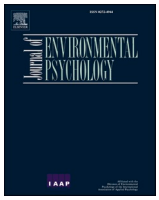
Journal of Environmental Psychology 97 (2024) 102356

Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep



Perceived carbon pricing effectiveness impacts its perceived fairness – Applying and extending a theoretical framework

Jean-Henri Huttarsch [a,*], Ellen Matthies [b]

[a] Research Institute for Sustainability – Helmholtz Centre Potsdam (RIFS), Germany
[b] Otto-von-Guericke University, Environmental Psychology, Magdeburg, Germany

ARTICLE INFO

Handling Editor: Wokje Abrahamse

Keywords:
Carbon pricing
Greed-efficiency-fairness hypothesis
Perceived policy fairness
Policy acceptance
Polluter-pays principle

ABSTRACT

Based on a theoretical framework inspired by the Greed-Efficiency-Fairness-Hypothesis (GEF), it is argued that perceived effectiveness of climate policies, in addition to other policy beliefs (i.e. perceived personal and distributional consequences), influences perceived overall policy fairness and acceptance. However, links between these policy beliefs and perceived overall fairness as well as whether perceived overall fairness might mediate effects of these beliefs on acceptance remains understudied. This study addresses these gaps and extends the GEF-inspired framework: We add procedural fairness to the list of fairness-relevant beliefs and analyze whether perceived overall carbon pricing fairness integrates and mediates their effect on acceptance, using survey data representative of Germany (n = 4646). Additionally, we test whether adherence to the polluter-pays principle (a general fairness principle) moderates the effects of perceived distributional consequences and effectiveness on perceived overall fairness. Results showed that perceived personal consequences, distributional consequences, procedural fairness, as well as perceived effectiveness, all impact perceived overall fairness, and that the latter (partially) mediates their effects on carbon pricing acceptance. We also find weak evidence that the impact of perceived effectiveness and negative distributional consequences on perceived overall fairness is greater for polluter-pays adherents than for non-adherents. These results suggest that, additionally to perceived personal and distributional consequences as well as fair procedures, perceiving a policy to be effective increases its perceived overall fairness.

1. Introduction

Carbon pricing is commonly suggested as an effective policy instrument to achieve climate mitigation targets (Climate Leadership Council, 2019; Drews et al., 2024; Edenhofer et al., 2019),[1] as called-for in the Paris Agreement. Despite the urgency of acting against climate change, carbon pricing struggles with low public acceptance (e.g. European Commission, 2019), an issue also attested by climate policy scholars (Savin et al., 2024). In Germany, where a national carbon pricing policy was implemented in 2021, public acceptance is fairly low – only 36 percent of the population support this policy in 2022 (Wolf et al., 2022). Most notably, in France, the "yellow vest" protests succeeded in stopping a planned increase in the French carbon tax (Douenne & Fabre, 2020). Other examples, where public opinion on carbon pricing had negative influences on its implementation, are Washington State (Anderson et al., 2019) and Australia (Crowley, 2017). Recent scenario modelling approaches acknowledge this impact of public support on policy feasibility (Konc et al., 2022).

Given the sometimes severe consequences of low public acceptance of carbon pricing for further policy implementation, research has extensively investigated the factors relevant for its acceptance (e.g. Bergquist et al., 2022; Dreyer & Walker, 2013; Ewald et al., 2022; Hammar & Jagers, 2007; Levi, 2021; Maestre-Andrés et al., 2019, 2021; Povitkina et al., 2021; Savin et al., 2020; Sommer et al., 2022). Specifically, recent evidence shows that perceived policy fairness is among the most important predictors of carbon pricing support (Bergquist et al., 2022; Ewald et al., 2022; Maestre-Andrés et al., 2021). In many of these studies, perceived fairness as predictor of support is often not used with regards to specific facets, such as distribution or procedures. Rather, looking at the operationalizations, a sense of *overall* fairness is implied. The same applies to a recent review on determinants of carbon pricing fairness perceptions, where perceived personal consequences,

* Corresponding author. Research Institute for Sustainability – Helmholtz Centre Potsdam, Berliner Strasse 130, D-14467, Potsdam, Germany.
E-mail address: jean-henri.huttarsch@rifs-potsdam.de (J.-H. Huttarsch).

[1] Note that there are also voices arguing against the pertinence of carbon pricing to foster carbon-neutral innovation (Green, 2021; Patt & Lilliestam, 2018).

https://doi.org/10.1016/j.jenvp.2024.102356
Received 1 September 2023; Received in revised form 22 April 2024; Accepted 7 June 2024
Available online 9 June 2024

distributional effects and procedural aspects are conceptualized to impact a fairness construct that most strongly coincides with perceived *overall* carbon pricing fairness (Maestre-Andrés et al., 2019). Drawing on this, we also imply perceived *overall* fairness, wherever we mention perceived fairness without specifying a distributional or procedural facet.

In the carbon pricing literature, we identify three gaps that we want to address with our study. First, missing from these empirical approaches to explaining perceived carbon pricing fairness and acceptance is guiding theory. As a remedy to this problem, we suggest to apply Schuitema and Bergstad's (2018) theoretical framework that drew inspiration from the Greed-Efficiency-Fairness Hypothesis (GEF; Wilke, 1991) to structure and further inform the predictors of carbon pricing fairness perceptions and acceptance. Second, despite the attested importance of perceived (overall) fairness for carbon pricing support and the knowledge on potential fairness determinants, as far as we know, close to none[2] studies simultaneously quantified the effects of fairness determinants proposed in the literature on perceived carbon pricing fairness. Lastly, a further desideratum is quantitative research investigating the determinants of perceived carbon pricing fairness in a non-prospective context. Douenne and Fabre (2020) and Dreyer and Walker (2013) provide examples of surveys on carbon pricing perceptions in such contexts, namely France and Australia respectively, however without a focus on predictors of perceived carbon pricing fairness. Povitkina et al. (2021) researched carbon pricing fairness perceptions in the U.S., yet, there is currently no national carbon price policy and the study was mainly qualitative. Sommer et al. (2022) also investigated carbon pricing fairness, though in a prospective context[3] and focusing on the implications of different revenue uses for perceived fairness. The same applies for Jagers et al. (2021) and Savin et al. (2020). Lastly, Maestre-Andrés et al. (2021) quantitatively assessed predictors of perceived carbon pricing fairness and support in a country without implementation, namely Spain.

This study aims to address these research gaps by investigating the factors influencing perceived fairness and acceptance of a currently implemented carbon pricing policy – the German "CO_2-Preis". In particular, we aim to answer the following research questions using data from a representative survey: (1) What is the effect of theoretically and empirically informed perceived policy fairness determinants on perceived (overall) policy fairness and does adherence to the polluter-pays principle play a moderating role? (2) Does perceived (overall) carbon pricing fairness integrate and mediate the effect of the proposed perceived fairness determinants on acceptance? The present study provides a novel context for the GEF-inspired theoretical framework and an extension thereof. We hope conclusions drawn will help foster public acceptance of this widely called-for climate mitigation policy.

2. Framework application and extension in the context of German carbon pricing policy

The original GEF, put forth by Wilke (1991), explains cooperation behaviour in social dilemmas. As carbon pricing usually increases the costs of widely consumed goods and at the same time (intends to) protect(s) the climate,[4] accepting carbon pricing can be considered cooperative behaviour in a social dilemma. Therefore, Schuitema and Bergstad's (2018) theoretical framework draws on GEF. In line with the original GEF, it describes three individual motives relevant for policy acceptance, namely greed, efficiency, and fairness – pertaining here to distribution (Wilke, 1991; see also Eek & Biel, 2003; von Borgstede et al., 2018). In the context of carbon pricing acceptance, following the greed motive would entail opposing this policy if individuals perceive it to be financially detrimental to them (hereafter referred to as personal consequences). However, two other motives are to be considered, namely efficiency and fairness. Following the efficiency motive, a "desire to use the resource [the environment] in an intelligent way" (Wilke, 1991, p. 170), would entail supporting carbon pricing if individuals perceive the policy to effectively protect the environment[5] (hereafter referred to as perceived effectiveness). According to the fairness motive in GEF, individuals strive for a fair distribution of policy outcomes. Hence, the fairness motive would entail opposing carbon pricing, if individuals believe carbon pricing to have negative distributional effects. As the most commonly used distributional effect in the carbon pricing literature are the perceived consequences for low-income groups (Maestre-Andrés et al., 2019), and coinciding with Maestre-Andrés et al. (2021), hereafter we address beliefs on distributional effects with perceptions of low-income consequences.

