%). However, when each expert was asked to indicate only one "most recommended option", the option "transfers to particularly affected households" ranks first, followed by "equal lump-sum transfers to households" and "reduction of distortionary taxes". Experts' recommendations on revenue usage also strongly depend on an expert's geographic context. For instance, the option "equal lump sum transfers to households" ranks first among North American experts (30%), whereas this option was indicated as most preferred by only 2% of Asian experts.

When analyzing drivers of experts' recommendations, we reveal systematic differences along country- and expert characteristics, such as GDP per capita and academic discipline. E.g., we find that the clear and significant support for carbon taxes over cap-and-trade only exists in countries with a high GDP per capita. Furthermore, regarding revenue usage, we document that while economists recommend lump-sum transfers and reductions in distortionary taxation more often, in line with efficiency considerations, non-economists rather recommend revenue use options via governmental spending, such as subsidies for renewables, which can help to raise public support for climate policies.

Overall, our data shows that experts' views are substantially more nuanced than previously acknowledged by the limited prior evidence. For example, the well-known IGM Economic Experts Panels were only conducted among a small set of general economists,

al. (2023); Howard and Sylvan (2020); Kornek et al. (2020); Meng et al. (2021); Moore et al. (2024); Nesje et al. (2023); Otto et al. (2020); Pindyck (2019); Victor et al. (2022); Zickfeld et al. (2007).

mostly without special climate policy expertise. In the US IGM Economic Experts Panel (2018), 66% of the panel members agreed to the statement that “Carbon taxes are a better way to implement climate policy than cap-and-trade”, 29% were uncertain. No single IGM Economic Experts Panel (2018) member expressed disagreement. In the European IGM (2020), which asked the same question, 53% of the panel members agreed, and 35% were uncertain. However, 11% expressed disagreement, preferring, for instance, emissions trading. Our data allows us to investigate, e.g., whether these differences carry over to experts on carbon pricing both within and beyond economics, or whether policy recommendations by American and European experts are representative of experts’ views in other parts of the world. A representative account of expert views on the implementation of BCA, as well as on the usage of revenues from carbon pricing is also missing in the literature.

The remainder of the paper is structured as follows: Sect. 2 provides a more detailed literature review. Sect. 3 introduces our methodology for the survey design and expert selection, and gives a broad overview of our data. Sect. 4 presents the results and analyzes possible drivers of experts’ recommendations on carbon pricing policy design. Sect. 5 discusses limitations of our methodology and approach. Sect. 6 concludes. The Online Appendix contains the full survey text and further details on our methodology and results.

2 Literature Review

In this section, we provide succinct reviews of the literature on each of our three key policy design issues: instrument choice, border carbon adjustment, and revenue use. We also discuss the role of surveys and professional petitions in this context.

First, whether a carbon tax is a preferable instrument for regulating greenhouse gas emissions in a country as compared to a cap-and-trade scheme, or vice versa, has been subject to recurring debates among economists and climate policy experts. Until today, there has been no consensus on this issue. Furthermore, an answer likely depends on numerous aspects that may differ across countries. Beginning with Weitzman’s (1974) seminal paper, several studies investigated when one instrument may dominate the other. Weitzman (1974) finds that, given uncertainty about the benefits and costs of abatement, taxes are preferable to emissions trading if the slope of the marginal cost curve is steeper than that of the marginal benefit curve. Newell and Pizer (2003) use a related framework with a stock externality and argue that in a dynamic context, an analog to this criterion is likely fulfilled when the model is applied to the problem of greenhouse gases (see also Hoel and Karp 2002). Karp and Traeger (2024) revisit the problem and instead find that persistence of greenhouse gases and technological innovations tend to favor cap-and-trade. While some of Weitzman’s original arguments carry over to strategic settings with multiple countries (e.g., Mideksa and Weitzman 2019), political economy considerations may affect instrument choice and recommendations for one, the other, or a hybrid approach (e.g., Hepburn 2006; Stavins 2022).

Prior survey work among academics is scarce on this topic, with the US IGM (2018), and the European IGM (2020), discussed in the introduction, providing prominent points of comparison prior to our study, and possibly affecting the views of some of our respondents. After our survey was conducted, Drews et al. (2024) surveyed a wide population of scientists (who published in the context of climate change mitigation) on criteria and policy instruments, assessed on a five-point scale. These authors find that all six presented instru-

ments, including carbon taxes and cap-and-trade schemes, are considered important, with direct regulation receiving the highest rating and cap-and-trade the lowest. They further explored a number of determinants, including the weight given to specific policy criteria, world views, research fields and continents, and find particularly strong support for carbon taxation among economists and more disciplinary variation in views regarding cap-and-trade. By contrast, our survey is more detailed on carbon pricing instruments, including sub-types of cap-and-trade or hybrid approaches, and allows investigating the heterogeneity of recommendations along country characteristics in more detail, but does not shed systematic light on non-market instruments. Lerner et al. (2025) complement our focus on academic experts by studying the views of 97 policy experts in developing countries, who have been involved with carbon pricing in practice, with a particular focus on how practitioners engage with trade-offs concerning effectiveness and feasibility of implementation. While expert surveys obviously cannot provide definite answers to the question of instrument choice, we can offer a more representative account of what experts recommend on this important but difficult issue across almost 40 countries. Because most of our responses are non-anonymous, we can also shed light on detailed country-level and expert determinants of instrument choice recommendations.

Second, the literature on border carbon adjustment (BCA/CBAM), initiated by a concern for carbon leakage (Hoel 1996), is also growing. While numerous more recent studies highlight the potential benefits of this instrument to overcome competitiveness issues related with unilateral carbon pricing (e.g., Böhringer et al. 2022) and find that BCA can also foster cooperation among countries (Helm and Schmidt 2015; Al Khourdajie and Finus 2020; Beaufils et al. 2024), the instrument is highly controversial due to complex legal issues. For instance, it may be seen as a potential barrier to international trade. Cosbey et al. (2019) discuss, among other things, how legal challenges in the context of the WTO interact with the design of the carbon pricing system of the regulating country, and the design of the BCA scheme. Böhringer et al. (2022) also argue that while BCA may appeal for several reasons “at first glance”, most countries largely shy away from using this instrument to avoid the risk of trade conflicts. While our study obviously cannot resolve the numerous and complex legal issues related to how border adjustments and carbon prices are implemented, we can shed light on the overall assessment of BCA among experts. In the light of this, we were careful in the design of the survey question and asked each expert if they would “strongly recommend introducing a border carbon adjustment scheme (if that is possible)” (see Sect. 3 for further details). With the exception of a petition among environmental economists in Europe (EAERE 2022), we are not aware of another expert survey on border carbon adjustment to date.

Third, the key policy design question of how to best use the revenues from a carbon pricing scheme is equally controversial. While early studies focused on how overall efficiency could be improved if revenues from carbon pricing were used to lower distortionary taxes (cf. the double dividend hypothesis of Bovenberg and De Mooij 1994), other contributions have largely focused on assessing revenue recycling options like rebates and public investments in addition to tax reductions. An issue is that there is a multitude of different ways in which these revenues could be used (see Barrez (2024) for a topology of revenue use options). While specific revenue use options have been emphasized in certain parts of the literature or by specific groups (e.g., the influential “Economists’ Statement on Carbon Dividends” (Wall Street Journal 2019) recommends lump-sum transfers), no single

option strikes out as preferred from both a theoretical and applied standpoint. For example, while a survey among citizens highlights that returning revenues to citizens is crucial for public support for a carbon pricing scheme (Carattini et al. 2019), other evidence suggests that existing rebate programs in Canada and Switzerland had only limited effects on public support of carbon pricing policies (Mildenberger et al. 2022). Similarly, as with the other key policy design options covered by our survey, we cannot offer a final resolution of the question which option is “best”, but our data can offer a more representative account of the heterogeneous expert views on this issue.

Whereas our focus is on experts’ views, other authors have conducted surveys on related questions among citizens. For instance, Carattini et al. (2019) surveyed around 5000 citizens in five countries, presenting a range of tax designs that include different revenue usage issues. These authors find that three designs receive a majority support in all five countries: “lowering income taxes, redistributing revenues domestically to each citizen, and earmarking funds for mitigation projects in all countries”. Douenne and Fabre (2022) use a survey among French people and find that these would largely reject a “carbon tax whose revenues are redistributed uniformly to each adult” (but also argue that changing people’s beliefs can increase support). We are not aware of an expert survey on revenue use from carbon pricing.

Finally, while no expert survey has investigated carbon pricing policy design as comprehensively as ours, it is still useful to compare and contrast our methodology with related approaches. Other recent surveys have investigated, among others, expert views on the social cost of carbon (e.g., Moore et al. 2024; Pindyck 2019), important determinants, such as discount rates or economic damages from climate change (e.g., Drupp et al. 2018; Gollier et al. 2023; Howard and Sylvan 2020; Nesje et al. 2023), or forecasts of economic growth rates and technology costs (e.g., Christensen et al. 2018; Meng et al. 2021), as well as views on international climate negotiations and policy implementation barriers (e.g., Dannenberg et al. 2017; Kornek et al. 2020; Victor et al. 2022). These surveys in the climate policy context have differed in at least two dimensions.

