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Majority of German citizens, US citizens and climate scientists support policy advocacy by climate researchers and expect greater political engagement

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Scientists' role in outreach and advocacy has been debated extensively, but empirical evidence on its perceived legitimacy is scarce. We contacted scientists researching climate change to investigate scientists' engagement levels, as well as expectations regarding political and public engagement. We then compared how scientists ($N = 1107$) and German and US citizens ($N = 884$) view scientists' engagement and how scientists' advocacy affects their credibility. We find that perceptions differ across countries, with scientists perceiving more strongly than the public that scientists should politically and publicly engage. However, the public agrees that scientists should engage, and that they should increase these efforts. The majority of citizens agrees that scientists should advocate for climate-related policies and work closely with policymakers but refrain from endorsing climate protests. Further, openly supporting climate policies does not adversely affect scientists' perceived trustworthiness or honesty, while it negatively affects perceptions of scientists' objectivity. Our study provides empirical evidence that can help climate change researchers to better understand the public's demand for, and perceived legitimacy of, different engagement activities.

1. Introduction

A strong science–policy interface has been the basis for the global climate targets ratified under the Paris Agreement. However, the extent to which scientists ought to engage in the science–policy interface, as well as the degree to which such engagement is considered legitimate, is still largely debated on theoretical and normative grounds. Different roles of experts in society have been distinguished in the literature given the nature and level of their engagement (e.g. 'pure scientists' or 'issue advocates') (Pielke 2007, Spruijt *et al* 2013, 2019).

Various arguments have been presented for and against political engagement, and specifically advocacy, by scientists (Nelson and Vucetich 2009). Arguments against political engagement state that it undermines scientists' credibility (Lackey 2007, Nelson and Vucetich 2009), that it negatively

influences scientists' ability to conduct science (e.g. due to time-constraints) (Nelson and Vucetich 2009) and that it contradicts the scientific ideal of value-neutrality (Nielsen 2001, Lackey 2007). Conversely, arguments in favour state that advocacy is appropriate when failure to advocate could be harmful to society (Douglas 2009), that scientists as citizens have the responsibility to engage in political and public debates (Lubchenco 1998, 2017), that epistemic proximity comes with the responsibility to engage (Oppenheimer *et al* 2019), and that since science can never actually be value-free, science and advocacy are impossible to differentiate (Elliott and Resnik 2014, Schmidt 2015). Such polarized accounts of political engagement have been challenged (Donner 2014, Singh *et al* 2014) and deserve careful deliberation, given the urgency to scale up action on climate change while preserving trust in science and scientists (Oreskes 2019, Cologna and Siegrist 2020).

We conceptualise engagement as a continuum that spans from public engagement (e.g. giving a public lecture) to political engagement (e.g. working with policymakers). For the purposes of this study, we treat public and political engagement as discrete forms of engagement and analyse advocacy as a subcategory of political engagement. Leaning on previous definitions (Lackey 2007, Nelson and Vucetich 2009), we define advocacy as ‘the active and open endorsement of a particular policy’.

Scientists’ engagement has gained in momentum over the past year. In Germany, Austria and Switzerland, over 26 800 scientists signed a statement to support climate strikes, stating that students’ concerns are justified (Hagedorn *et al* 2019) and calling for drastic increases in action required to meet climate targets. Similar calls were published in scientific journals and newspapers (Hagedorn *et al* 2019, The Guardian 2019, Warren 2019, Ripple *et al* 2020). Moreover, some scientists have endorsed protests calling for climate change action through civil disobedience (Independent 2019, Reuters 2019). Given these developments, it is important to understand to what extent scientists and the public legitimise different types of engagement by scientists, as well as how engagement affects public credibility.

Studies to date have analysed scientists’ motives and barriers for engagement (Poliakoff and Webb 2007, Martín-Sempere *et al* 2008, Crettaz von Roten 2011, Reiners *et al* 2013, Singh *et al* 2014, Boykoff and Oonk 2018, Entradas and Bauer 2019, Entradas *et al* 2019), as well as how scientists’ engagement affects their credibility (Beall *et al* 2017, Kotcher *et al* 2017, Palm *et al* 2020). Work to date has suggested that the credibility of scientists is not compromised when they advocate for greater climate action, but that it may suffer when scientists advocate for certain specific climate policies (Beall *et al* 2017, Kotcher *et al* 2017) as well as for changes in individual behaviour (Palm *et al* 2020). While these studies analysed either scientists’ or the public’s opinions on engagement, only two small-scale studies published over a decade ago have looked at both and have done so only for specific case studies (Lach *et al* 2003, Steel *et al* 2004). Further, no previous study has compared scientists’ and public expectations across different countries regarding public engagement, political engagement and policy advocacy. However, this cross-country comparison of public and scientists’ views is important for at least two reasons. First, if members of the public consider it inappropriate for scientists to engage, scientists may rightly weigh this in making decisions about their own engagements. Many scientists anecdotally cite public disapprobation as a reason not to advocate for particular climate solutions (Oppenheimer *et al* 2019), so it is important to try to determine to what extent scientists’ concerns are consistent with, or diverge from, public concerns. Second, scientists often work