In Germany, to achieve emissions reduction targets in the transport and energy sectors, the government introduced national carbon pricing in 2021 as a tax levied on heating oil, natural gas, gasoline and diesel (German Federal Government, 2022). The German *carbon price* was set to 25 Euro/ton of CO_2 in 2021 and is planned to increase yearly to 45 Euro/ton of CO_2 in 2025. From 2020 to 2021, this translated to an increase in gasoline price of 7 Cents and in diesel price of 8 Cents (German Environment Agency, 2021). As such, the German carbon price might be perceived to be financially detrimental to oneself and low-income groups. Part of the German carbon pricing policy is, moreover, that revenues feed into a transformation fund that finances a diverse set of climate-friendly projects, such as public transportation and electric mobility infrastructure, and an electricity tax rebate (German Federal Government, 2022). Hence, the German carbon pricing policy might also be perceived as having positive consequences for oneself and low-income groups. Additionally, taking into consideration revenue uses is important for investigating carbon pricing acceptance and fairness, because different uses have been identified as relevant factors (for an overview see Maestre-Andrés et al., 2019). Note, however, that a recent study showed that in real-world cases, redistribution of revenues has only limited effects on support (Mildenberger et al., 2022).

In summary, the GEF-inspired framework posits that policy-specific beliefs reflective of the three motives, i.e. perceived personal consequences, perceived low-income consequences and perceived effectiveness will influence policy acceptance, defined in this study as a supportive attitude (Kyselá et al., 2019). These GEF-assumptions are empirically supported. In an exemplarily study on transport policy (Schuitema et al., 2011), beliefs about policy consequences reflective of the three GEF motives were elicited and found to be related to policy acceptability. In more recent research, all three policy-specific beliefs were found to be explanatory variables of carbon pricing acceptance (Maestre-Andrés et al., 2021). Lastly, climate policy in general receives support when negative personal and distributional consequences are low and effectiveness is perceived to be high (Drews & van den Bergh, 2016; Ejelöv & Nilsson, 2020).

2.1. Predictors of perceived policy fairness and its role as mediator

In the following, we bring together empirical work on carbon pricing and GEF-inspired theory to suggest why perceived (overall) carbon pricing fairness integrates motive-reflective policy-specific beliefs, i.e. perceptions of personal consequences, low-income consequences and

[2] Maestre-Andrés et al. (2021) did quantify perceived fairness determinants, however, procedural aspects were only distally operationalized with a measure of trust in politicians and perceived effectiveness was not included as predictor of perceived (overall) fairness.

[3] No carbon price was implemented in Germany at the time of data collection.

[4] Whether this is in fact the consequence of carbon pricing is not object of this paper. For a discussion see Lilliestam et al. (2021) and the subsequent debate (Lilliestam et al., 2022; van den Bergh & Savin, 2021).

[5] Protecting the environment coincides with intelligent collective resource usage according to the efficiency motive.

effectiveness, and thus might mediate their effects on acceptance.

As mentioned above, perceived policy fairness is the most effectual factor in explaining policy acceptance in general (Bergquist et al., 2022) and support for carbon pricing specifically (Maestre-Andrés et al., 2021). But which specific perceived fairness is meant? Many studies reporting this result let respondents evaluate fairness in a general manner, not specifying any certain fairness aspect, such as regarding distribution or procedure (see Clayton, 2018; Jagers et al., 2021; Maestre-Andrés et al., 2021; Schuitema et al., 2011 and many more).[6] This reflects an *overall* fairness perception as predictor of acceptance, a construct well researched in organizational psychology with more specific fairness concepts, such as distributive and procedural fairness, as predictors (Ambrose et al., 2015). Having explicated that the often-found predictor of policy acceptance is perceived (overall) policy fairness, we now specify its predictors.

Schuitema et al. (2011; 2018) state that policy-specific beliefs reflecting the three motives in GEF affect perceived policy fairness in addition to policy acceptance.[7] A policy is perceived as fair, when one expects no negative personal consequences and no negative low-income (i.e. distributional) consequences. For (overall) fairness judgements, individuals compare, for instance, if the implementation of a policy leads them or others to be better or worse off (Gollwitzer & van Prooijen, 2016; Schuitema & Bergstad, 2018). These coincide with fairness-relevant policy-specific beliefs also identified by Maestre-Andrés et al. (2019). Additionally and according to the GEF-inspired framework, when policy is perceived to be effective in protecting a collective resource, it is perceived as fair. Effectiveness of climate policy can be linked to policy fairness, because it reflects environmental justice (Schuitema & Bergstad, 2018). According to this strand of literature, protecting the environment and future generations is a precondition for a just world (Clayton et al., 2016). This strengthens the argument that believing climate policy to be effective ought to increase its (overall) fairness perception. In the carbon pricing literature (e.g. Maestre-Andrés et al., 2019, 2021), however, perceived effectiveness is missing from the list of perceived fairness determinants. This is despite empirical hints at an existing link. In two recent studies on carbon price fairness perceptions, perceived effectiveness was found to be important for its perceived fairness (Povitkina et al., 2021; Savin et al., 2020). Following from the above, we argue that perceived fairness is influenced by and thus integrates perceptions of personal and low-income consequences, *as well as* effectiveness of carbon pricing.

We have now established (1) that perceived policy fairness is an important predictor of policy acceptance and (2) that predictors of perceived policy fairness are the policy-specific beliefs reflecting the three GEF motives. Note that these are the same as the aforementioned acceptance predictors. From this, we conclude that the effect of the motive-reflective policy-specific beliefs on acceptance might be, at least partially, mediated via perceived fairness. This conclusion is in line with the integrating and mediating role of perceived carbon pricing fairness for two of the motive-reflective policy-specific beliefs, i.e. perceived personal and low-income consequences, in the conceptual model developed in the review by Maestre-Andrés et al. (2019). Our conclusion is furthermore in line with Savin and colleagues' (2020) suggestion that the third motive-reflective policy-specific belief, perceived carbon price effectiveness, influences acceptance "indirectly by increasing fairness perceptions" (p. 2125). Lastly, the mediating role of (overall) fairness is well established in organizational psychology, because it transmits the effect of more specific fairness aspects on numerous outcomes (Ambrose et al., 2015).

2.2. Perceived procedural fairness as further predictor of perceived fairness

When reviewing the literature on policy acceptance in general (e.g. Drews & van den Bergh, 2016; Ejelöv & Nilsson, 2020; Schuitema & Bergstad, 2018; Steg, 2023; Steg et al., 2021), and carbon pricing in particular (Maestre-Andrés et al., 2019), it emerges that, regarding (overall) fairness evaluation of policy, procedural aspects are to be accounted for in addition to distributional fairness concerns. Procedural fairness perception is conceptualized as an evaluative attitude towards the procedures used in deciding on and implementing policy and is a crucial fairness dimension in psychological justice literature (Gollwitzer & van Prooijen, 2016). In organizational psychology, procedural fairness has been conceptualized as a precursor of overall fairness perceptions (Ambrose et al., 2015; Colquitt & Rodell, 2015). Relevant criteria in fairness of political processes are fair participation for all citizens, impartiality, and transparency in decision making (e.g. Schnaudt et al., 2021). In the context of this study, political processes in the carbon price-relevant sectors, energy and transport, ought to be fair, impartial and transparent in order to increase perceived fairness and garner support for this policy. Against this background, we argue that an extensive model of carbon pricing acceptance, where its perceived fairness plays a central mediating role, ought to include evaluations of procedural fairness as further predictor thereof. Indeed, Maestre-Andrés et al. (2019) include procedural aspects as antecedent of perceived policy fairness.

2.3. Adherence to the polluter-pays principle as moderator

Carbon pricing entails that costs borne by consumers increase proportionally to the consumption of high-carbon goods included in the carbon price. The more one emits, because a great amount of high-carbon goods are consumed, the more this person has to pay. As those who are causing emissions are forced to take responsibility and pay for it, carbon pricing is in line with the polluter-pays principle, closely aligned with the fairness principle *equity* (Povitkina et al., 2021).

Fairness principles, such as the polluter-pays principle (or equity), are "normative attitudes relate[d] to the rules or norms people think should guide the allocation and distribution of goods and burdens within social groups and society" (Hülle et al., 2018, p. 664). Equity, then, is a fairness principle that dictates that "social goods (and bads) ought to be distributed in proportion to how much each and every claimant has contributed" (Povitkina et al., 2021, p. 4; see also Deutsch, 1975; Hülle et al., 2018). In the polluter-pays case, the bad, namely bearing mitigation costs, should be proportional to the contribution to climate change.