First, surveys differ in the type of information that they seek. They may, for instance, elicit facts or forecasts (e.g., Christensen et al. 2018; Meng et al. 2021), test the understanding of mechanisms or assessment of barriers to climate action (e.g., Kornek et al. 2020), or elicit recommendations (e.g., Drupp et al. 2024). Frequently, expert surveys have contained a mix of eliciting factual information, such as forecasts, as well as recommendations or views, including those that may exhibit normative content (see, e.g., Drupp et al. 2018; Moore et al. 2024; Nesje et al. 2023; Pindyck 2019). Here, our main focus is on policy design recommendations, and we solely elicit factual expectations, such as on mitigation costs and climate damages, as potential determinants of these recommendations.

Second, surveys differ in whether they target wide populations (e.g. Drews et al. 2024) or narrow populations (e.g. Christensen et al. 2018), striking a balance between different considerations. Targeting a wider audience may help gather a more representative account of expert views, but it generally leads to much lower response rates, connected issues of response bias and a potentially diluted extent of expertise and/or less control or information about the sample. For instance, Christensen et al. (2018) carried out an elicitation of a hand-selected sample of 16 experts concerning forecasts of long-term growth, with full information on identities but without assessing whether they are representative of broader expert views on the topic. By contrast, Drews et al. (2024) contacted more than 15,000 scientists who have published on climate change mitigation with a keyword-based search strategy

and obtain a response rate of 5% without being able to assess non-response and strategic response bias due to the anonymous nature of the survey. In between these two contrasting cases, Moore et al. (2024) contacted all 176 authors of studies in a meta-analysis on the social cost of carbon and obtained a response rate of 39%, of which the majority responded non-anonymously. Here, we target a relatively broad sample of more than 2000 experts on carbon pricing in general. Thus, while all will have some general familiarity with carbon pricing policy design, expertise on specific sub-elements will be heterogenous.

3 Methodology and Data

3.1 Expert Selection

To identify experts, we ran an automated keywords search in SCOPUS, and defined a potential expert as a (co-)author of at least two publications matching our keyword criteria since the year 2000, that have been cited at least once. The search string contained “carbon tax”, “cap-and-trade”, and variations of these and equivalent terms (see Online Appendix A.1.2 for the full search string). We narrowed our sample to those experts for whom we could find a workable e-mail address. This way, we identified 2106 potential publication-based experts on carbon pricing. Although other definitions of expertise exist, several of the studies cited above also rely on objective criteria like publication-based expertise rather than hand-selected experts.

Among these experts, we conducted an online survey on carbon pricing. Invitations to the survey were sent out by e-mail. The survey took place from June to November 2019, with four rounds of reminders. By the end of November 2019, we received 574 responses (including 97 explained non-responses), with 468 providing responses on policy design issues, amounting to a response rate of at least 22%. Out of the responses, 406 were non-anonymous, with experts providing their name to us at the end of our survey, while 62 were anonymous. We make use of this information to test for strategic response bias in Sect. 5.3. For further details on our research methodology, see Online Appendix A.1.

3.2 Survey Design

In the survey, we included questions on key policy design issues that are analyzed in the present paper: instrument choice, border carbon adjustment, and revenue usage. We provide the main questions in Table 1. Note that, to gain first representative insights on carbon pricing design, we aimed at surveying high-level information in each category, while giving experts the option to provide more detailed qualitative comments at the end of the survey. Furthermore, we asked each expert questions on their recommended level of carbon prices in different scenarios that we analyze in a companion paper (Drupp et al. 2024), which solely uses recommendations for policy design at a more aggregated level alongside other covariates to explain the variation in recommended carbon price levels. Additionally, we included a question on potential determinants of experts’ recommendations (such as global emission reduction targets or expected climate damages). The full survey text (including the preamble) is available in Online Appendix A.1.1.

Table 1 Summary of survey questions on policy design issues

Country	<i>Please specify the country you would feel most comfortable advising on carbon pricing (below, we will refer to this as "your country").</i>
Instrument choice	<i>Assuming that no carbon pricing scheme has been implemented in your country yet, which instrument would you recommend? Carbon tax, cap-and-trade with price collar (price floor and price cap), cap-and-trade without price collar, other (please specify).</i>
BCA	<i>If your country implements a carbon pricing scheme unilaterally, would you strongly recommend introducing a border carbon adjustment scheme (if that is possible)?</i>
Revenue usage	<i>How should your government use the revenues raised by carbon pricing? (Multiple answers are possible)</i> a) General government spending b) Equal lump-sum transfers to households c) Transfers to particularly affected households d) Reduction of distortionary taxes e) Grandfathering or tax cuts for firms f) Transfers to particularly affected firms g) Spending on environmental public goods h) Green R&D i) Subsidies for renewable energy j) International transfers to countries particularly affected k) International transfers to support climate policy in other countries l) Other.

If you suggest more than one use, please indicate your most recommended option.

Notes: The table provides a summary of the survey questions (shortened) related with key policy design issues. The full survey text is in the Online Appendix

The rationale behind the first question (about an expert's country) is that experts could participate anonymously in our survey. As noted above, they were asked to reveal their identity at the end of the survey, but 13% refrained from doing so. Additionally, an expert's current affiliation may not coincide with the country that the expert feels more ready to advise on carbon pricing policy, especially if it is not the expert's home country. We thus left it at experts' own discretion to choose "their country".

The second question on the choice of an instrument for carbon pricing focused on the two that are widely seen as the most effective ones among economists: taxation (carbon tax) and emission trading (cap-and-trade, with or without a price collar). Other approaches such as "command-and-control" type of regulations are usually seen as inefficient and were, thus, left out from the pre-defined categories. However, experts were free to indicate any instrument choice or to provide more detailed considerations under the open-ended "Other" option.³

Also, the next question on BCA aims at the high level: whether border carbon adjustment is *strongly* recommended. We did not specify which instrument choice the scheme is established in conjunction with and abstracted from other implementation issues related to it. Our interest is, simply put, to shed light on the broad question of whether experts generally find BCA (highly) recommendable.

Our revenue usage options were designed to include the main options covered in recent academic and policy discussions. Also here, we did not specify implementation details.⁴ Motivated by the vast range of possible revenue usage options (and combinations of those), we pre-defined options that could be selected. Compared to only offering an open response field, pre-defining broad usage categories helped organizing the data. As for the instrument choice question, we added an open-ended "Other" option to capture more nuanced views.

3.3 Data

Our primary data derives from the expert survey. The variables of interest include instrument choice (including the "other" option), BCA choice, revenue usage (each selected option, the most recommended option, as well as the "other" option). From the survey, we also recorded the timing of responses, which we use to test for strategic response bias in Sect. 5.3. Table A1 in the Online Appendix gives a descriptive overview. A more complete descriptive overview is provided in the next section where we present the results. A full list of variables for all the data is given in Table A2 in the Online Appendix, where it is also recorded whether variables are of the dummy, count, numerical, categorical, or textual types. We also provide further insight into how the variables are coded.⁵

³ We did not differentiate sub-level implementation questions, such as whether a carbon price is applied to households, industrial firms, or other entities. While such issues are undeniably important for public policy, we aimed at a general comparison of carbon tax vs. cap-and-trade to keep the survey succinct. This design is deliberate, and the survey was piloted beforehand (Drupp et al. 2024).

⁴ For example, "transfers to particularly affected firms" (option f in Table 1) may cover some forms of rebating that we did not specify, as our interest lies with identifying experts' broader views on revenue use.

⁵ We also indicate in the next section when results are based on re-coded variables (for instance, to ease comparisons). Note that while we summarize the type of responses under the "Other" options for instruments and revenue use when we document experts' recommendations on aggregate, this data is not re-coded into the remaining pre-defined categories in further analysis of the data. E.g., we do not re-classify a reply to the "Others" option for instrument choice that may resemble a carbon tax as "Carbon tax".

As part of the expert survey, we also record the following determinants of carbon pricing to analyze drivers of experts' recommendations: the global emission reduction targets, reduction costs, expected climate damages (also in percent), as well as utility discounting (see Fig. 1). The variables are categorical from 1 to 5 according to the order of pre-defined options in the survey text.

Outside of the survey, we used further data sources in order to analyze possible drivers. Based on an expert's country, as revealed in the survey, we collected country-level data including CO2 emissions, GDP per capita, fossil fuel energy consumption, mean of world governance indicators rank score, climate change knowledge, as well as the existing weighted carbon price and type of regulation in the country, if any (Dolphin 2022; Pelham 2009; World Bank 2022a, b, c, d). These variables are also used to test for non-representation bias in Sect. 5. A descriptive overview of our survey data and country characteristics is presented in Table A1.