in international settings in which they strive for consistent messaging that transcends national and cultural differences. Yet, public responses to science differ greatly across national boundaries; therefore, it behoves us to consider these responses in national context. We thus undertake a large-scale study to: (a) identify the number of engagement activities of scientists researching climate change; (b) examine the predictors of expected political and public engagement; (c) compare the public’s and scientists’ expected levels of engagement; and (d) analyse whether openly supporting policies affects scientists’ credibility.

2. Methods

2.1. Data collection

To obtain a large sample of scientists researching climate change, we contacted the corresponding authors of journal articles published in the past three years in either natural science, social science or interdisciplinary science journals which publish research on climate change. Overall, 22 205 articles were downloaded from 25 journals (see supplementary figure 1 (available online at stacks.iop.org/ERL/16/024011/mmedia)). We then used a Python code to retrieve email addresses of corresponding authors and contacted 16 995 researchers after eliminating duplicates. Emails were sent from an institutional email account that was created for the purpose of this survey and which was set up in the name of the second author. In the emails, researchers were asked to fill out a survey on scientists’ engagement and directed to the survey link. We noted down all automatic replies of absence and failed delivery notices and when new addresses were provided in automatic replies, we added them to our mailing list. We also recruited scientists at the American Geophysical Union meeting and the Society for Risk Analysis conference both of which took place in December 2019. The second and fourth author advertised this survey by handing out flyers. Since the conferences took place at the same time the emails were sent out, we cannot provide an accurate response rate. We cannot exclude self-selection bias, as scientists interested in the topic of public engagement might have been more inclined to participate; we acknowledge the relevance of this to interpreting the findings of this study. In January 2020, we sent out a reminder email. Overall, $N = 1380$ scientists completed our survey, with a final sample of $N = 1107$ once researchers working in industry or in fields not related to climate change had been excluded (see sample statistics in supplementary table 1). Given that the majority of researchers declared to be resident in Germany ($N = 166$) and the US ($N = 238$), we recruited representative samples of the US and German public with the use of professional providers of consumer panels (Respondi AG in Germany and Prodege in

the US) to compare expectations of engagement (see public sample statistics in supplementary table 2). Participants were quota-sampled for the variables gender and age.

2.2. Measures used in the questionnaire

To assess expectations of political engagement, we adapted six items that assess different roles of scientists in a decision-making setting (Lach *et al* 2003) and added five advocacy items, which asked whether scientists *should* advocate for certain policies. These 11 items were averaged to create our ‘expectations of political engagement’ scale. As for public engagement, we adapted two items from Poliakoff and Webb (2007) and added three items that measured perceived expectations and duties regarding public engagement. To create our ‘expectations of public engagement’ scale, these five items were averaged. Items relating to public and political engagement were shown to both scientists and the public.

The scientists’ questionnaire further assessed intrinsic motivation with a scale composed of the average of three items adapted from the Intrinsic Motivation Inventory (McAuley *et al* 1989). Scientists’ extrinsic motivation was also assessed with a scale composed of three items, namely whether researchers would conduct more activities if there were prizes/awards for it, if it helped career progress or if it increased their scientific reputation (Entradas *et al* 2019).

As for the public, levels of trust in climate researchers were assessed with a scale comprising six items that measured agreement to different characteristics of climate scientists (e.g. competence, sincerity) (Wissenschaftsbarometer Schweiz 2019). We further asked participants whether they believe that climate change is happening and if so, whether it is human-caused (Leiserowitz *et al* 2019). Climate change concern was measured with a scale comprising six items from Shi *et al* (2016) and perceived consensus questions were taken from Leiserowitz *et al* (2019) (see supplementary material for questionnaires). All scales were created by averaging items.