Because individuals support fairness principles to differing extents (Hülle et al., 2018), adherence to fairness principles is similar to value endorsement. The more individuals endorse a specific value, the more strongly they are likely to think and behave in line with this value (Schwartz, 2012). Coincidingly, literature on formation of fairness perceptions has proposed that evaluations of fairness depend on individual differences, such as values (Barclay et al., 2017). Building on this, we conclude the following. If individuals adhere to the polluter-pays principle, that is, they regard as fair when those who are contributing to a problem should be charged to fix it, perceiving the carbon price to be effective should be related more strongly to perceived carbon pricing fairness than if individuals adhere less to this principle. This is because, for polluter-pays adherents, evaluating a policy as fair necessitates perceiving the charges levied by the policy as contributing to mitigating the problem at hand.

With regards to the influence of low-income consequences on perceived carbon pricing fairness, it is plausible that this link is weaker for adherents of the polluter-pays principle. If an individual believes that it is fair when those who are contributing to a problem are charged

[6] This study, too, operationalizes perceived policy fairness in a non-specified manner, reflecting perceived overall policy fairness.

[7] The original term in this study was acceptability, as they researched acceptance of yet to be implemented policy. Both, acceptance and acceptability, however, refer to a passive evaluation of policy, i.e. supportive or opposing attitude (Kyselá et al., 2019).

more, a negative effect on low-income groups should be less strongly related to the evaluation of carbon pricing fairness. This is because low-income groups can be polluters, too, and according to the polluter-pays principle, they then should also bear costs. Note that, even for adherents of the polluter-pays principle, we still expect there to be an effect of perceived negative low-income consequences on perceived fairness, however to a lesser degree.

3. Present study

By integrating recent empirical work on carbon pricing acceptance and fairness (Maestre-Andrés et al., 2019, Povitkina et al., 2021; Savin et al., 2020) as well as psychological theory on policy acceptance (Schuitema & Bergstad, 2018; von Borgstede et al., 2018) and perceived fairness aspects (Ambrose et al., 2015; Gollwitzer & van Prooijen, 2016), we go beyond existing research in a threefold manner. First, we probe the effect of perceived effectiveness in addition to formerly proposed predictors of perceived (overall) carbon pricing fairness, namely perceived personal consequences, perceived distributional (i.e. low-income) consequences, and perceived procedural fairness, and suggest adherence to the polluter-pays principle as moderator of selected policy-specific beliefs – fairness links. Second, we extend the GEF-inspired framework not only by applying it to a novel context, carbon pricing, but also, third, by proposing procedural fairness as an overlooked predictor of perceived (overall) fairness and suggesting that perceived fairness might mediate the effects of all other policy-specific beliefs on carbon pricing acceptance.

Building on reported theory and empirical evidence, we derive the following hypotheses (see Fig. 1) that we test with data from the Social Sustainability Barometer (SSB), a nationally representative survey on energy and transport transition related attitudes of German citizens:

Hypothesis 1. (H1): Carbon pricing acceptance will be negatively influenced by perceived negative personal consequences, perceived negative distributional (i.e. low-income) consequences, lower perceived procedural fairness and lower perceived effectiveness thereof.

Hypothesis 2. (H2): Perceived carbon pricing fairness will be negatively influenced by perceived negative personal consequences, perceived negative distributional (i.e. low-income) consequences, perceived lower procedural fairness and lower perceived effectiveness thereof.

Hypothesis 3. (H3): The effects of perceived personal consequences, perceived distributional (i.e. low-income) consequences, perceived procedural fairness and perceived effectiveness on carbon pricing acceptance will all be (partially) mediated via perceived carbon pricing fairness.

Hypothesis 4. (H4): The effect of perceived distributional (i.e. low-income) consequences and perceived effectiveness on perceived carbon pricing fairness will be moderated by strength of adherence to the polluter-pays principle.

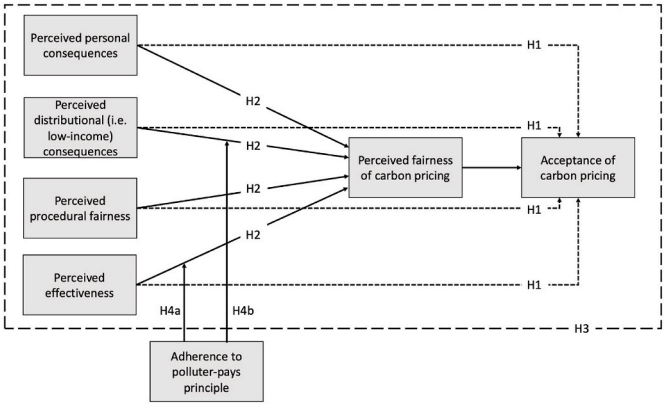


Fig. 1. Conceptual model and hypotheses.

H4a. The positive effect of perceived effectiveness on perceived fairness will be stronger for those who adhere to the polluter-pays principle.

H4b. The negative effect of perceived negative distributional (i.e. low-income) consequences on perceived fairness will be weaker for those who adhere to the polluter-pays principle.

4. Method

4.1. Sample and procedure

For the analyses conducted in this study we use data from the Social Sustainability Barometer (SSB), a three-wave online panel survey representative of the German adult population (Fischer et al., 2022). Panel members were recruited by multistep random sampling using computer assisted telephone interviews and are representative of the German population (Wolf et al., 2021, 2022, 2023). A number of socio-demographical and other attitudinal control variables are elicited in addition to the answers to energy and transport transition-specific questions. For more information on the SSB see Appendix.

Responses to the main variables of interest in this study were elicited in Wave 2 in 2022. However, procedural fairness and adherence to the polluter-pays principle were surveyed in Wave 1 in 2021 (see Section 4.2 Measures). Hence, we only included individuals that participated in both waves ($n = 4646$). The characteristics of this sample are as follows: 46.6% of participants self-identified as female, 28,6% had some kind of college degree (Bachelor, Master, PhD or equivalent). Participants' age ranged from 19 to 91 years with a mean of 57.8 years and a standard deviation (SD) of 15.3. These sample characteristics are comparable to official statistics, except for a slight overrepresentation of older individuals, with higher education and middle income (see Appendix Table A.1). Overall, 34.9% of the participants supported carbon pricing (strong support: 10.4%), 41.4% opposed carbon pricing (strong opposition: 22.9%), and 20% chose the neutral option (neither support nor opposition). The survey company that implemented the questionnaire obtained informed consent from all participants. Respondents took on average about 30 min to finish the survey. All responses were given on 5-point Likert-scales, if not indicated otherwise. Before questions regarding carbon pricing were posed, participants were parsimoniously informed on the German carbon price in general and revenue usage similar to the information provided by governmental websites in both waves (see Appendix Section 1).

4.2. Measures

Acceptance. In line with a wide range of policy acceptance research (Kyselá et al., 2019), carbon pricing acceptance was measured with one item eliciting a passive evaluative response with the labels "strongly oppose" to "strongly support". The question stated: "Please indicate to what extent you oppose or support the current carbon pricing policy."

Perceived fairness was measured in line with former research on carbon price and other climate policy (e.g. Clayton, 2018; Maestre-Andrés et al., 2021). Participants were asked to answer the item, "Please indicate to what extent you feel the current carbon pricing policy to be fair" with labels ranging from "very unfair" to "very fair". Coinciding with the bulk of the literature, the item does not specify any particular fairness aspect, thus implying a sense of overall fairness.

Perceived personal consequences. In line with previous research, beliefs about personal consequences were operationalized by asking whether respondents believe that carbon pricing will lead them to being personally better or worse off (e.g. Maestre-Andrés et al., 2021). The item stated: "Please indicate how the current carbon pricing policy affects you financially" and answers given ranged from "puts me

financially much worse off" to "puts me financially much better off".

Perceived low-income consequences. Similarly, beliefs about low-income consequences were operationalized by asking whether respondents believe that carbon pricing will lead to low-income groups being better or worse off (e.g. Maestre-Andrés et al., 2021). The item stated: "Please indicate how the current carbon pricing policy affects low-income households". Answers were labeled from "puts them financially much worse off" to "puts them financially much better off".

Perceived procedural fairness. Procedural fairness has a long tradition of being operationalized as the meeting of different criteria fundamental to a fair political process, such as fairness of processes in general (item 1), impartiality (item 2), and transparency in decision making (item 3) (e.g. Schnaudt et al., 2021). Three items found in wave 1 of the SSB capture these criteria and were averaged ("In your view, to what extent does the political system in Germany ensure that everyone has a fair opportunity to participate in shaping energy and transport transition policy?"; "In your view, how much does the government in Germany take into account the interests of all citizens when shaping the energy and transport transition?"; "In your view, how transparent are decisions in energy and transport transition policy in Germany, i.e. that everyone can see how they were made?"). They specifically refer to the policy fields in which German carbon pricing is implemented, namely energy and transport. Answers were elicited on a seven-point Likert-scale ranging from 1 (not at all) to 7 (very much). The items showed good internal consistency (Cronbach's alpha = 0.86). We argue that including this assessment from Wave 1 is warranted, because, in Germany, perceptions of procedural fairness are relatively stable over time (for results on stability from 1994 to 2014 see Sachweh & Sthamer, 2019).