We have also collected publicly observable information on the experts who provided their name to us at the end of our survey. These data were collected from SCOPUS (Elsevier

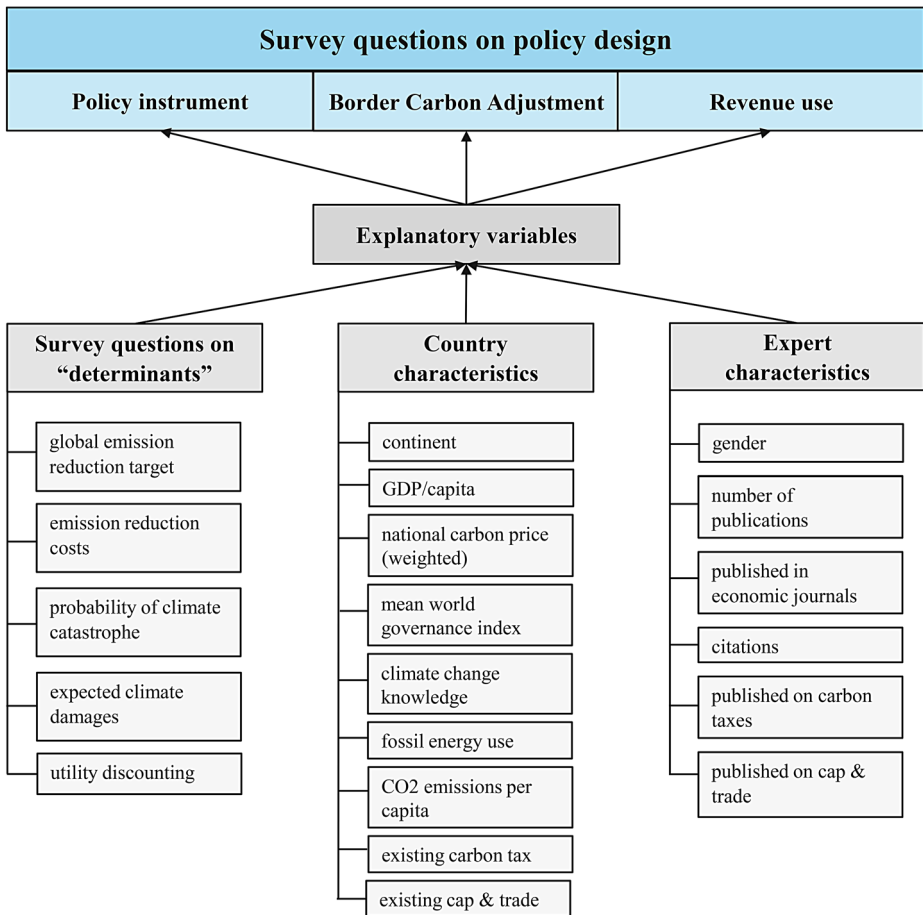


Fig. 1 Overview of survey questions and the three pillars of explanatory variables used for analyzing policy design recommendations

Table 2 Selected descriptive overview: expert characteristics

Variable	Respondent		Population	
	Mean	Obs.	Mean	Obs.
Region of affiliation: Europe (0=no, 1=yes)	54%	428	43%	1890
Region of affiliation: Oceania (0=no, 1=yes)	8%	428	8%	1890
Region of affiliation: Asia (0=no, 1=yes)	12%	428	21%	1890
Region of affiliation: South America & Africa (0=no, 1=yes)	1%	428	2%	1890
Gender (0=female, 1=male)	84%	428	82%	1789
Number of publications	3.88	435	3.47	2009
Published in Econ journals (0=no, 1=yes)	51%	435	41%	2009
Number of citations	97.37	435	91.89	2009
Published on tax (0=no, 1=yes)	53%	435	49%	2009
Published on cap-and-trade (0=no, 1=yes)	9%	435	10%	2009

Notes: By population, we refer to all potential experts

2019) and the web pages of experts. The variables of interest include gender, whether the expert has published on the topic in economics journals, the region of affiliation as well as further details (i.e., number of publications and citations) and whether the publications concern topics such as instrument choice. Importantly, the collected data allows us to compare respondents to the population of experts in terms of their key characteristics (c.f., Nemet et al. 2017): gender, field, country, and proxies of academic seniority including number of publications and number of citations. Table 2 presents a selected descriptive overview, indicating, for example, that economists with a European affiliation selected into responding to the survey. We use this data for the non-response bias tests reported below. Moreover, we also collect expert characteristics such as the round in which an expert responds to address strategic response bias.⁶

Standard concerns with surveys, related to non-response bias, strategic response bias, and non-representation bias are addressed in Sect. 5, building on the data collected. We do not find evidence for non-response bias and strategic response bias in our survey. There is some evidence of non-representation bias, but this is to be expected as the population of experts is not globally representative.

4 Results

4.1 Descriptive Results

Instrument choice:

Figure 2 shows recommendations on instrument choice on aggregate and split by continents and countries. We find that, on aggregate, almost twice as many experts recommend using a carbon tax (49%) as compared to cap-and-trade with (23%) or without (6%) a price

⁶To preserve the anonymity of respondents, we only report results of aggregated data that makes use of these expert characteristics and we do not provide this data linked to individual survey responses. For linked country-level data, we set the threshold at a minimum of five potential experts from a country within the full population of potential experts and here also report data on policy design responses at a country-level only when at least five experts from a given country responded.

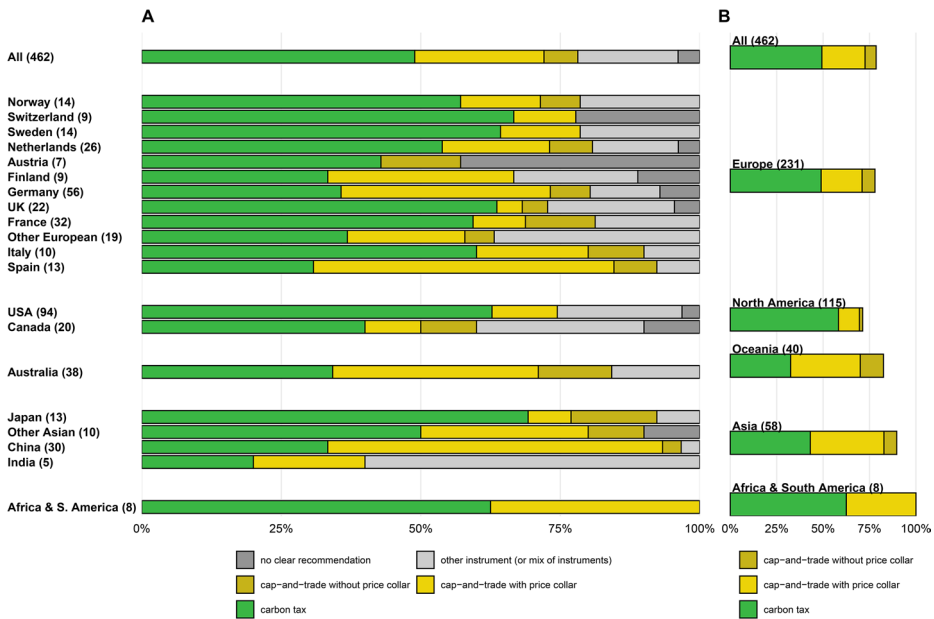


Fig. 2 Carbon pricing instruments. The shares of experts recommending the use of certain carbon pricing instruments, by experts’ countries (panel A), and continental groups of countries (panel B), with carbon tax (green), cap-and-trade with price collar (yellow), cap-and-trade without price collar (dark yellow), other instrument or mix of instrument (light gray), and no clear recommendation (dark gray). Countries are ordered by continental groups and along GDP per capita within a continent. (Number of observations in parentheses)

collar. A carbon tax is thus clearly preferred over cap-and-trade schemes on aggregate (two-sided t-test: $p < 0.000$). While 4% of experts selected “no clear recommendation” regarding instrument choice, 18% recommend some “other instrument or mix of instruments”. These were then asked to specify what other instrument or mix of instruments they had in mind. The majority of these responses also contain some variant of “carbon tax” or “cap-and-trade” in combination with other instruments or additional measures. The ratio of prices vs. quantities in these qualitative responses is very similar to the one in the overall sample. Around 10% of these experts recommend cap-and-trade specifically for larger emitters or energy intensive industries, and a carbon tax for smaller emitters or other sectors, such as for agriculture or small and medium-sized firms (see Table A3 in the Online Appendix for further details).

Examining the heterogeneity of recommendations across continents and countries, we find that a carbon tax is most strongly preferred over any other instrument in North America (two-sided t-test: $p < 0.000$), followed by Africa & South America. The share of European experts who prefer a carbon tax (49%) coincides with the share of experts who prefer a tax in the overall sample. There are some notable exceptions within Europe, though. For instance, experts from Germany and Spain recommend cap-and-trade more often (see Fig. 2 Panel A). Furthermore, 50% of the experts from Oceania recommend cap-and-trade, with a lower support for carbon taxes, whereas Asian experts are almost equally split in their preference for tax vs. cap-and-trade. Among Asian experts, those from China exhibit a clear preference for cap-and-trade with a price collar.

Border Carbon Adjustment (BCA):

Regarding experts’ views on BCA, we find that 74% of all respondents strongly recommend its usage (if that is possible), assuming that their country plans to implement a (new) carbon pricing scheme unilaterally (see Fig. 3). We find that this recommendation for BCA is consistent across all continents and virtually all countries. Solely experts from Norway are split equally between a strong recommendation on BCA or not (see Fig. 3 Panel A). On the other end, all experts from Switzerland strongly recommend the usage of BCA.

Revenue use:

Experts’ recommendations on the use of revenues from carbon pricing display substantial heterogeneities. We first asked respondents to choose one or several among *multiple options* for the recommended usage of the revenues (see Table 3). Here, we find the strongest support for “green R&D”: 59% of the respondents who answered the question chose this option (among others). The second most frequently suggested usage is “transfers to particularly affected households” (56%), followed by a reduction in distortionary taxes (43%). The option “equal lump-sum transfers to households” was chosen only by 25% of respondents. This contrasts strongly with the “Economists’ Statement on Carbon Dividends” (Wall Street Journal 2019) that explicitly recommended (only) lump-sum transfers. Some of the detailed responses also contain other ways to use the revenues than our specified options. Examples include “climate adaptation”, “dealing with the regressive impacts on poorer households ... in order to mitigate political resistance”, “green infrastructure investments”, “international transfers to support carbon sinks in other countries”, and “transfers to low-income households” (see Table A4 in the Online Appendix).