2.3. Data analysis

Reliability of scales was assessed with Cronbach’s alpha, with all scales being sufficiently reliable (supplementary table 3). To compare the number of engagement activities between natural and social scientists, female and male scientists and between scientists who perceive barriers to greater engagement and who do not, we conducted chi-square analyses. To assess the predictors of expectations to politically and publicly engage, we ran linear regression models. To compare the levels of expected political and public engagement across the German and US public and German and US scientists, we computed ANOVAs with Tukey’s Honestly Significant Difference (HSD) post-hoc analyses. To compare means

across items in our between-subjects design, we used two-sample *t*-tests. We conducted all data analysis in R-Studio (RStudio Team 2015). Scientists whose discipline did not fall within one of the categories presented in the survey, but provided information on their discipline, were independently coded by the first and fourth author as either natural scientists, social scientists or “not clear”, and agreement was found for the categorisation of all items. Only the categories natural scientists and social scientists were used for regression models. To compare scientists’ engagement levels and expectations across 13 countries, we created a web-based software app with the Shiny package for R (Chang *et al* 2020): https://scientistsengagement.shinyapps.io/r_shiny/. The data that support the findings of this study are openly available.

3. Results

3.1. Levels of engagement

Overall, 90% ($n = 992$) of scientists declared to have conducted at least one engagement activity in the past 12 months, with an average of 6–10 activities. By scientists, we mean both natural and social scientists who research climate change. As in other studies (Bentley and Kyvik 2011, Jensen 2011, Entradas *et al* 2019), we find a small proportion (14%, $n = 140$) of highly active researchers, who conducted over 20 activities in the past year. Further, social scientists in our sample conducted significantly more engagement activities than natural scientists ($\chi^2(5) = 24.13$, $p = <0.001$). Contrary to other research (Crettaz von Roten 2011, Jensen 2011, Ecklund *et al* 2012, Johnson *et al* 2014, Singh *et al* 2014), we did not observe gender differences in the number of engagement activities ($\chi^2(5) = 6.87$, $p = 0.23$), or in how often female and male scientists reach out to the media ($\chi^2(3) = 2.3$, $p = 0.51$). A total of 57% ($n = 631$) of scientists further declared to perceive barriers to greater engagement (supplementary table 4). Interestingly, there was no difference in the number of engagement activities between scientists who did and did not perceive barriers to greater engagement ($\chi^2(5) = 8.39$, $p = 0.14$). We note that the levels of engagement should not be interpreted as reflective of the general population of climate change scientists, since the findings reflect a sample of participants who opted into a survey about public engagement.

3.2. Predictors of engagement expectations

Our ‘expectations of political engagement’ scale included statements that asked respondents whether scientists ‘should’ conduct certain political engagement activities, while our ‘expectations of public engagement’ scale included items asking whether scientists have the duty to engage with the public. We interpret higher levels of agreement to items of these scales to show higher perceived legitimacy of these

Table 1. Predictors of scientists' political and public engagement expectations.

	Expectations—political engagement			Expectations—public engagement		
	B	95% CI	β	B	95% CI	β
(Intercept)	2.90	(2.54–3.27)	—	2.05	(1.71–2.39)	—
Intrinsic motivation	0.25	(0.20–0.31)	0.26***	0.40	(0.35–0.45)	0.43***
Extrinsic motivation	0.09	(0.05–0.12)	0.13***	0.08	(0.05–0.12)	0.13***
Male ^a	−0.03	(−0.13–0.07)	−0.02	0.00	(−0.09–0.10)	0.00
Social scientist ^b	0.12	(0.02–0.23)	0.07*	0.05	(−0.05–0.15)	0.03
Political orientation ^c	−0.01	(−0.01 to −0.00)	−0.12***	0.00	(−0.00–0.00)	−0.02
Early career ^d	−0.07	(−0.24–0.10)	−0.04	0.16	(0.00–0.31)	0.10*
Senior ^d	−0.21	(−0.38 to −0.04)	−0.11*	0.13	(−0.03–0.29)	0.07
Prof ^d	−0.10	(−0.27–0.07)	−0.06	0.24	(0.08–0.40)	0.14**
Religiosity ^e	0.00	(0.00–0.01)	0.13***	0.00	(−0.00–0.00)	0.05

Note. Adjusted R^2 political engagement = 13.6%, $df = 1047$. Adjusted R^2 public engagement = 21.1%, $df = 1047$. * $p < 0.05$,

** $p < 0.01$, *** $p < 0.001$.

^a 0 = female, 1 = male.

^b 0 = natural scientist, 1 = social scientist.

^c 0 = strongly left-wing, 100 = strongly right wing.

^d Reference category: PhD.