Perceived effectiveness. Similarly to existing research (Maestre-Andrés et al., 2021), perceived effectiveness of carbon pricing was elicited with agreement or disagreement with one item, "The carbon price is generally an effective tool to reduce energy consumption and emissions of climate-damaging gases in Germany".

Polluter-pays principle. Adherence to the polluter-pays principle was assessed in wave 1 of the SSB with one item eliciting the general energy transition cost distribution preference: "Each household should bear costs according to its energy consumption. Thus, households with high energy consumption bear a higher share of the costs". Respondents could rate from "totally disagree" to "totally agree". We argue that using this assessment from Wave 1 is acceptable, because attitude research suggests that value-like attitudes, such as adherence to fairness principles, are relatively stable over time (Bardi & Goodwin, 2011; Sagiv et al., 2017; Schwartz, 1992).

Controls. Several background variables have been identified to be relevant to climate policy support in general and carbon pricing acceptance in particular. Hence, we included the following control variables in the present analyses.

A number of socio-demographics were reported to have an influence on climate policy acceptance, namely gender, education, age, and income (e.g. Bergquist et al., 2022). The former two are also important for carbon pricing acceptance in particular (e.g. Levi, 2021). The SSB provides data on all these characteristics. Education was assessed with 8 categories 1 (no school diploma) to 8 (doctoral degree). Monthly household net income was assessed with 10 categories ranging from 1 (less than 900 Euros) to 10 (more than 10,000 Euros).

Moreover, ideology and climate change evaluations were found to be relevant to climate policy support (e.g. Bergquist et al., 2022) and carbon pricing support in particular (e.g. Levi, 2021). As a proxy for ideology, voting behavior in the 2021 national election was provided in the SSB dataset. To parsimoniously integrate this variable in the analyses, we dichotomized it to reflect voting for the German green political party (Bündnis90/Die Grünen). This party is a strong advocate of carbon pricing and voting for them had the largest effect in explaining carbon pricing acceptance (see Appendix Table A.2).

As climate sceptics are a marginal group in Germany (Kácha, Vintr, & Brick, 2022), we did not include a measure of climate change belief. However, concern over climate change was included as a climate change evaluation relevant for climate policy support ("How worried are you about climate change"; from 1 (not worried at all) to 5 (extremely worried)).

As a more proximal measure of ideological influence on climate policy, we included an additional concept provided in the SSB dataset, namely general climate policy preference in terms of rather paternalistic or liberal climate mitigation policy preferences. It is measured with agreement or disagreement with two items that are averaged (Cronbach's alpha = 0.81; "To ensure that individuals do enough for climate protection, legal regulations and rules are needed"; "Whether and to what extent one does something for climate protection should be left to each individual" – inverted).

4.3. Data analyses

Analyses were conducted in Stata 16. Hypotheses 1, 2, and 3 (mediation) were tested in a path model run with the structural equation modeler in STATA. As path modelling is based on multiple regressions, it allows to test the relational hypotheses 1 and 2. Furthermore, as it distinguishes direct and indirect effects it is suitable to detect mediation pathways. All path models were assessed with maximum likelihood method. All reported control variables (age, gender, education, income, concern over climate change, political orientation, and general climate policy preference) are entered as additional predictors of carbon pricing acceptance in the path model. Covariances between all predictors were allowed for in the model, which coincides with our data (see Appendix Table A.4). As χ^2-tests are not well suited for large samples (Shi et al., 2019), we rather opt for the other commonly used indices, the Root-Mean-Square-Error-of-Approximation (RMSEA), the Comparative-Fit-Index (CFI), the Tucker-Lewis-Index (TLI), and the Standardized-Root-Mean-Squared-Residual (SRMR) as measures to estimate goodness of fit. To provide additional robustness to the mediation analysis, we ran the medsem package for STATA (Mehmetoglu, 2018). With medsem, standard Sobel tests are supplemented by more appropriate Monte Carlo tests as well as ratios of indirect effect to total effect (RIT) and indirect effect to direct effect (RID) to better gauge the indirect effect size (Mehmetoglu, 2018). Lastly, we compared the hypothesized model to a reduced model that omits the non-significant paths with a likelihood-ratio test. Hypotheses 4a to 4d (moderation) were tested by calculating an interaction effect and subsequent simple slope analyses. Due to the large sample, we omitted participants with missing values in all analyses. Before conducting the OLS based path analysis we checked OLS assumptions, which were sufficiently met. In particular, potentially problematic multicollinearity of predictors and mediator, hinted at by the intercorrelation matrix (see Appendix Table A.4), was assessed using the variance inflation factor (VIF). As all VIFs were <2.5, we carried on with our analysis.

5. Results

5.1. Path analysis

Means, standard deviations and intercorrelations of all model variables are reported in the Appendix Table A.4. All control variables significantly predicted carbon pricing acceptance and perceived fairness explaining 36% and 26% of the variance respectively (see Appendix Table A.3). Overall, the path model tested showed very acceptable indices, as CFI was 0.98, TLI was 0.92, RMSEA was equal to and SRMR below 0.08 (see Fig. 2) – all in line with the advised cutoff criteria (West et al., 2012). About 70 % of the variance in carbon pricing acceptance can be explained by the control variables and the postulated model.

In line with H1, all posited links from the policy-specific beliefs towards carbon pricing acceptance were significant. Note that here we report only effects excluding the mediator (see Table 1), as, for mediation, we first have to establish that there is an effect to be mediated

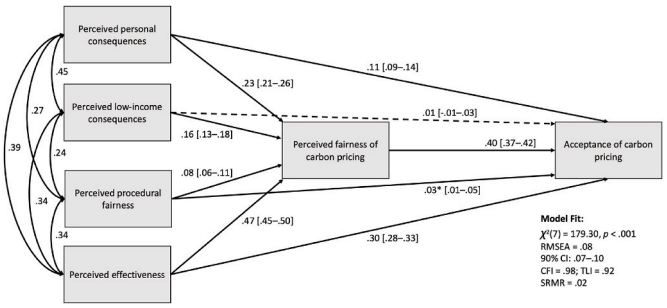


Fig. 2. Path model with standardized direct effects (95% confidence intervals in parentheses) and covariances. All coefficients shown have a p-value of $p < 0.001$, except * $p = 0.003$, non-significant paths are dotted. $n = 3452$. Overall $R^2 = 0.69$, for acceptance $R^2 = 0.70$, for fairness $R^2 = 0.52$.

Table 1
Indirect effects and effects without mediator of policy-specific perceptions on carbon price acceptance.

Outcome: carbon pricing acceptance	B	SE (B)	β
Effects of predictors excluding the mediator			
Perceived personal consequences	0.39	0.02	0.20***
Perceived low-income consequences	0.15	0.02	0.08***
Perceived procedural fairness	0.07	0.01	0.06***
Perceived effectiveness	0.51	0.01	0.49***
Indirect effects			
Perceived Personal consequences → perceived fairness → acceptance	0.17	0.01	0.09***
Perceived low-income consequences → perceived fairness → acceptance	0.12	0.01	0.06***
Perceived procedural fairness → perceived fairness → acceptance	0.04	0.01	0.03***
Perceived effectiveness → perceived fairness → acceptance	0.20	0.01	0.19***

(Baron & Kenny, 1986; Mehmetoglu, 2018). The more individuals perceive carbon pricing to have negative personal consequences, the less they tended to accept carbon pricing. As higher values in perceived personal consequences of carbon pricing indicate positive financial effects this path resulted in positive beta-weights ($\beta = 0.20$, $p < 0.001$). Similarly, the more individuals perceive carbon pricing to have negative low-income consequences, the less they tended to accept carbon pricing ($\beta = 0.08$, $p < 0.001$). Regarding procedural fairness, perceiving the political processes in carbon pricing sectors to be fairer resulted in higher carbon pricing acceptance ($\beta = 0.06$, $p < 0.001$). Lastly, higher perceived effectiveness also resulted in higher carbon pricing acceptance ($\beta = 0.49$, $p < 0.001$).

In line with H2, all policy-specific beliefs that were expected to have an effect on perceived fairness indeed showed significant beta-weights. Here we report the direct effect paths from the predictors towards perceived carbon pricing fairness shown in Fig. 2 (for a full model including control variables see Appendix Figure A.1; for a full list of covariances see Appendix Table A.5). Similar to the paths towards carbon pricing acceptance, perceiving carbon pricing to have negative personal consequences led to lower perceived carbon pricing fairness ($\beta = 0.23$, $p < 0.001$). The same applies for perceived low-income consequences ($\beta = 0.16$, $p < 0.001$), perceived procedural fairness ($\beta = 0.08$, $p < 0.001$), and perceived effectiveness ($\beta = 0.47$, $p < 0.001$).