Among the largest discrepancies between the recommendations of experts from different continents are much stronger support for equal lump-sum transfers in North America (42%), compared to the rest and especially compared to Asia (9%); higher support for transfers to

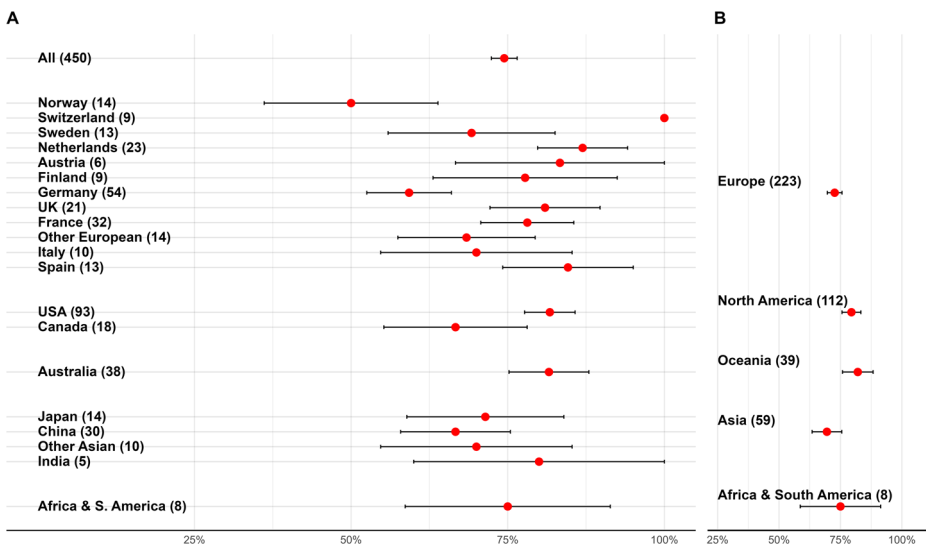


Fig. 3 Border carbon adjustment. Bars show mean *strong recommendation for BCA* (in percent) for countries (panel A) and continental groups of countries (panel B) (respectively for all respondents), with standard errors. (Number of observations in parentheses)

Table 3 Carbon pricing revenue use (multiple options possible)

Revenue use (multiple options possible)	All	EU	North America	Asia
a) General government spending	17%	19%	13%	21%
b) Equal lump-sum transfers to households	25%	25%	42%	9%
c) Transfers to particularly affected households	56%	57%	54%	45%
d) Reduction of distortionary taxes	43%	44%	44%	38%
e) Grandfathering or tax cuts for firms	7%	6%	4%	16%
f) Transfers to particularly affected firms	24%	28%	15%	26%
g) Spending on environmental public goods	35%	32%	24%	48%
h) Green R&D	59%	55%	56%	79%
i) Subsidies for renewable energy	35%	29%	25%	66%
j) International transfers to countries particularly affected by climate change	23%	22%	23%	22%
k) International transfers to support climate policy in other countries	23%	24%	22%	16%
l) Other	11%	13%	12%	0%

Notes: The fraction of experts who recommend different options for revenue usage, for continental groups of countries

particularly affected firms in the EU (28%), especially compared to North America (15%); and much stronger support for subsidies for renewable energy in Asia (66%), especially compared to North America (25%). These discrepancies are broadly in line with differences in policies across these continents. For example, equal lump-sum transfers are consistent with a *laissez-faire* approach that is popular especially in the US; transfers to particularly affected firms are consistent with an interventionist approach that is often associated with policies in (some) European countries; and subsidies for renewable energy are typical for China, the largest Asian country, which strongly supports the expansion of the renewable energy sector (e.g., Banares-Sanchez et al. 2024).

We additionally allowed respondents to indicate one “most recommended option” in case they selected several options for the usage of revenues from carbon pricing (see Fig. 4). We observe that the option “transfers to particularly affected households” is most favored by experts, i.e., indicated by respondents as their most preferred option most frequently (24%). The option “equal lump-sum transfers to households” now ranks second (but at solely 15%), followed by “reduction of distortionary taxes” (15%). The option “green R&D” that ranked first among all options selected when multiple options are possible, only ranks fourth among experts’ most recommended options (11%).

There are also some clear differences across continents and countries. Regarding experts’ most recommended options for revenue usage, we observe that “equal lump sum transfers to households” ranks first among North American experts (30%), whereas this option was indicated as the most preferred one by only 2% of Asian experts. Among the Asian experts, the strongest support is for the option “green R&D” (indicated as most recommended by 22%), followed by “reduction of distortionary taxes”, “spending on environmental public goods”, and “subsidies for renewable energy” (16% for each of these three options). Among European experts, by contrast, the option “transfers to particularly affected households” is indicated as “most recommended” most frequently (25%). Across Europe, however, there are notable heterogeneities. This is perhaps most striking for France, where political feasibility constraints due to distributional issues and inequality were very salient in public

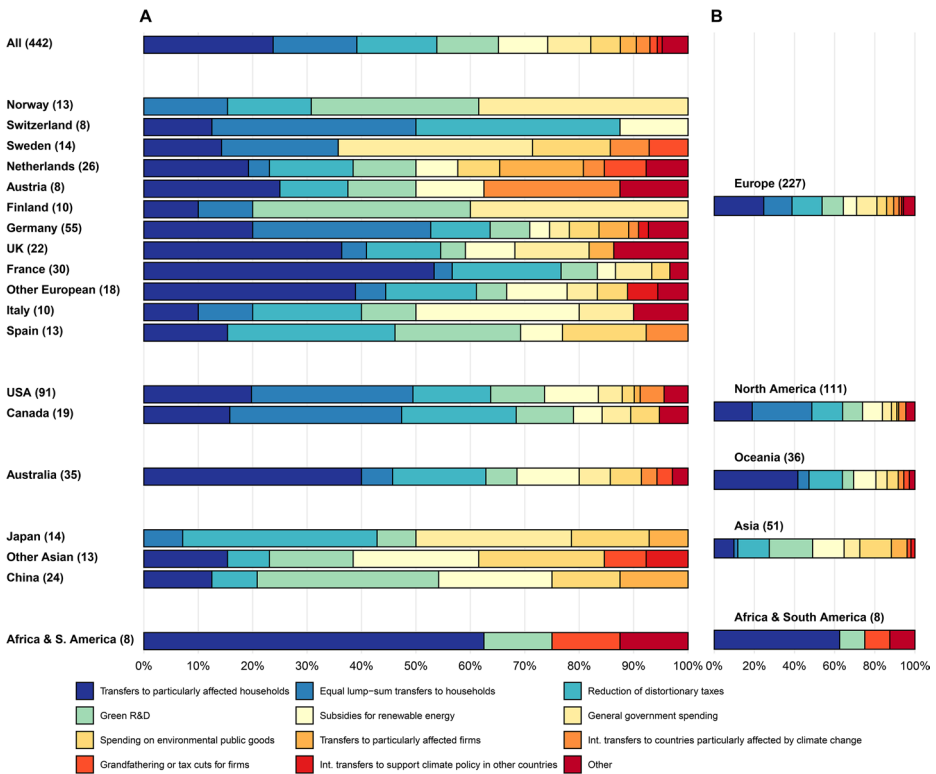


Fig. 4 Carbon pricing revenue use – most recommended option (in percent). Fraction of experts that indicate each of the options for revenue usage as “most recommended” for countries (panel A) and continental groups of countries (panel B). The option chosen by any expert who selected only a single option when several options are possible is also counted as this expert’s most recommended option. (Number of observations in parentheses)

discourse (e.g., Douenne and Fabre 2022). In contrast, none of the experts from Norway, which exhibits a lower degree of inequality, recommends this option (see Panel A in Fig. 4).

4.2 Analysis of Experts’ Policy Design Recommendations

We now analyze how the policy design recommendations presented above can be explained with the additional data that we have collected. We first analyze correlations among policy design recommendations. Subsequently, we use the three “pillars” of explanatory data presented in Fig. 1 in univariate and multivariate regressions. We present the univariate results in a table in the main text, and provide the table for the multivariate analysis in the Online Appendix. The Online Appendix also contains bar-chart illustrations for selected comparisons (carbon tax, cap-and-trade, BCA and lump-sum transfer across selected categories of all three pillars of explanatory variables). Our regressions presented in the tables draw on ordered logistic regressions to account for categorical dependent variables for survey questions on “determinants”, and linear regressions otherwise. In analyses of individual results, we additionally report χ^2 -tests where appropriate (e.g., in the context of two dummy variables), to ease interpretation.

Cross-correlations:

Table 4 presents a correlation matrix for policy design recommendations. As expected, experts' recommendations on carbon tax as compared to other instruments vs. cap-and-trade as compared to other instruments are strongly negatively related; this is related with the design of the survey question.⁷ More interesting is the positive relation between carbon tax and BCA recommendations, significant at the 10-percent level. This finding is not entirely surprising, because border carbon adjustment may be more readily implementable for a carbon price implemented via a carbon tax rather than via cap-and-trade.⁸

Regarding experts' recommendations on revenue usage, we find that those experts who recommend a carbon tax tend to have opposing views compared to those favoring cap-and-trade: most of the cross-correlations have opposite signs, and these are statistically significant in several cases (see Table 4). For example, recommendations on each of the following revenue usage options is negatively related with experts' preference for a carbon tax: "green R&D", "subsidies for renewable energy", "international transfers to countries particularly affected by climate change", "international transfers to support climate policy in other countries" (all: $p < 0.098$); each of these options can be seen as more "interventionist". By contrast, for experts who favor cap-and-trade, we either do not find significant correlations, or a positive one for these ("subsidies for renewable energy", $p < 0.029$).