^e 0 = not at all religious, 100 = very religious.

behaviours. Not surprisingly, we find that higher intrinsic and extrinsic motivation to engage increase scientists' perceptions that scientists should engage, both politically and publicly, with intrinsic motivation resulting in a medium to large effect size and extrinsic motivation in a small effect size (Funder and Ozer 2019) (table 1). It should be kept in mind that participants in our study might be more intrinsically motivated than the average climate researcher, meaning that expectations of political and public engagement might be higher in our sample compared to the average climate research community. As shown in table 1, left-wing orientated scientists, as well as more religious ones, perceive more strongly that scientists should politically engage. Compared to PhD students, scientists at early career stages and professor-level agree more strongly that scientists should publicly engage. Social scientists perceive more strongly than natural scientists that scientists should politically engage, yet there are no differences in public engagement. As the aggregation of international data might obscure cultural and institutional differences on the national level, we conducted separate regression analyses on the engagement expectations of German and US scientists, who are the focus of this study. Intrinsic motivation remains the strongest predictor also on the national level (supplementary tables 5 and 6).

By analysing responses from German and US citizens, we find that higher trust in climate scientists, higher climate change concern, and left-wing political orientations positively predict agreement with the statements that scientists should politically engage, with climate change concern having a very large effect size (Funder and Ozer 2019) (table 2). In the US, younger citizens agree more strongly than older citizens that scientists should politically engage.

Regarding public expectations of scientists to engage publicly, trust in climate scientists is a significant predictor in the US but not in Germany, and climate change concern is a strong predictor in both countries. Political orientation does not directly predict expectations, but its strong correlation with climate change concern suggests an indirect effect (supplementary table 7). Further, we find that perceived scientific consensus on the existence of climate change negatively predicts expectations of engagement in Germany. Thus, the lower Germans believe the scientific consensus to be, the more they perceive that scientists should publicly engage. In the US, higher perceived consensus on climate change being mainly anthropogenic leads to higher expectations of scientists to publicly engage.

3.3. Comparing the views of scientists and the public

When comparing expectations regarding scientists' political and public engagement between scientists and citizens from Germany and the US, responses from our sample suggest that a higher proportion of scientists, compared with members of the public, expects scientists to engage politically and publicly (figure 1). Regarding political engagement, the activity that the public perceived to be the least legitimate was scientists endorsing protests that call for action on climate change, with 53% of Germans and 52% of Americans disagreeing that scientists should endorse protests (see supplementary tables 8 and 9 for differences of individual items across groups). The highest level of agreement across groups was perceived for the statement that scientists should work closely with policymakers to integrate scientific results into climate-related policymaking.

Table 2. Predictors of political and public engagement expectations for the German and US public.

	Expectations—political engagement						Expectations—public engagement					
	German public			US public			German public			US public		
	B	95% CI	β	B	95% CI	β	B	95% CI	β	B	95% CI	β
(Intercept)	1.64	(1.10, 2.18)	0.00	0.98	(0.56, 1.4)	0.00	1.99	(1.23, 2.75)	0.00	0.94	(0.35, 1.54)	0.00
Trust scientists	0.16	(0.06, 0.26)	0.15**	0.33	(0.24, 0.41)	0.29***	0.11	(-0.03, 0.24)	0.09	0.17	(0.05, 0.29)	0.15**
Climate change concern	0.42	(0.34, 0.49)	0.51***	0.42	(0.36, 0.49)	0.53***	0.32	(0.22, 0.43)	0.34***	0.44	(0.34, 0.53)	0.54***
Age	-0.00	(-0.01, 0.00)	-0.03	-0.01	(-0.01, 0.00)	-0.08**	0.01	(0.00, 0.01)	0.08	0.00	(0.00, 0.01)	0.03
Consensus climate change ^a	0.00	(0.00, 0.00)	0.01	-0.00	(-0.01, 0.00)	-0.03	-0.01	(-0.01, 0.00)	-0.17**	0.00	(-0.01, 0.00)	-0.06
Consensus cause ^a	0.00	(0.00, 0.01)	0.03	0.00	(0.00, 0.01)	0.06	0.00	(0.00, 0.01)	0.09	0.01	(0.00, 0.01)	0.12*
Education	-0.05	(-0.12, 0.02)	-0.05	0.03	(-0.02, 0.07)	0.03	-0.05	(-0.15, 0.04)	-0.05	0.01	(-0.05, 0.08)	0.02
Political orientation ^b	-0.01	(-0.01, 0.00)	-0.14***	-0.00	(-0.01, 0.00)	-0.11***	-0.00	(-0.01, 0.00)	-0.04	0.00	(0.00, 0.00)	-0.02
Religiosity ^c	0.00	(0.00, 0.00)	0.02	-0.00	(0.00, 0.00)	-0.02	0.00	(0.00, 0.01)	0.05	0.00	(0.00, 0.00)	0.00