Our data supports H3 which posited that the effects of all motive-reflective policy-specific beliefs on carbon pricing acceptance were at least partially mediated by perceived fairness (see Table 1). The indirect path from perceived personal consequences via perceived fairness to carbon pricing acceptance was significant ($\beta = 0.07$, $p < 0.001$). However, the direct path from personal consequences towards acceptance while controlling for the mediator, perceived fairness, still persisted ($\beta = 0.11$, $p < 0.001$), indicating partial mediation. The Sobel test for the indirect effect is $z = 14.57$, $p < 0.001$, $z = 14.64$, $p < 0.001$ for Monte Carlo. The RIT indicates that about 45 % of the effect of perceived personal consequences on acceptance is mediated by perceived fairness. The RID indicates that the indirect effect is about 0.8 times the direct effect. For the effects of perceived low-income consequences on carbon pricing acceptance the indirect effect via perceived fairness was significant ($\beta = 0.06$, $p < 0.001$) and the direct effect on acceptance while controlling for the mediator was non-significant ($\beta = 0.01$, $p = 0.22$). The Sobel test for the indirect effect is $z = 10.76$, $p < 0.001$, $z = 10.78$, $p < 0.001$ for Monte Carlo. The RIT indicates that about 82 % of the effect of perceived personal consequences on acceptance is mediated by perceived fairness. The RID indicates that the indirect effect is about 4.6 times larger than the direct effect. This indicates a full mediation – perceiving carbon pricing to be detrimental to low-income groups only exerts an influence on acceptance because carbon pricing is perceived to be less fair. Regarding perceived procedural fairness the data supports a partial mediation (indirect effect: $\beta = 0.03$, $p < 0.001$; direct effect while controlling for the mediator: $\beta = 0.03$, $p = 0.003$; $z = 6.50$, $p < 0.001$ for both Sobel and Monte Carlo tests). About 53 % of the effect of perceived procedural fairness is mediated via perceived fairness and the indirect effect is about 1.1 times as large as the direct effect, partial mediation applies. Lastly, regarding perceived effectiveness, the results also support partial mediation (indirect effect: $\beta = 0.19$, $p < 0.001$; direct effect while controlling for the mediator: $\beta = 0.30$, $p < 0.001$; Sobel test: $z = 22.27$, $p < 0.001$; Monte Carlo test: $z = 21.53$, $p < 0.001$). About 38 % of the effect of perceived effectiveness is mediated and the indirect effect is about 0.6 times as large as the direct effect.

To further consolidated these results, we ran a path model that omits the non-significant direct path from perceived low-income consequences towards acceptance (see Appendix Figure A.2). The novel more parsimonious model resulted in the same path pattern and had as acceptable fit as the initial model ($\chi^2(8) = 180.82$, $p < 0.001$; RMSEA = 0.08, 90% CI: 0.07–0.09; CFI = 0.97; TLI = 0.93; SRMR = 0.02). However, as the χ^2-difference was non-significant ($\Delta\chi^2(1) = 1.52$, $p = 0.22$), the initial, more complex model did not fit the data better than the reduced one. Hence, omitting the direct path (low-income consequences → acceptance) is warranted. This provides additional support for the full mediation of the effect of perceived low-income consequences on acceptance via fairness.

5.2. Moderation analysis

To investigate the moderating role of adherence to the polluter-pays principle on the links of perceived effectiveness and low-income consequences on carbon pricing fairness, we tested the significance of an interaction term based on standardized variables. To further validate our results, we additionally tested the interaction terms with inclusion of the control variables discussed in the previous section. The results did not differ from the ones discussed below (see Appendix Tables A.7 and A.8). Moreover, we tested the differences in simple slopes according to Robinson, Tomek, & Schumacker (2013). For this analysis see Appendix (Table A.6).

Regarding the effectiveness-fairness link, results are shown in Table 2. Our hypothesis that perceived effectiveness has a stronger influence on perceived fairness for individuals that adhere to the polluter-pays principle was supported. The interaction between perceived effectiveness and adherence to the polluter-pays principle was significant ($\beta = 0.03$; $p = 0.014$). As depicted in Fig. 3, this results in a smaller effect of perceived effectiveness on perceived fairness for individuals that adhere less to the polluter-pays principle (at −1 SD of the polluter-pays measure: $b = 0.46$, $p < 0.001$) compared to strong adherents (at +1 SD of the polluter-pays measure: $b = 0.52$, $p < 0.001$). It should be noted, though, that including an interaction term did not increase the explained variance in perceived fairness substantially (<1%).

Table 2
Interaction of perceived effectiveness and adherence to the polluter-pays principle.

Explanatory variables	Perceived fairness					
	Without interaction			With interaction		
	B	SE (B)	β	B	SE (B)	β
Perceived personal consequences	0.32	0.02	0.21***	0.32	0.02	0.21***
Perceived low-income consequences	0.26	0.02	0.16***	0.26	0.02	0.16***
Perceived procedural fairness	0.08	0.01	0.09***	0.08	0.01	0.09***
Perceived effectiveness	0.50	0.01	0.46***	0.49	0.01	0.49***
Polluter-pays principle (PPP)	0.09	0.01	0.09***	0.10	0.01	0.07***
Perceived effectiveness X PPP	–	–	–	0.03	0.01	0.03*

Variables used in the interaction (effectiveness and adherence to polluter-pays) were standardized.
Without interaction: $n = 3926$. $F(5, 3920)$ 887.52, $p < 0.001$, adj. R^2 0.53.
With interaction: $n = 3, 926$; $F(6, 3919)$ 741.56, $p < 0.001$, adj. R^2 0.53.
*$p = 0.014$, ***$p < 0.001$.

Table 3
Interaction of perceived low-income effect and adherence to the polluter-pays principle.

Explanatory variables	Perceived fairness					
	Without interaction			With interaction		
	B	SE (B)	β	B	SE (B)	β
Perceived personal consequences	0.32	0.02	0.21***	0.32	0.02	0.21***
Perceived low-income consequences	0.18	0.01	0.16***	0.18	0.01	0.16***
Perceived procedural fairness	0.08	0.01	0.09***	0.08	0.01	0.09***
Perceived effectiveness	0.39	0.01	0.46***	0.38	0.01	0.46***
Polluter-pays principle (PPP)	0.09	0.01	0.09***	0.10	0.01	0.09***
Perceived low-income consequences X PPP	–	–	–	0.03	0.01	0.03*

Variables used in the interaction (perceived low-income consequences and adherence to polluter-pays) were standardized.
Without interaction: $n = 3926$. $F(5, 3920)$ 887.52, $p < 0.001$, adj. R^2 0.53.
With interaction: $n = 3, 926$; $F(6, 3919)$ 741.31, $p < 0.001$, adj. R^2 0.53.
*$p = 0.021$, ***$p < 0.001$.

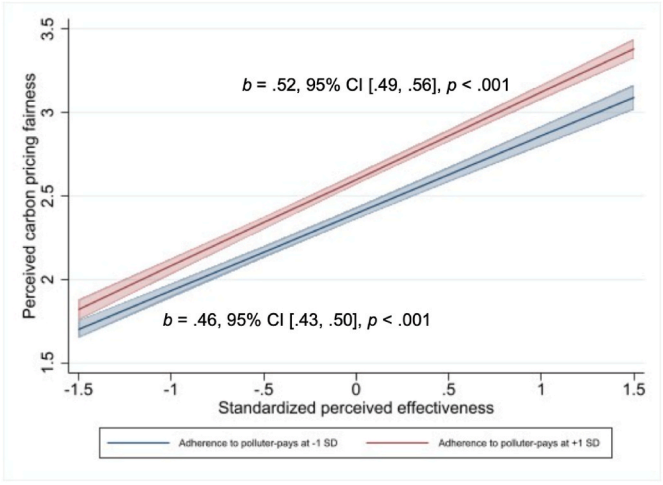


Fig. 3. (in color): Simple slopes of the effect of perceived effectiveness on perceived fairness at high and low levels of polluter-pays principle adherence with 95 % confidence intervals. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