Conversely, experts who recommend a carbon tax tend to recommend using revenues for "general government spending" more often (albeit insignificantly so), whereas experts who recommend cap-and-trade recommend this revenue usage option less frequently ($p < 0.069$). Experts favoring cap-and-trade also tend to favor "grandfathering or tax cuts for firms" more often ($p < 0.080$). Experts' recommendation for BCA does not strongly correlate with their preferences for revenue usage, with a notable exception that those experts supporting BCA tend to recommend using revenues for "green R&D" more often ($p < 0.001$).

Cross-correlations between different revenue usage options are, perhaps not surprisingly, generally positive (often at the 1-percent level) when comparing those options that are "interventionist", such as "spending on environmental public goods" and "green R&D". The options "equal lump-sum transfers to households" and "transfers to particularly affected households" are strongly negatively correlated, suggesting that experts tend to favor either the one or the other. The more "laissez-faire" option "equal lump-sum transfers to households" also correlates negatively with other "interventionist" revenue use options, such as "spending on environmental public goods", "green R&D", and "subsidies for renewable energy" (at the 5 or 1% levels).

Survey questions on "determinants":

We next examine univariate relations between experts' policy design recommendations and the different types of explanatory variables (see Table 5). Here we use data gathered in the survey on experts' views on issues such as global emission reduction targets (Ques-

⁷The negative relation is not 1:1, due to the possibility to recommend other instruments or combinations thereof.

⁸Böhringer et al. (2022) write: "international law views carbon taxes as fiscal instruments, akin to indirect taxes, such as excise and value-added taxes, which are commonly border adjusted". Additionally, our companion paper has shown that experts recommending a carbon tax recommend higher carbon prices on average (Drupp et al. 2024). Higher carbon prices may render the use of BCA more relevant to alleviate competitiveness concerns (e.g., Nachtigall 2019).

Table 4 Pairwise correlations

Instrument	BCA		Revenue use											
	C&T	BCA	a)	b)	c)	d)	e)	f)	g)	h)	i)	j)	k)	
Tax	1.00													
C&T	1.00													
BCA	0.09 *	1.00												
a)	0.08	-0.09 *	1.00											
b)	0.03	-0.07	-0.06	1.00										
c)	-0.00	-0.02	0.06	-0.14 ***	1.00									
d)	0.01	-0.04	0.01	-0.06	0.10 **	1.00								
e)	-0.04	0.08 *	0.02	0.10 **	0.05	-0.02	0.06	1.00						
f)	0.02	0.00	-0.07	-0.04	0.05	0.24 ***	0.03	0.06	1.00					
g)	-0.07	0.05	0.02	-0.06	-0.11 **	0.03	-0.03	0.04	-0.00	1.00				
h)	-0.08 *	0.04	0.16 ***	-0.12 ***	-0.10 **	0.04	-0.07	-0.03	0.09 **	0.32 ***	1.00			
i)	-0.09 *	0.10 **	0.04	-0.10 **	-0.20 ***	0.01	-0.12 ***	0.03	-0.02	0.34 ***	0.34 ***	1.00		
j)	-0.08 *	-0.00	0.06	0.06	-0.05	0.12 ***	-0.02	-0.01	0.02	0.26 ***	0.15 ***	0.15 ***	1.00	
k)	-0.18 ***	-0.00	-0.06	-0.04	0.02	0.04	-0.09 *	-0.09 *	0.11 **	0.20 ***	0.18 ***	0.17 ***	0.40 ***	1.00

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The variables are as given in Fig. 1. By “Tax” we refer to carbon tax vs. all other instruments; “C&T” to cap-and-trade vs. all other instruments. Analysis is displayed for the following revenue use options, with multiple options possible: a) General government spending, b) Equal lump-sum transfers to households, c) Transfers to particularly affected households, d) Reduction of distortionary taxes, e) Grandfathering or tax cuts for firms, f) Transfers to particularly affected firms, g) Spending on environmental public goods, h) Green R&D, i) Subsidies for renewable energy, j) International transfers to countries particularly affected by climate change, k) International transfers to support climate policy in other countries

tion 8a-e in the survey – see Appendix A.1.1 for the full survey text) to explain policy recommendations.⁹

We find that support for cap-and-trade as compared to other instruments decreases with the recommended stringency of the global emission reduction target (univariate logistic regression, 1% significance level; illustrated for a binary comparison in the bar chart in Fig. A1 in the Appendix). Indeed, in a separate analysis of this result, we confirm that experts who recommend more stringent global emission reduction targets tend to recommend carbon taxes as opposed to cap-and-trade.¹⁰ We also observe, on average, that the strong support for BCA can be explained by the same determinant (at the 10% level). Furthermore, there is a positive relation between recommending “equal lump-sum transfers to households” and more stringent global emission reductions.¹¹ Other revenue use categories that are positively related with a more stringent global emission reduction target are “transfers to particularly affected households”, “international transfers to countries particularly affected by climate change”, and “international transfers to support climate policy in other countries” (univariate logistic regression: $p < 0.024$).

Next, we find that policy instrument recommendations do not vary strongly with experts’ views on emission reduction costs (see Table 5). We solely find that experts recommend using revenues from carbon pricing less frequently for the option “equal lump-sum transfers to households” as their estimated emission reduction costs increase (univariate logistic regression: $p < 0.014$). By contrast, support for BCA tends to increase when experts view the probability of severe climate damages to be higher (logistic regression: $p = 0.035$). They also recommend “reduction of distortionary taxes” less frequently (logistic regression: $p = 0.018$), but more often suggest using the revenue for environmental purposes, including “green R&D” and “subsidies for renewable energy” (logistic regressions: all $p < 0.01$). Table 5 shows that several other revenue use categories are related with this “determinant”. The qualitative insights are rather similar for experts who view expected climate damage costs to be higher.

Finally, experts who suggest placing more weight on the well-being of future generations, i.e. for using a lower discount rate or higher discount factor, like those who recommend more stringent global emission reductions, also recommend supporting particularly affected households—both domestically and abroad—and climate policy in other countries more often (when evaluated at the 5% level).

Country characteristics:

Next, we examine possible relations between experts’ policy design recommendations and the characteristics of “their country” as revealed in the survey (see Table 5). For the continental groups variables, that is whether an expert feels more comfortable advising a

⁹When we write “explain”, we do not claim causal relationships.

¹⁰This also holds when controlling for a country’s GDP per capita, whether experts published in economics journals, and their gender (univariate logistic regression: $p = 0.012$; multivariate logistic regression: $p = 0.015$).

¹¹Our finding that experts who recommend more stringent emission cuts are relatively more in favor of compensating households who are disproportionately burdened by carbon pricing, compared to other uses of the revenue, may be rationalized by political economy considerations. Under smaller emission cuts, efficiency considerations may play a central role. By contrast, tighter regulations are more likely to face tough political opposition. Therefore, compensating affected households may play a more important role in garnering support for the carbon pricing policies under large emission cuts.

Table 5 Univariate analysis of determinants of carbon pricing policy recommendations

	Instrument		Revenue use											
	Tax	C&T	BCA	a)	b)	c)	d)	e)	f)	g)	h)	i)	j)	k)
<i>Survey questions on "determinants"</i>														
Glob.em. red.target	0.10	-0.34 ***	0.22 *	0.12	0.28 **	0.34 ***	-0.08	-0.12	0.06	0.06	0.06	-0.17	0.29 **	0.28 **
Emission red. costs	0.03	0.04	0.04	-0.13	-0.26 **	-0.08	0.02	-0.19	0.00	0.06	-0.11	0.09	-0.11	-0.05
Prob.clim. catastr.	0.01	-0.04	0.18 **	-0.13	0.08	0.05	-0.18 **	-0.24 *	-0.04	0.50 ***	0.33 ***	0.38 ***	0.24 ***	0.24 ***
Exp.clim. damages	-0.04	-0.06	0.16 *	-0.25 **	-0.08	0.11	-0.21 **	-0.25	-0.12	0.44 ***	0.28 ***	0.22 **	0.21 **	0.28 ***
Utility discount.	-0.01	-0.10	0.02	-0.06	0.14 *	0.14 **	-0.04	-0.18	-0.03	0.20 ***	0.08	-0.03	0.23 **	0.18 **
<i>Country characteristics</i>														
Europe	-0.01	-0.00	-0.04	0.04	-0.02	0.03	0.01	-0.03	0.07 *	-0.05	-0.08 *	-0.10 **	-0.04	0.04
Oceania	-0.18 **	0.23 ***	0.08	-0.08	-0.12 **	0.10	0.04	0.00	-0.02	-0.28 ***	0.04	0.12	0.23 ***	0.06
Asia	-0.07 ***	0.20 ***	-0.06	0.04	-0.20 ***	-0.13 *	-0.07	0.09 *	0.02	0.15 **	0.23 ***	0.36 ***	-0.02	-0.08
Africa & S.America	0.13	0.08	0.00	0.08	-0.14	0.19	0.19	0.18	0.14	0.03	-0.09	-0.09	-0.24 ***	-0.23 ***
GDP/capita	0.00 ***	-0.00 ***	-0.00	0.00	0.00 ***	-0.00	0.00	-0.00 ***	-0.00	-0.00 ***	-0.00 ***	-0.00 ***	0.00	0.00 *
Nat.carb. price (w'd)	0.00 **	-0.00 **	-0.00	0.00 **	-0.00	0.00	-0.00	-0.00	0.00	-0.00 **	-0.00 **	-0.00 ***	-0.00 *	-0.00
M.World gov.index	0.00 *	-0.00 ***	-0.00	0.00 *	0.00 ***	-0.00	0.00	-0.00 *	-0.00	-0.00 **	-0.00 ***	-0.01 ***	0.00 **	0.00
Clim.ch. knowledg.	0.00 **	-0.00 **	0.00	0.00	0.00 ***	0.00	-0.00	-0.00 **	-0.00	-0.00 **	-0.00 **	-0.01 ***	0.00	0.00
Foss.en. use	-0.10	0.28 **	-0.02	-0.28 **	-0.09	-0.12	-0.11	0.07	-0.11	0.32 **	0.29 **	0.40 ***	0.19 *	0.09