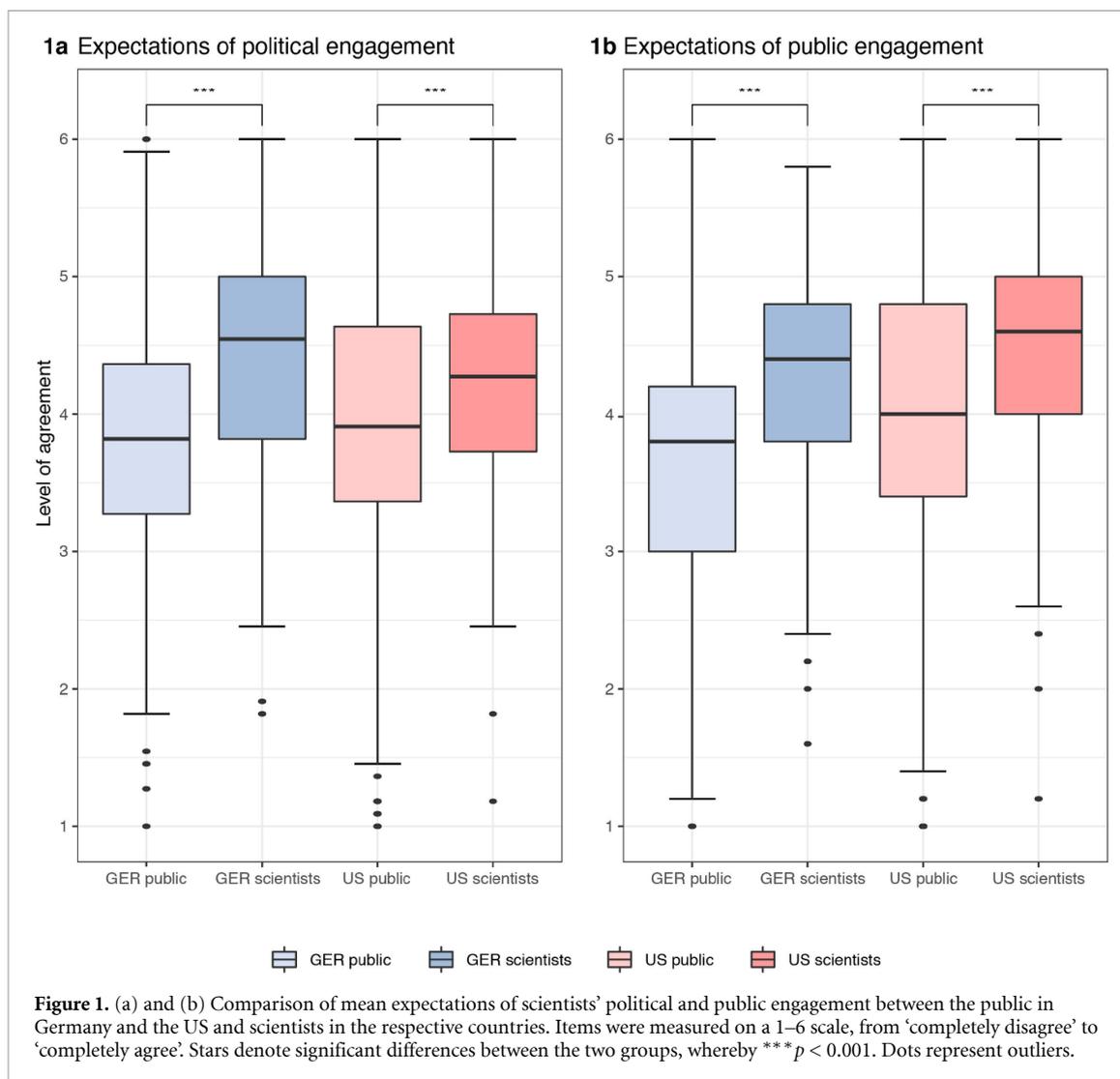
Note. Political engagement: adjusted R^2 Germany = 44.4%, df = 404. Adjusted R^2 US = 73.7%, df = 415. * p < 0.05, ** p < 0.01, *** p < 0.001.

^a 0%–100% perceived consensus.