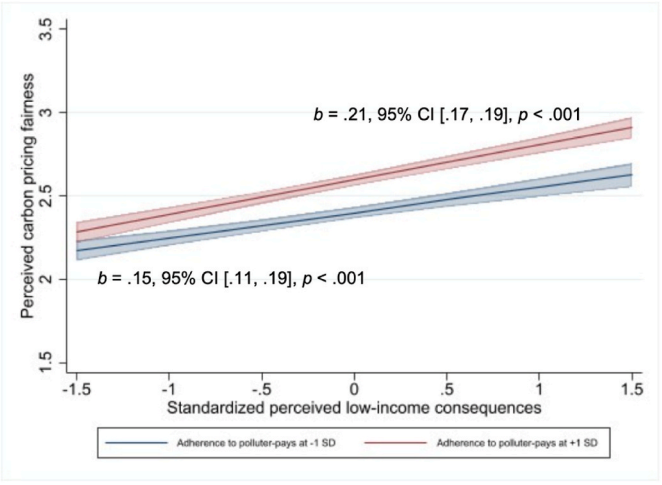


Fig. 4. (in color): Simple slopes of the effect of perceived low-income consequences on perceived fairness at high and low levels of polluter-pays principle adherence with 95 % confidence intervals. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Regarding the low-income consequences–fairness link, results are shown in Table 3. Results did not support our hypothesis that for individuals that adhere more strongly to the polluter-pays principle the influence of perceived low-income consequences is weaker than for those who adhere less to this principle. While the interaction between perceived low-income consequences and adherence to the polluter-pays principle was significant ($\beta = 0.03$; $p = 0.021$), the moderating effect was opposed to our expectations. Fig. 4 shows a smaller effect of perceived low-income consequences on perceived fairness for individuals that adhere less to the polluter-pays principle (at −1 SD of the polluter-pays measure: $b = 0.15$, $p < 0.001$) compared to strong adherents (at +1 SD of the polluter-pays measure: $b = 0.21$, $p < 0.001$). Individuals who believe to a greater extent that contributors to emissions should bear higher costs show a stronger relationship between perceived low-income consequences and perceived fairness than those who believe less so. Again, it should be noted, though, that including an interaction term did not increase substantially the explained variance in perceived fairness (<1%).

6. Discussion

Based on GEF-inspired theory (Schuitema & Bergstad, 2018; von Borgstede et al., 2018; Wilke, 1991) and empirical evidence on carbon pricing acceptance determinants (e.g. Levi, 2021; Maestre-Andrés et al., 2019, 2021), we aimed to investigate the influence of perceived carbon pricing effectiveness amongst other policy-specific beliefs (perceived personal consequences, distributional (i.e. low-income) consequences and procedural fairness) on perceived (overall) carbon pricing fairness and whether the latter mediates the effect of policy-specific beliefs on acceptance. Our results go beyond existing literature on perceived carbon pricing fairness determinants (e.g. Maestre-Andrés et al., 2019) and carbon pricing acceptance research in general (e.g. Douenne & Fabre, 2020; Levi, 2021; Maestre-Andrés et al., 2021; Merten et al., 2022; Sommer et al., 2022) in three ways. First, we find perceived effectiveness, a previously understudied determinant of perceived carbon pricing fairness, to be the strongest fairness predictor compared to perceived personal consequences, distributional (i.e. low-income) consequences

and procedural fairness. Our results furthermore point in the direction that perceived carbon pricing fairness might play a central mediating role for at least a part of the effects of all policy-specific beliefs on acceptance. Second, we go beyond GEF in the context of policy acceptance by, on the one hand, observing perceived procedural fairness as an additional determinant of more general perceived carbon pricing fairness and, on the other, providing novel but somewhat limited evidence for the moderating role of adherence to the polluter-pays principle. Third, and in contrast to the bulk of existing research on carbon pricing, we conducted our analyses in a real-world context where carbon pricing is already concretely implemented.

With regards to the application of a GEF-inspired acceptance framework (Schuitema & Bergstad, 2018) to the carbon pricing context, our study provides evidence that the relations posited hold: policy-specific beliefs, namely personal and low-income consequences, and effectiveness - reflective of the three motives greed, fairness and efficiency respectively - predict perceived (overall) carbon pricing fairness and its acceptance. By exerting the strongest influence on perceived fairness amongst all considered policy-specific beliefs, the presented results on perceived effectiveness provide quantitative evidence for the conclusions drawn from former research on perceived carbon pricing fairness (Povitkina et al., 2021; Savin et al., 2020). Incidentally, in their implicit GEF application study, Schuitema et al. (2011) also found perceived effectiveness to be more strongly related to perceived fairness with regard to a set of transport policies compared to other policy-specific beliefs.

Moreover, our results hint at a potentially crucial role of perceived (overall) fairness for policy acceptance. In our study, amongst all acceptance predictors, perceived (overall) fairness exerts the biggest effect. This coincides with meta-analyses of the determinants of climate policy instruments (Bergquist et al., 2022). It is also in line with carbon price-specific studies that simultaneously gauged the effect of (at least) perceived fairness and effectiveness, finding a stronger influences of the former on acceptance (Dreyer & Walker, 2013; Maestre-Andrés et al., 2021). Additionally, our results provide first, but limited quantitative evidence for the mediation model put forth in a perceived carbon pricing fairness literature review (Maestre-Andrés et al., 2019).

Lastly, we suggested adherence to the polluter-pays principle as moderating value-orientation that might moderate the effects of the selected policy-specific beliefs, perceived distributional (i.e. low-income) consequences and effectiveness, on perceived (overall) fairness. Regarding these hypotheses, our data provide only limited and ambiguous results. As the explained variance in perceived fairness only increased by less than one percent due to the inclusion of the interactions, the following discussion is to be taken with a grain of salt. While the posited moderating influence of adherence to this fairness principle regarding the effect of perceived effectiveness on perceived fairness was supported by our results (that is, the effect was larger for polluter-pays adherents) the moderating influence regarding the effect of perceived distributional (i.e. low-income) consequences on perceived fairness was not. Contrary to our expectations, adherents of the polluter-pays principle did not show a weaker link between perceived low-income consequences and perceived fairness. Rather, when individuals want polluters to pay, perceiving the carbon price to be detrimental to lower income groups results in even lower perceived fairness compared to non-adherents. This is interesting, because recent research has shown that low-income groups are not the ones polluting most (e.g. Nielsen et al., 2021). Do the results thus point to a common awareness of this fact? Is it because individuals know that low-income groups are anyway not the biggest emitters that adhering to the polluter-pays principle makes perceiving negative low-income consequences decrease perceived fairness even further? These questions remain for future studies. Controlling for the beliefs about the polluting extent of different income groups might be a first step towards answering these questions in a similar research design. Lastly, it is worthwhile noting that other fairness principles, such as need, exist and are adhered to by large segments of the public to varying extents in different domains (Van Hootegem et al., 2020). Different fairness principles might interact and be more or less impactful regarding the links between different beliefs on policy consequences and perceived policy fairness. Future research might tackle these issues by investigating the role of adherence to other fairness principles in predicting perceived fairness.

6.1. Limitations and future research

Our study's limitations mainly revolve around two issues. First, due to the use of an already existing dataset, the operationalization of concepts is partly not optimal. For instance, the effectiveness measure is not regarding the effectiveness of the actually implemented German carbon price. Rather than eliciting an effectiveness evaluation that also considers the current carbon price level, a design aspect important to its effectiveness (Pietzcker et al., 2021), the wording pertains to a statement regarding the general effectiveness of such policy. Moreover, more closely aligned to GEF development in the policy context (Schuitema & Bergstad, 2018), the distributional consequences would have been better operationalized as a statement eliciting the consequences for low-compared to higher-income groups. Lastly, perceived (overall) fairness, procedural fairness and polluter-pays measures might have been worded differently. Precise measures of overall fairness usually include *overall* or *all in all* in their items (Colquitt & Rodell, 2015). Procedural fairness could have referred to carbon pricing directly rather than to energy and transport policy decision making in general. The polluter-pays item should not have referred to the amount of energy consumed in general but rather to the amount of carbon-intensive energy. More pertinent operationalizations of variables should be used in coming research.

Second, due to the correlational design in our study, the implied causal pathway that perceived effectiveness precedes perceived fairness and that the latter acts as a mediator cannot be tested causally. The coefficients are only to be interpreted as strength of relationship between concepts. Regarding the implied causal order, it is interesting to note that Bolderdijk et al. (2017) suggested and found evidence for an opposed causal ordering for a car tax based on kilometrage. In their study, fairness perceptions precede effectiveness skepticism. As, except for this publication, there are no hints at a reverse causal pathway, we did not test it. How this contradictory causal reasoning might be reconciled should be tackled by future studies.

6.2. Policy implications

Lessons for policy-makers drawn from this investigation are, in accordance with the literature, that, regarding attitudes towards policy, individuals are justice sensitive. Our results further underline the importance of perceived fairness for policy support. Governments planning to garner support for the implementation of carbon pricing ought to have simultaneous strategies: (1) Reduce the feeling of being worse off due to policy. This can be achieved by providing easily accessible low-carbon alternatives. If the public is aware of these and has sufficient behavioral control to use them, this should result in perceptions of feeling less worse off due to carbon pricing. Research has indeed shown that perceiving emissions reduction options heightens carbon price acceptance (Merten et al., 2022). Also, a redistributive mechanism, as planned by the German government but not yet implemented, might reduce feelings of being worse off. (2) The design of carbon pricing must be with little to no detrimental effects on low-income groups. This might also be achieved by implementing a redistributive mechanism such as lump-sum payments (Kalkuhl et al., 2021). (3) The effectiveness of carbon pricing should be better communicated. In Germany, there is generally a lack of comprehension of carbon pricing policy and its effectiveness (Matthies et al., 2020). According to the present investigation, if all three recommendations are implemented, perceived fairness and subsequently public support for carbon pricing should increase

substantially.