Table 5 (continued)

	Instrument		Revenue use												
	Tax	C&T	BCA	BCA	a)	b)	c)	d)	e)	f)	g)	h)	i)	j)	k)
CO2em./cap.	0.00	-0.00	0.00	0.00	-0.01	0.01	-0.00	-0.00	-0.00	-0.01	-0.00	-0.00	-0.01	-0.01	0.00
Existing carb.taxes	0.16	-0.15	-0.01	0.15	0.15	-0.11	-0.01	-0.00	-0.06	-0.01	-0.09	-0.10	-0.11	-0.08	-0.07
Existing cap&trade	-0.02	0.00	-0.04	0.03	0.03	-0.01	0.02	0.01	-0.02	0.07	-0.05	0.07	-0.10	-0.04	0.04
<i>Expert characteristics</i>															
Gender	0.13	-0.01	0.02	0.07	0.07	0.11	-0.05	0.01	-0.02	-0.07	-0.12	-0.19	-0.06	-0.07	-0.12
Nb. of publicat.s	-0.01	0.01	-0.01	-0.00	-0.00	0.02	-0.01	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.00	0.01
Publish econ.	0.03	-0.08	-0.09	0.02	0.02	0.09	-0.03	0.24	0.01	0.01	-0.10	-0.13	-0.20	-0.12	-0.02
Nb. of citations	-0.00	0.00	-0.00	-0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00
Publish on carb.taxes	0.05	-0.05	0.08	0.04	0.04	-0.09	0.06	0.06	0.00	-0.08	0.09	0.05	0.09	-0.07	-0.04
Publish on cap&trade	0.02	-0.04	-0.01	0.06	0.06	-0.04	-0.03	0.01	-0.01	0.13	-0.19	0.08	-0.08	0.01	-0.02

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The univariate regressions are estimated by ordered logit to account for categorical dependent variables for survey questions on “determinants, and ordinary least squares for country and expert characteristics. The explanatory variables are as given in Fig. 1. By “Tax”, we refer to carbon tax vs. all other instruments; “C&T” to cap-and-trade vs. all other instruments. Analysis is displayed for the following revenue use options, with multiple options possible: a) General government spending, b) Equal lump-sum transfers to households, c) Transfers to particularly affected households, d) Reduction of distortionary taxes, e) Grandfathering or tax cuts for firms, f) Transfers to particularly affected firms, g) Spending on environmental public goods, h) Green R&D, i) Subsidies for renewable energy, j) International transfers to countries particularly affected by climate change, k) International transfers to support climate policy in other countries

country in Europe, Oceania, Asia, or Africa & South America on carbon pricing (see the survey text in Appendix A.1.1), we broadly confirm the descriptive results presented in Sect. 4.1. We thus focus on the country-specific variables in the following.

We find that support for carbon taxes tends to increase in GDP per capita (linear regression: $p=0.002$), while recommending cap-and-trade as compared to other instruments declines with GDP per capita. In a separate analysis of this result, we split the sample at the median GDP per capita and find a clear difference for recommending carbon taxes as opposed to cap-and-trade between high and low GDP per capita (χ^2 -test: $p=0.002$; see bar chart illustration in Fig. A2 in the Appendix). A possible explanation is that under cap-and-trade, lower-income countries may benefit from selling emission permits on the global market (see Keen and Kotsogiannis 2014; Bauer et al. 2020). In line with this, experts from such countries recommend cap-and-trade more often. In the discussion (Sect. 5), we document how limited global representation of expertise (“non-representation bias”) affects instrument choice recommendations.

Our analysis further reveals that support for BCA is widespread without much heterogeneity across country characteristics. Regarding experts’ recommendations on revenue usage, support for “equal lump-sum transfers to households” tends to increase along GDP per capita in the expert’s country, while the support for “spending on environmental public goods” and a number of other targeted options decrease with it (these options are “grandfathering or tax cuts for firms”, “green R&D”, and “subsidies for renewable energy” when evaluated at the 1% level; see Table 5 for the complete picture). Fig. A2 in the Appendix depicts a clear difference concerning “equal lump-sum transfers to households” when splitting the sample at the median GDP per capita (χ^2 -test: $p=0.000$).

We further find that the existence of a carbon tax in an expert’s country (“Existing carb. taxes” in Table 5) is associated with a lower propensity to recommend cap-and-trade (in separate analysis: 18 vs. 33%; χ^2 -test: 0.002) and with a higher propensity to recommend carbon taxes (in separate analysis: 61 vs. 45%; χ^2 -test: $p=0.002$),¹² suggesting that regional and country-specific differences in the support for carbon taxes may reflect differences in experience with such measures.

Table 5 also shows that the support for the instrument choice options, carbon tax and cap-and-trade, vary in a qualitatively similar way with a higher mean world governance index as for higher GDP per capita. Support for carbon taxes is, however, not associated with climate change knowledge, fossil fuel energy consumption, or CO₂ emissions per capita. Instrument choice recommendations are generally unrelated, on average, to CO₂ emissions per capita.

Revenue use recommendations also depend on other country-level determinants than GDP per capita in the univariate analysis. It is, for example, interesting to note that support for “spending on environmental public goods”, “green R&D” and “subsidies for renewable energy” increase in fossil energy use, contrasting with the relation for GDP per capita documented above (see Table 5 for the complete account).

Expert characteristics:

Finally, we examine possible relations between experts’ policy design recommendations and observable expert characteristics. We find that support for carbon taxes as compared

¹²By contrast, the existence of cap-and-trade in a given country is not significantly related to recommending either a carbon tax or cap-and-trade (χ^2 -tests: $p>0.100$).

to other instruments is higher for male experts (52 vs. 38%; χ^2 -test: $p=0.058$; see bar chart illustration in Figure A.3 in the Appendix). Furthermore, in a separate analysis of this result we find that female experts recommend a mix of instruments more often (30 vs. 16%; χ^2 -test: $p=0.008$). The higher aggregate recommendation for instruments other than a carbon tax in our expert sample compared with the IGM Economic Experts Panels (IGM Economic Experts Panel 2018; European IGM Economic Experts Panel 2020) may thus also be due to the limited geographical coverage and the stronger gender imbalance of the IGM Panels.

As above, our analysis reveals that support for BCA is widespread, again without much heterogeneity (see Table 5 for some nuance). Considering revenue usage, we find that recommendations of revenue use for “general government spending” and “equal lump-sum transfers to households” are more prevalent among male experts, while “spending on environmental public goods”, “green R&D”, and “international transfers to support climate policy in other countries” are less prevalent (linear regression: $p<0.10$; $p<0.01$ for green R&D).

Table 5 also confirms that expert-level variables such as the number of publications and number of citations exhibit rather similar results, both being positively associated with “equal lump-sum transfers to households” and negatively associated with “spending on environmental public goods” and “subsidies for renewable energy”.

We find no differences in recommending carbon taxes relative to other instruments for economists and non-economists, while economists recommend cap-and-trade less frequently. Interestingly, also support for BCA correlates negatively with publishing in economics journals, when compared to those who do not (70 vs. 80%; χ^2 -test: $p=0.032$). Still, there is an overwhelming majority favoring BCA. In a separate analysis we find that experts who have published in economics journals recommend “reduction of distortionary taxes” and “equal lump-sum transfers to households” more often than non-economists (χ^2 -tests: $p=0.000$ and $p=0.035$), while they recommend targeted options such as for example “subsidies for renewable energy” or “spending on environmental public goods” less frequently (see Table 5 for the complete list). Economists thus generally recommend options more in line with efficiency considerations, while non-economic experts tend to recommend options that have been shown to raise public support for climate policies more often (e.g., Douenne and Fabre 2022). Non-economic experts also recommend using parts of the revenue for “international transfers to countries particularly affected by climate change” more frequently.

While recommendations on carbon pricing instruments and BCA do not correlate with publishing on carbon taxes as compared to not, a few observations stand out regarding the usage of carbon pricing revenues: these experts tend to recommend “spending on environmental public goods” and “subsidies for renewable energy” more often, and “equal lump-sum transfers to households” and “transfers to particularly affected firms” less often.

The data in combination:

We complement the above univariate analysis with a multivariate approach. These regressions are estimated by ordered logit. See Table A5 in the Online Appendix for the complete overview. In the following, we focus primarily on similarities and differences between the results from the univariate and multivariate analyses. In line with standard tests for multicollinearity (cross-correlations and variance inflation factors), we exclude the con-

tinental variables as well as the following country-specific variables from the analysis: mean world governance index, climate change knowledge, and fossil energy use.