^b 0 = Strongly left-wing, 100 = Strongly right wing.

^c 0 = not at all religious, 100 = very religious.

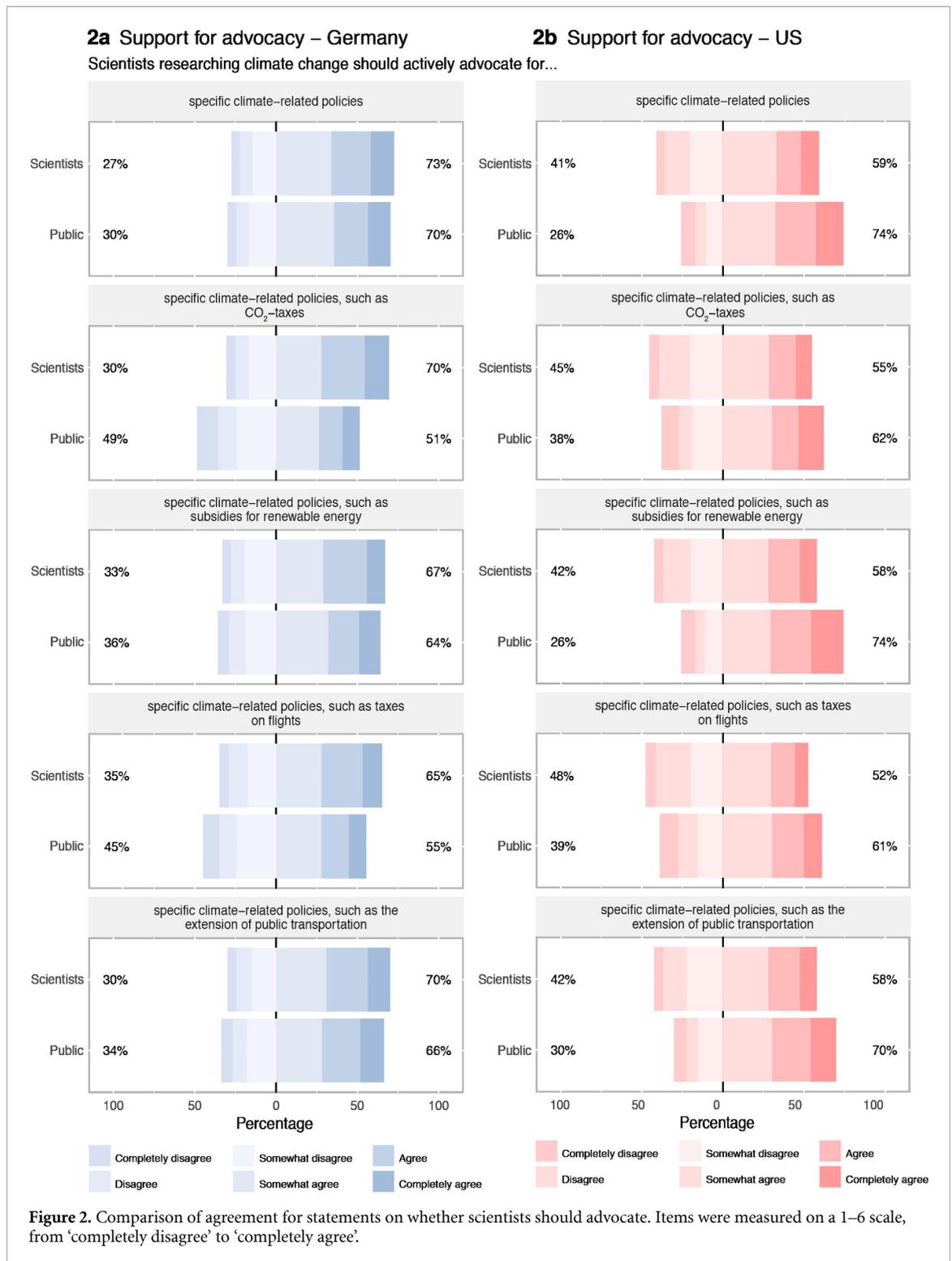
Public engagement: adjusted R^2 Germany = 16.6%, df = 404. Adjusted R^2 US = 47.4%, df = 415. * p < 0.05, ** p < 0.01, *** p < 0.001.