Declarations of interest

None.

CRediT authorship contribution statement

Jean-Henri Huttarsch: Conceptualization, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Ellen Matthies:** Supervision, Writing – review & editing.

Acknowledgements

We thank Ingo Wolf for his advisory assistance. This research was funded by the German Ministry of Education and Research (Grant Ariadne – 03SFK5M0).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2024.102356.

References

Ambrose, M. L., Wo, D. X. H., & Griff, M. D. (2015). Overall justice: Past, present, and future. In R. S. Cropanzano, & M. L. Ambrose (Eds.), *The oxford handbook of justice in the workplace*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199981410.013.0005.

Anderson, S. T., Marinescu, I., & Shor, B. (2019). *Can Pigou at the polls stop us melting the poles?* (Vol. 26146). NBER Working Paper Series.

Barclay, L. J., Bashshur, M. R., & Fortin, M. (2017). Motivated cognition and fairness: Insights, integration, and creating a path forward. *Journal of Applied Psychology, 102*(6), 867–889. https://doi.org/10.1037/apl0000204

Bardi, A., & Goodwin, R. (2011). The dual route to value change: Individual processes and cultural moderators. *Journal of Cross-Cultural Psychology, 42*(2), 271–287. https://doi.org/10.1177/0022022110396916

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Bergquist, M., Nilsson, A., Harring, N., & Jagers, S. C. (2022). Meta-analyses of fifteen determinants of public opinion about climate change taxes and laws. *Nature Climate Change, 12*(3), 235–240. https://doi.org/10.1038/s41558-022-01297-6

Bolderdijk, J. W., Steg, L., Woerdman, E., Frieswijk, R., & De Groot, J. I. M. (2017). Understanding effectiveness skepticism. *Journal of Public Policy and Marketing, 36*(2), 348–361. https://doi.org/10.1509/jppm.16.118

Clayton, S. (2018). The role of perceived justice, political ideology, and individual or collective framing in support for environmental policies. *Social Justice Research, 31*(3), 219–237. https://doi.org/10.1007/s11211-018-0303-z

Clayton, S., Kals, E., & Feygina, I. (2016). Justice and environmental sustainability. In C. Sabbagh, & M. Schmitt (Eds.), *Handbook of social justice theory and research* (pp. 369–386). New York: Springer. https://doi.org/10.1007/978-1-4939-3216-0_20.

Colquitt, J. A., & Rodell, J. B. (2015). Measuring justice and fairness. In R. S. Cropanzano, & M. L. Ambrose (Eds.), *The oxford handbook of justice in the workplace*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199981410.013.8.

Crowley, K. (2017). Up and down with climate politics 2013–2016: The repeal of carbon pricing in Australia. *WIREs Climate Change, 8*(3). https://doi.org/10.1002/wcc.458

Deutsch, M. (1975). Equity, equality, and need: What determines which value will Be used as the basis of distributive justice? *Journal of Social Issues, 31*(3), 137–149. https://doi.org/10.1111/j.1540-4560.1975.tb01000.x

Douenne, T., & Fabre, A. (2020). French attitudes on climate change, carbon taxation and other climate policies. *Ecological Economics, 169*, Article 106496. https://doi.org/10.1016/j.ecolecon.2019.106496

Drews, S., Savin, I., & van den Bergh, J. (2024). A global survey of scientific consensus and controversy on instruments of climate policy. *Ecological Economics, 218*, Article 108098. https://doi.org/10.1016/j.ecolecon.2023.108098

Drews, S., & van den Bergh, J. C. J. M. (2016). What explains public support for climate policies? A review of empirical and experimental studies. *Climate Policy, 16*(7), 855–876. https://doi.org/10.1080/14693062.2015.1058240

Dreyer, S. J., & Walker, I. (2013). Acceptance and support of the Australian carbon policy. *Social Justice Research, 26*(3), 343–362. https://doi.org/10.1007/s11211-013-0191-1

Edenhofer, O., Flachsland, C., Kalkuhl, M., Knopf, B., & Pahle, M. (2019). Optionen für eine CO2-Preisreform. *MCC-PIK-Expertise für den Sachverständigenrat zur Begutachtung der Gesamtwirtschaftlichen Entwicklung*, 04/2019) http://hdl.handle.net/10419/201374.

Eek, D., & Biel, A. (2003). The interplay between greed, efficiency, and fairness in public-goods dilemmas. *Social Justice Research, 16*(3), 195–215. https://doi.org/10.1023/A:1025984611796

Ejelöv, E., & Nilsson, A. (2020). Individual factors influencing acceptability for environmental policies: A review and research agenda. *Sustainability, 12*(6), 2404. https://doi.org/10.3390/su12062404

Ewald, J., Sterner, T., & Sterner, E. (2022). Understanding the resistance to carbon taxes: Drivers and barriers among the general public and fuel-tax protesters. *Resource and Energy Economics, 70*(101331). https://doi.org/10.1016/j.reseneeco.2022.101331

Fischer, A.-K., Huttarsch, J.-H., & Wolf, I. (2022). *Soziales Nachhaltigkeitsbarometer der Energie- und Verkehrswende – Daten- und Methodenbericht 2021*.

Gollwitzer, M., & van Prooijen, J.-W. (2016). Psychology of justice. In C. Sabbagh, & M. Schmitt (Eds.), *Handbook of social justice theory and research* (pp. 61–82). New York: Springer. https://doi.org/10.1007/978-1-4939-3216-0_4.

Green, J. F. (2021). Does carbon pricing reduce emissions? A review of ex-post analyses. *Environmental Research Letters, 16*(4), Article 043004. https://doi.org/10.1088/1748-9326/abdae9

Hammar, H., & Jagers, S. C. (2007). What is a fair CO2 tax increase? On fair emission reductions in the transport sector. *Ecological Economics, 61*(2–3), 377–387. https://doi.org/10.1016/j.ecolecon.2006.03.004

Hülle, S., Liebig, S., & May, M. J. (2018). Measuring attitudes toward distributive justice: The basic social justice orientations scale. *Social Indicators Research, 136*(2), 663–692. https://doi.org/10.1007/s11205-017-1580-x

Jagers, S. C., Lachapelle, E., Martinsson, J., & Matti, S. (2021). Bridging the ideological gap? How fairness perceptions mediate the effect of revenue recycling on public support for carbon taxes in the United States, Canada and Germany. *The Review of Policy Research, 38*(5), 529–554. https://doi.org/10.1111/ropr.12439

Kácha, O., Vintr, J., & Brick, C. (2022). Four Europes: Climate change beliefs and attitudes predict behavior and policy preferences using a latent class analysis on 23 countries. *Journal of Environmental Psychology, 81*, Article 101815. https://doi.org/10.1016/j.jenvp.2022.101815

Kalkuhl, M., Knopf, B., & Edenhofer, O. (2021). *CO2-Bepreisung: Mehr Klimaschutz mit mehr Gerechtigkeit*.