Results for the survey questions on “determinants” have little predictive power on experts’ views on instrument choice. Most relations are insignificant in the univariate analysis, with the strongly significant negative impact of the global emission reduction target on experts’ recommendations of cap-and-trade as the notable exception. The same holds true in the multivariate case, but now also the impact of the emission reduction target on recommendations for cap-and-trade turns statistically insignificant. The “determinants” had some significant associations with experts’ recommendations on BCA in the univariate analysis, which are mostly preserved in the multivariate case. A change is that the sign of the relation between expected climate damages and BCA support (positive and significant at the 10% level in the univariate case) is changed in the multivariate case, but the association becomes insignificant.

The relations between instrument choice and BCA of those country characteristics that are contained in both types of analysis (i.e., GDP per capita, national weighted carbon price, CO₂ emissions per capita, existing carbon taxes, and existing cap-and-trade) are broadly consistent across the univariate and multivariate analyses. A notable difference is that the relation between CO₂ emissions per capita and experts’ recommendation of cap-and-trade turns positive and significant at the 5% level in the multivariate case. And its relation with BCA turns negative and significant at the 10% level. Both are statistically insignificant in the univariate case. The variables “existing carbon taxes”, respectively “existing cap-and-trade”, exhibit a positive (resp. negative) relation to experts’ recommendation of a carbon tax (both significant at the 5% level) in the multivariate case. Not surprisingly, the impact of these explanatory variables on experts’ preference for cap-and-trade shows the opposite signs (but the negative relationship of “existing carbon taxes” with recommending cap-and-trade becomes insignificant, while it was significant at the 1% level in the univariate analysis). Experts from countries with a cap-and-trade scheme are also less likely to recommend BCA (negative association, $p=0.033$). In the univariate case, the relations between “existing cap-and-trade” and these three variables are all insignificant.

Experts’ observable characteristics have little predictive power on instrument choice and BCA in the univariate regressions, with only a few exceptions (e.g., for “published in economic journals”). All these relations are statistically insignificant in the multivariate case.

Regarding the impact of the explanatory variables on the various revenue use options, we find that overall, results are broadly consistent across the two types of analyses (univariate/multivariate). However, due to the large number of independent and dependent variables, we find differences in significance levels and signs of the coefficients in several cases. For example, many of the relations between the “determinants” variables and experts’ recommendations for revenue usage turn insignificant in the multivariate case. Also, some of the previously statistically significant relations between the characteristics of experts and their countries turn insignificant in the multivariate case, while a few others turn significant. For those that stay significant, the signs of the relations are mostly preserved.

To illustrate the results, we focus on two “representative” revenue use options: “equal lump sum transfers to households” and “subsidies for renewable energy”; the former reflects a more laissez-faire type of policy, whereas the latter can be seen as more interventionist. We highlight only some of the differences across the two types of analysis for these revenue use options (see Table A5 in the Online Appendix for the complete picture). For example,

regarding experts' recommendations for equal lump-sum transfers, the positive relation with the global emission reduction target is preserved in the multivariate case, whereas the relation with the emission reduction costs turns insignificant; the corresponding relations with experts' views on climate damages (probability of catastrophic damages, and expected damages for 3°C global warming) turn significant at the 5% level in the multivariate case, with a positive, resp. negative, sign of the coefficient, and stronger associations than in the univariate case. The highly significant relation between GDP per capita and lump-sum transfers is also preserved in the multivariate case. By contrast, the relation between CO₂ emissions per capita and lump-sum transfers (positive and highly significant in the univariate case) turns statistically insignificant in the multivariate case. All associations between experts' characteristics and their preference for equal lump sum transfers (mostly significant at different levels in the univariate case) turn insignificant in the multivariate case.

Regarding experts' views on "subsidies for renewable energy", we find the following changes when moving from the univariate to multivariate setting: the relationship with expected climate damages turns insignificant, whereas the significant relationship with the estimated probability of catastrophic damages is preserved (now significant at the 5% level). The negative relations with GDP per capita and the national weighted carbon price are preserved (but are now only significant at the 10% level). The remaining country characteristics have no significant relations in the multivariate case. Regarding experts' characteristics, most relationships with this variable turn insignificant in the multivariate case, with the exception of "published in economics journals", where the relation remains negative and significant at the 5% level in the multivariate case (and a larger effect size than in the univariate analysis).

In combination, our data on "determinants" as well as country and expert characteristics can explain between 7 to 12% of the total variation in instrument choice recommendations in the multivariate case, and between 3 and 18% of the total variation in revenue use recommendations. Around 5% of the total variation in the support for BCA can be explained. Overall, these findings suggest sizable, unexplained variation in expert's recommendations on carbon pricing policies.

5 Discussion

In this section, we discuss limitations of our approach and assess, to the extent possible, the robustness and sensitivity of our findings. In separate subsections, we conduct tests for non-response bias, strategic responses bias and also for what we term "non-representation bias" (cf. Armstrong and Overton 1977; Necker 2014; Johnson and Wislar 2012). More generally, our results are limited by both our survey design and sampling strategy. Nemet et al. (2017), for instance, caution that estimates across studies are not easily comparable due to biases in the survey design and expert selection, or due to potential over-confidence of experts. Among other things, they show that when experts respond to elicitation in person, they express lower confidence in their estimates. The authors argue that such issues should be seriously considered in interpreting the results of elicitation. Here, we did not conduct individual in-person interviews but carried out an expert survey with a broad population online. As with any survey that requires voluntary participation, we had to strike a balance between the depth of questions asked and between targeting a broad sample with a good

response rate. It would have naturally been desirable to ask more specific questions on the composition of instruments mixes and on instrument sequencing, for instance, or about the specific design of BCA and its repercussions. We leave a systematic investigation of these extensions to future work. General discussions of the role of experts in policy making can be found in our companion paper (Drupp et al. 2024).

5.1 Non-Response Bias

We reweight the recommendations on carbon taxes versus other instruments, cap-and-trade versus other instruments, BCA, and revenue use options by the characteristics of both respondents and non-respondents. Table A6 in the Online Appendix shows descriptive statistics for each of these variables, as well as the unweighted and weighted data. The unweighted data is the raw data for respondents that reveal their identity and is used for comparison to the weighted data. For the weighted data, we rebalance recommendations by propensity score matching using the following characteristics: whether the expert is based in Europe, Oceania, Asia or the category of Africa & South America (obtained from SCOPUS), is a male, as well as number of publications and citations, whether the publications are in economics journals, and consider issues like carbon taxes or cap-and-trade. Weights are estimated by propensity score matching with a probit model, with imposition of common support and where one neighbor is used (for an illustration, see Tables A7–A9 and Figure A4 in the Online Appendix for the implementation for carbon taxes versus other instruments). Table A6 in the Online Appendix shows that there is no systematic and qualitative changes in recommendations by weighting for any of the policy design questions. Moreover, quantitative implications are also minor. We can address other concerns related to non-response bias, including differences between respondents and non-respondents that do not depend on observable characteristics (Dutz et al. 2021), by design, as we are able to identify 97 explained non-respondents.

5.2 Strategic Response Bias

We conduct two tests for strategic response bias. First, we compare experts revealing their identity to us to experts who do not, to see if anonymous experts give systematically different recommendations as this has been a concern in the literature. Here, we find that experts who do not reveal their identity give similar recommendations in favor of carbon taxes versus other instruments, cap-and-trade versus other instruments, BCA, as well as for most revenue use categories compared to those revealing their identity (all χ^2 -tests: $p > 0.250$). The exceptions are that these respondents are less likely to recommend “transfers to particularly affected firms” (14 vs. 25%; χ^2 -test: $p = 0.049$), “spending on environmental public goods” (24 vs. 36%; χ^2 -test: $p = 0.057$) and “green R&D” (46 vs. 61%; χ^2 -test: $p = 0.025$).

Second, we compare experts replying early to those replying late to our survey invitation, e.g. after a reminder instead of the initial invitation to participate. The idea here is to check whether those replying early, who might have a strategic interest in influencing the results, differ in their recommendations. We do not find that experts replying to the initial invitation give different recommendations, on average, for carbon taxes versus other instruments, cap-and-trade versus other instruments, BCA, or any of the revenue uses than those who replied to a reminder (χ^2 -tests: $p > 0.140$). This holds also, on average, for those

who replied to the second, third as well as fourth (and final) invitation to participate, when not considering recommending cap-and-trade versus other instruments, strong support for BCA or recommending international transfers to support climate policy in other countries (χ^2 -tests: $p=0.270$ for round 2, $p=0.259$ for round 3, $p=0.282$ for round 4). For cap-and-trade versus other instruments, we find that experts replying to the second invitation were more likely to recommend it (36 vs. 27%; χ^2 -test: $p=0.020$). For BCA, we find that experts replying to the second invitation were less likely to support its introduction (66 vs. 78%; χ^2 -test: $p=0.020$), while those replying to the final invitation did so more frequently (85 vs. 72%; χ^2 -test: $p=0.023$). The findings for cap-and-trade versus other instruments and support for BCA are not worrying as any conjectured strategic response bias concerns only those replying early on, and – if it were a concern – would bias our results in the more conservative direction (compared to how we present the main descriptive results of the paper). For international transfers to support climate policy in other countries, we pick up a significant association only for the second round (31 vs. 21%; t-test: $\chi^2=0.042$). Finally, we split the sample into two equal parts based on the order of responses by calendar time. Also here the results are reassuring since early respondents give similar recommendations for carbon taxes versus other instruments, cap-and-trade versus other instruments, BCA and most revenue uses compared to late respondents (χ^2 -test: $p>0.100$; with one exception). The only exception is “subsidies for renewable energy”, which were recommended less frequently by experts filling out the survey early on (30 vs. 39%; χ^2 -test: $p=0.046$). If this was a concern, it would bias our results in a conservative direction (compared to how we present the main descriptive results of the paper).