As for advocacy, in both countries the majority of the public agrees that scientists should advocate for climate-related policies, in general (figure 2). Notably, the degree of public support shifts when specific policies are mentioned; then we find that the public's perceived legitimacy of advocacy depends on the policies being advocated (table 3). When asked about policies in general, 70% of German and 74% of American respondents think that scientists should actively advocate for climate-related policies. But when asked about *specific* policies, those numbers drop, for example, to only 51% of Germans and 62% of Americans supporting advocacy for CO₂ taxes. Public agreement in favour of advocacy is higher when the policy is subsidising renewable energy or extending public transportation than when it is advocacy of taxes. We believe that this can be explained by the fact that relative popularity of these policy items among members of the public corresponds (at least partially) to the relative popularity of scientific advocacy for them (Howe *et al* 2015). Scientists advocating for unpopular policy measures might thus face greater challenges in legitimising their advocacy.

A difference between the US and Germany arises with respect to the comparison of public and scientists' views of policy advocacy. In Germany, both scientists and the public think that scientists should actively advocate for policies, with scientific support for that position slightly stronger than public support. However, in the US, the situation is reverse: the public believes that scientists should support policies more than scientists do. These national differences call for greater efforts to investigate public sentiment regarding scientists' engagement in other countries.

With respect to public engagement, both German and US scientists agree more strongly than the public in their respective countries that scientists should engage. The greatest agreement across groups relates to the item stating that scientists should share opinions on different solutions to climate change. Further, when asking scientists and the public whether scientists should engage more, a majority of German (78%) and US scientists (87%) and German (57%) and US citizens (67%) agreed that scientists should engage more. Excluding climate change deniers, agreement raises to 63% in Germany and 74% in the US. These



findings can help researchers to better understand the demand for, and legitimacy of, different engagement activities, both of which are often assumed to be very low (Ecklund et al 2012).

3.4. Effects of engagement on credibility

Given that the public largely expects scientists to advocate, we conducted a between-subjects design with German and American participants to examine whether openly supporting climate policies affects

public views of scientists’ credibility. One group of participants was shown a statement reporting that a fictional scientist Prof. Jones openly supports certain policies, as well as protests that call for climate action and that she discusses the policies she supports with policymakers and the media, while other participants read that Prof. Jones engages with policymakers and the media without openly supporting certain policies or protests. Overall, levels of credibility did not differ between the two groups, with only two

Table 3. Descriptives and ANOVA results for advocacy items.

	GER public (<i>n</i> = 441)	GER scientists (<i>n</i> = 166)	US public (<i>n</i> = 443)	US scientists (<i>n</i> = 238)
Scientists researching climate change should actively advocate for...	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Specific climate-related policies.	4.00 ^a (1.31)	4.07 ^a (1.32)	4.09 ^a (1.44)	3.71 ^b (1.34)
Specific climate-related policies, such as taxes on flights.	3.63 ^{ab} (1.41)	3.91 ^a (1.37)	3.68 ^{ab} (1.48)	3.49 ^b (1.35)
Specific climate-related policies, such as the extension of public transportation.	3.97 ^{ab} (1.40)	4.02 ^{ab} (1.36)	4.02 ^a (1.41)	3.73 ^b (1.35)
Specific climate-related policies, such as CO ₂ taxes.	3.50 ^c (1.47)	4.07 ^a (1.37)	3.80 ^{ab} (1.49)	3.6 ^{bc} (1.38)
Specific climate-related policies, such as subsidies for renewable energy.	3.85 ^a (1.38)	3.98 ^{ab} (1.31)	4.16 ^b (1.46)	3.70 ^a (1.37)

Note. a, b and c indicate non-significant differences between groups.

Table 4. Two-sample *t*-tests for between-subjects design.

	Advocacy <i>M</i> (<i>SD</i>)	No advocacy <i>M</i> (<i>SD</i>)	<i>t</i> -Statistic
Trustworthy	4.15 (1.2)	4.19 (1.15)	<i>t</i> (882) = -0.51
Honest	4.21 (1.22)	4.32 (1.14)	<i>t</i> (882) = -1.28
Objective	3.86 (1.32)	4.24 (1.15)	<i>t</i> (882) = -4.59***
Acts in the interest of society	4.23 (1.36)	4.00 (1.27)	<i>t</i> (882) = 2.64**

Note. ***p* < 0.01, ****p* < 0.001.

of the four items of our credibility scale differing significantly across groups (table 4). Specifically, openly supporting policies did not affect perceptions of Prof. Jones being trustworthy and honest in reporting findings. However, openly supporting policies did negatively affect Prof. Jones' perceived objectivity, yet positively affect perceptions that she acts in the interest of society.