Konc, T., Drews, S., Savin, I., & van den Bergh, J. C. J. M. (2022). Co-dynamics of climate policy stringency and public support. *Global Environmental Change, 74*, Article 102528. https://doi.org/10.1016/j.gloenvcha.2022.102528

Kyselá, E., Ščasný, M., & Zvěřinová, I. (2019). Attitudes toward climate change mitigation policies: A review of measures and a construct of policy attitudes. *Climate Policy, 19*(7), 878–892. https://doi.org/10.1080/14693062.2019.1611534

Levi, S. (2021). Why hate carbon taxes? Machine learning evidence on the roles of personal responsibility, trust, revenue recycling, and other factors across 23 European countries. *Energy Research & Social Science, 73*, Article 101883. https://doi.org/10.1016/j.erss.2020.101883

Lilliestam, J., Patt, A., & Bersalli, G. (2021). The effect of carbon pricing on technological change for full energy decarbonization: A review of empirical ex-post evidence. *WIREs Climate Change, 12*(1). https://doi.org/10.1002/wcc.681

Lilliestam, J., Patt, A., & Bersalli, G. (2022). On the quality of emission reductions: Observed effects of carbon pricing on investments, innovation, and operational shifts. A response to van den Bergh and Savin (2021). *Environmental and Resource Economics, 83*(3), 733–758. https://doi.org/10.1007/s10640-022-00708-8

Maestre-Andrés, S., Drews, S., Savin, I., & van den Bergh, J. (2021). Carbon tax acceptability with information provision and mixed revenue uses. *Nature Communications, 12*(1), 7017. https://doi.org/10.1038/s41467-021-27380-8

Maestre-Andrés, S., Drews, S., & van den Bergh, J. (2019). Perceived fairness and public acceptability of carbon pricing: A review of the literature. *Climate Policy, 19*(9), 1186–1204. https://doi.org/10.1080/14693062.2019.1639490

Matthies, E., Becker, A., & Bobeth, S. (2020). CO 2 -Bepreisung zwischen wirkungsvollem Instrument und Überforderung? Eine Pilotstudie zu Bedingungen der Akzeptabilität. *GAIA - Ecological Perspectives for Science and Society, 29*(4), 249–257. https://doi.org/10.14512/gaia.29.4.10

Mehmetoglu, M. (2018). medsem: a Stata package for statistical mediation analysis. *International Journal of Computational Economics and Econometrics, 8*(1), 63. https://doi.org/10.1504/IJCEE.2018.088321

Merten, M. J., Becker, A. C., & Matthies, E. (2022). What explains German consumers' acceptance of carbon pricing? Examining the roles of pro-environmental orientation and consumer coping style. *Energy Research & Social Science, 85*, Article 102367. https://doi.org/10.1016/j.erss.2021.102367

Mildenberger, M., Lachapelle, E., Harrison, K., & Stadelmann-Steffen, I. (2022). Limited impacts of carbon tax rebate programmes on public support for carbon pricing. *Nature Climate Change, 12*(2), 141–147. https://doi.org/10.1038/s41558-021-01268-3

Nielsen, K. S., Nicholas, K. A., Creutzig, F., Dietz, T., & Stern, P. C. (2021). The role of high-socioeconomic-status people in locking in or rapidly reducing energy-driven greenhouse gas emissions. *Nature Energy, 6*(11), 1011–1016. https://doi.org/10.1038/s41560-021-00900-y

Patt, A., & Lilliestam, J. (2018). The case against carbon prices. *Joule, 2*(12), 2494–2498. https://doi.org/10.1016/j.joule.2018.11.018

Pietzcker, R. C., Feuerhahn, J., Haywood, L., Knopf, B., Leukhardt, F., Luderer, G., Osorio, S., Pahle, M., Dias Bleasby Rodrigues, R., & Edenhofer, O. (2021). *Notwendige CO2-Preise zum Erreichen des europäischen Klimaziels 2030*. https://doi.org/10.48485/pik.2021.007

Povitkina, M., Jagers, S. C., Matti, S., & Martinsson, J. (2021). Why are carbon taxes unfair? Disentangling public perceptions of fairness. *Global Environmental Change, 70*, Article 102356. https://doi.org/10.1016/j.gloenvcha.2021.102356

Robinson, C. D., Tomek, S., & Schumacker, R. E. (2013). Tests of moderation effects: Difference in simple slopes versus the interaction term. *Multiple Linear Regression Viewpoints, 1*(39), 16–24.

Sachweh, P., & Sthamer, E. (2019). Why do the affluent find inequality increasingly unjust? Changing inequality and justice perceptions in Germany, 1994–2014. *European Sociological Review, 35*(5), 651–668. https://doi.org/10.1093/esr/jcz024

Sagiv, L., Roccas, S., Cieciuch, J., & Schwartz, S. H. (2017). Personal values in human life. *Nature Human Behaviour, 1*(9), 630–639. https://doi.org/10.1038/s41562-017-0185-3

Savin, I., Drews, S., Maestre-Andrés, S., & van den Bergh, J. (2020). Public views on carbon taxation and its fairness: A computational-linguistics analysis. *Climatic Change, 162*(4), 2107–2138. https://doi.org/10.1007/s10584-020-02842-y

Savin, I., Drews, S., & van den Bergh, J. (2024). Carbon pricing – perceived strengths, weaknesses and knowledge gaps according to a global expert survey. *Environmental Research Letters, 19*(2), Article 024014. https://doi.org/10.1088/1748-9326/ad1c1c

Schnaudt, C., Hahn, C., & Heppner, E. (2021). Distributive and procedural justice and political trust in Europe. *Frontiers in Political Science, 3*. https://doi.org/10.3389/fpos.2021.642232

Schuitema, G., & Bergstad, C. J. (2018). Acceptability of environmental policies. In L. Steg & Groot (Ed.), *Environmental psychology* (pp. 295–306). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119241072.ch29.

Schuitema, G., Steg, L., & van Kruining, M. (2011). When are transport pricing policies fair and acceptable? *Social Justice Research, 24*(1), 66–84. https://doi.org/10.1007/s11211-011-0124-9

Schwartz, S. H. (1992). Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Advances in Experimental Social Psychology, 25*, 1–65. https://doi.org/10.1016/S0065-2601(08)60281-6

Schwartz, S. H. (2012). An overview of the Schwartz theory of basic values. *Online Readings in Psychology and Culture, 2*(1), 1–20. https://doi.org/10.9707/2307-0919.1116

Shi, D., Lee, T., & Maydeu-Olivares, A. (2019). Understanding the model size effect on SEM fit indices. *Educational and Psychological Measurement, 79*(2), 310–334. https://doi.org/10.1177/0013164418783530

Sommer, S., Mattauch, L., & Pahle, M. (2022). Supporting carbon taxes: The role of fairness. *Ecological Economics, 195*, Article 107359. https://doi.org/10.1016/j.ecolecon.2022.107359

Steg, L. (2023). Psychology of climate change. *Annual Review of Psychology, 74*(1). https://doi.org/10.1146/annurev-psych-032720-042905

Steg, L., Perlaviciute, G., Sovacool, B. K., Bonaiuto, M., Diekmann, A., Filippini, M., Hindriks, F., Bergstad, C. J., Matthies, E., Matti, S., Mulder, M., Nilsson, A., Pahl, S., Roggenkamp, M., Schuitema, G., Stern, P. C., Tavoni, M., Thøgersen, J., & Woerdman, E. (2021). A research agenda to better understand the human dimensions of energy transitions. *Frontiers in Psychology, 12*. https://doi.org/10.3389/fpsyg.2021.672776

van den Bergh, J., & Savin, I. (2021). Impact of carbon pricing on low-carbon innovation and deep decarbonisation: Controversies and path forward. *Environmental and Resource Economics, 80*(4), 705–715. https://doi.org/10.1007/s10640-021-00594-6

Van Hootegem, A., Abts, K., & Meuleman, B. (2020). Differentiated distributive justice preferences? Configurations of preferences for equality, equity and need in three welfare domains. *Social Justice Research, 33*(3), 257–283. https://doi.org/10.1007/s11211-020-00354-9

von Borgstede, C., Johansson, L.-O., & Nilsson, A. (2018). Social dilemmas. In L. Steg, & J. I. M. De Groot (Eds.), *Environmental psychology* (pp. 207–216). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781119241072.ch21.

West, S. G., Taylor, A. B., & Wu, W. (2012). Model fit and model selection in structural equation modeling. In R. H. Hoyle (Ed.), *Handbook of structural equation modeling* (pp. 209–231). Guilford Press.

Wilke, H. A. M. (1991). Greed, efficiency and fairness in resource management situations. *European Review of Social Psychology, 2*(1), 165–187. https://doi.org/10.1080/14792779143000051

Wolf, I., Ebersbach, B., & Huttarsch, J.-H. (2023). Soziales Nachhaltigkeitsbarometer der Energie- und Verkehrswende 2023: Was die Menschen in Deutschland bewegt - Ergebnisse einer Panelstudie zu den Themen Energie und Verkehr. https://snb.ariadneprojekt.de/sites/default/files/medien/dokumente/230705_iass_soziales_barometer_2023_digital_0.pdf.

Wolf, I., Fischer, A.-K., & Huttarsch, J.-H. (2021). Soziales Nachhaltigkeitsbarometer der Energie- und Verkehrswende 2021. *Kernaussagen und Zusammenfassung der wesentlichen Ergebnisse*. https://snb.ariadneprojekt.de/sites/default/files/medien/dokumente/soziales_nachhaltigkeitsbarometer_2021.pdf.

Wolf, I., Huttarsch, J.-H., Fischer, A.-K., & Ebersbach, B. (2022). Soziales Nachhaltigkeitsbarometer der Energie- und Verkehrswende 2022: Was die Menschen in Deutschland bewegt - Ergebnisse einer Panelstudie zu den Themen Energie und Verkehr. https://snb.ariadneprojekt.de/sites/default/files/medien/dokumente/soziales_nachhaltigkeitsbarometer_2022.pdf.