5.3 Non-Representation Bias

Our survey seeks recommendations on designing carbon pricing policies based on a population of experts that is itself not globally representative, since a disproportionate fraction of academic experts are located in higher-income countries. Here, we investigate this potential non-representation bias by exploring how country and observable expert characteristics are associated with policy design recommendations and then perform a reweighting of responses according to the global average of these country-level characteristics. To illustrate, we hereby focus only on GDP per capita, the share of experts with an economics publication, as well as the share of female experts (thereby re-coding the gender variable to ease comparisons). For the share of female experts, we take 50% as the representative share, and contrast this with a much lower share of females of less than 20%, as in our sample.

Figure 5 shows that recommendations for a carbon tax versus cap-and-trade are far less frequent for global average GDP per capita compared to the average in our sample (Panel A). This support is not differing along the other dimensions (see Fig. A5 Panels B and C in the Online Appendix). The strong support for BCA is consistently high along GDP per capita (see Fig. 5 Panel B). However, this support is lower for respondents with an economics publication, and comparably higher for experts without (Panel B of Fig. A6).

According to Fig. 5 Panel C, recommendations for the use of revenue for “equal lump-sum transfers to households” are far less frequent at global average GDP per capita. In comparison, they are only slightly less likely for non-economic experts (Fig. A7 Panels A and B). Our non-representation bias analysis also reveals that recommendations for the use of revenue for transfers to particularly affected households are not affected by the three

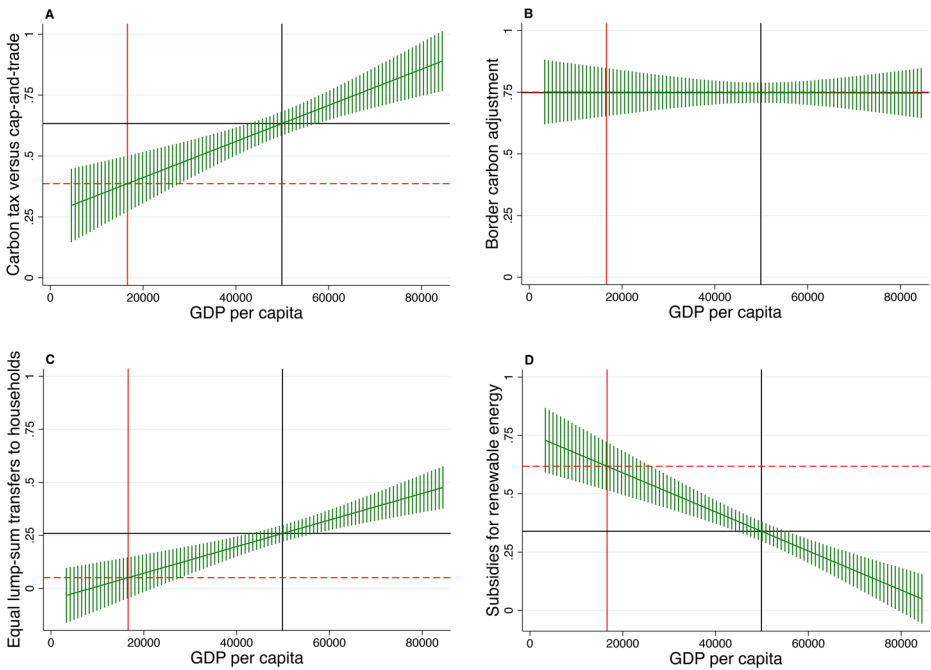


Fig. 5 Selected reweighting of recommendations by GDP per capita. The shares of experts recommending the use of a carbon tax versus cap-and-trade with and without price collar (panel **A**), the use of border carbon adjustment (panel **B**), as well as the use of revenue for lump-sum transfers to households (panel **C**) and for subsidies for renewable energy (panel **D**) along GDP per capita, from the sample mean GDP per capita to the global mean GDP per capita. A more detailed analysis of the relationship between recommendations and country- and expert characteristics is contained in the Online Appendix

country characteristics (Fig. A7 Panels D-F). Recommendations for the use of revenue for “subsidies for renewable energy” are, on the other hand, much more frequent at a global average GDP per capita (Fig. 5 Panel D), and somewhat more likely among non-economists (Fig. A7 Panels G and H). Finally, the use of revenue for a “reduction of distortionary taxes” is recommended less often at global average GDP per capita and at a much lower share of economic experts (Fig. A7 Panels J and K). We do not find any gender effects in the exemplary revenue use categories (Fig. A7 Panels C, F, I and L); Below a 5% significance level, female experts only recommend “green R&D” much more often than males (χ^2 -test: $p=0.006$), leading to an adjustment from a share of 61% of experts recommending green R&D (among other options) in the sample to a share of 67% in the hypothetical population.

6 Conclusion

Tackling climate change requires an effective design of climate policy, including the pricing of carbon. Building on a rich dataset from a global survey of academic experts, we investigate recommendations on key policy design issues related to carbon pricing. While we document strong support for the use of carbon taxes and border carbon adjustment, our results also highlight important heterogeneities in recommendations. Notably, while prior surveys

on carbon pricing, such as by the IGM Economic Experts Panel (2018), have often focused on general economists from North America (yielding similar results as our survey reveals for the US), we find much more nuanced recommendations when considering experts on carbon pricing in the rest of the world as well as for non-economists. For instance, the option “equal lump-sum transfers to households”, which corresponds to the only revenue usage emphasized prominently in the US “Economists’ Statement on Carbon Dividends” (Wall Street Journal 2019), is recommended only by a quarter of all experts (when multiple usage options can be selected), solely ranking fourth among all options in our survey. Specifically, while the equal lump-sum option is recommended by 42% of experts in North America, it is only recommended by 21% in the rest of the world. Relatedly, while compensating particularly affected households is frequently recommended to governments in lower and higher income countries alike, recommendations for equal lump-sum transfers increase with a country’s GDP per capita. In contrast, experts from lower income countries recommend governmental spending on subsidies for renewable energy or environmental public goods much more frequently.

We also find that the clear and significant support for carbon taxes over cap-and-trade only exists in countries with a high GDP per capita. In poorer countries, we find that cap-and-trade tends to be favored at least as often as carbon taxes. This finding may seem surprising, given the substantial transaction costs involved with setting up a cap-and-trade scheme, but it has since been corroborated by the practitioner expert survey reported in Lerner et al. (2025). Using a conjoint experiment, they find that practitioners believe that emissions trading tends to be somewhat more effective and is judged as being significantly more feasible to implement as compared to a carbon tax. With reference to our working paper, they likewise hypothesize that this may be due to options of permit-based revenue transfers across countries.

The broad support for BCA we document aligns well with wording in the “Economists’ Statement on Carbon Pricing” (EAERE 2019), which suggests BCA as a potential solution in the multilateral context. Although its implementation may involve considerable bureaucratic costs as well as legal challenges (Kruse-Andersen and Sørensen 2021; Böhringer et al. 2022; Dominioni and Esty 2022), our findings suggest that the benefits clearly outweigh those costs in the assessment of most experts. Particularly for higher carbon prices, the risks of carbon leakage, competitiveness losses, and firm relocation may be substantial (e.g., Nachtigall 2019).

Furthermore, we document that while economists recommend lump-sum transfers and reductions in distortionary taxation more often, in line with efficiency considerations, experts from other disciplines rather recommend options for the use of revenue via governmental spending that have been shown to be more effective in raising public support for climate policies. Finally, we find that experts who support more stringent global climate policy and suggest placing greater weight on the well-being of future generations consistently suggest using the revenue from carbon pricing to support particularly affected households—both domestically and abroad—and to support climate policy in other countries. Our nuanced results on policy recommendations can serve as important inputs for climate policy modeling, and can help inform policy-makers and researchers in the search for suitable carbon pricing policies that balance efficiency, distributional and political acceptability considerations in addressing the climate challenge.

The considerable heterogeneity in recommendations for instrument choice and revenue use we document may lead to different conclusions concerning the role of evidence-based knowledge on how to best price carbon. On a pessimistic note, the results on cross-country heterogeneity concerning recommendations for carbon taxes versus cap-and-trade schemes, for instance, may suggest that policy-makers have less clear-cut recommendations at hand, which can stall progress on carbon pricing. On a more optimistic reading, further explorations of the heterogeneities we document on instrument choice and revenue use can help tailoring and targeting carbon pricing policy design such that it becomes more amenable for local contexts. Such local tailoring may help to make carbon pricing policies more likely to be implemented and succeed.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10640-025-01036-3>.

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Data Availability We can make available our data in a format that maintains the anonymity of individual respondents, and will publicly make available all code for replication purposes. Specifically, we can provide all survey data except the information on an expert's country for those few for whom we do not have a sufficient number of potential experts in the population to preserve their anonymity, and can also provide linked country-level observable characteristics up to that level. Finally, we cannot provide observable data on expert characteristics (collected outside of our survey) to ensure that experts cannot be re-identified. The data is available at <https://doi.org/10.7910/DVN/90S6CR>

Declarations

Conflict of Interest We, the authors, hereby declare that there persists no conflict of interest regarding the publication of this paper. This includes any financial, personal, or professional relationships that could potentially be perceived as influencing the research presented in this manuscript.

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