To increase confidence in our null findings, we conducted sensitivity analyses in order to determine what effect size would have been detectable given our sample size (supplementary material). Sensitivity analyses showed that our *t*-tests would have been able to detect small-to-medium size effects, our effect size of interest. Given the sample size used for this analysis, we thus have high confidence in our null finding. Future studies could use larger sample sizes to specifically investigate small effect sizes.

Thus, we confirm previous findings that openly supporting climate policies (as well as protests that call for action on climate change) does not necessarily adversely affect public perceptions of credibility. Relating this to our previous finding, we can thus preliminarily conclude that even though the public neither strongly agrees nor disagrees that scientists should endorse protests, it does not affect scientist's credibility if they do so. While scientists might be perceived as less objective, they are perceived to be

more strongly acting in the interest of society, the latter of which has been found to be a strong predictor of trust (Kasperson *et al* 1992). Indeed, the apparent intent of an actor (in this case to act in the interest of society) has been shown to influence communicator's credibility, meaning that advocacy might make scientists seem more welcoming to the public (Fiske and Dupree 2014).

4. Discussion and conclusion

We have quantified the expectations of the public regarding scientists' engagement and the extent to which these expectations differ from the expectations of the climate change research community. We show that legitimisation of different engagement activities differs across countries and that scientists' perceptions differ from those of the public. Both the public and scientists believe that scientists should engage more, and scientists perceive this even more strongly than the public.

This points towards a perception-engagement gap, namely that scientists might be reticent to engage as much as our survey data indicate that rank and file perceive they in fact should (Singh *et al* 2014). In 2007, James Hansen criticized his colleagues for the 'reticence' in regard to speaking up about the threat of sea level rise from anthropogenic climate change. He blamed this reticence on 'the scientific method,' which he equated with 'objective scepticism,' suggesting that scientists feared that speaking up would be viewed as compromising their objectivity (Hansen 2007). Our results suggest that scientists' anxieties about loss of credibility from engagement may be misplaced. So far as our data go, they indicate that the majority of the public feel that scientists should be engaged.

With the results gained from this study, the comments provided by scientists in our survey and the

wider literature, we identified two types of barriers that help explain the perception-engagement gap: instrumental and regulative barriers. On the one hand, instrumental barriers relate to the skills and time that are needed to engage, as well as to possible legal guidelines imposed on scientists if they wish to engage in their institutional capacities. On the other hand, regulative barriers relate to the conceptions of the role of scientists in society. While many researchers stated that instrumental barriers are deterring them from engaging more, our results indicate that researchers who perceive instrumental barriers do not engage less than researchers who do not, in line with previous findings (Poliakoff and Webb 2007, Singh *et al* 2014). Rather, it seems that regulative barriers play a stronger role in explaining the perception-engagement gap. A qualitative study that analysed IPCC scientists' views regarding political engagement, found that while scientists perceive a moral responsibility to engage, this conflicts with the regulative ideal of the value-free ideal of science and the IPCC's rule of being policy-relevant but not policy-prescriptive (Gundersen 2020). In that study, interviewed scientists stated that since engagement often entails a degree of value-ladenness, they worried that this will negatively affect their credibility and perceived level of objectivity. This concern was also expressed by several scientists in our survey. Our findings provide empirical evidence that, contrary to the view of many scientists, particularly in the US, the majority of the public *expects* scientists to engage in policy advocacy, indicating that the public legitimises this value-laden activity. A recent survey in Germany confirms these findings, showing that about half of respondents agreed that it is scientists' duty to engage in policymaking (Wissenschaftsbarometer 2019). These findings challenge IPCC scientists' assumption that the majority of the public considers a policy-relevant but not policy-prescriptive approach to be more legitimate than a policy-prescriptive approach. However, as our study shows, support for policy advocacy is dependent on the policy in question and left-wing political orientations predict political engagement expectations. Previous findings show that conservatives legitimise environmental scientists' policy influence less than liberals regardless of the scientists' perceived credibility (Gauchat *et al* 2017). Thus, achieving legitimisation of political engagement across the political spectrum might be challenging.

Interestingly, we found that the lower the perceived consensus on climate change in Germany, the more Germans expect scientists to publicly engage. One explanation could be that individuals who are uncertain about the level of consensus on climate change feel that scientists should engage more so as to clarify the perceived uncertainty. On the contrary, but in line with prior studies (Gauchat *et al* 2017), the opposite is the case in the US, where higher levels

of perceived consensus predict political engagement expectations. Since these results are ambivalent and point to national differences in how perceived consensus influences perceptions of scientists' engagement, future research efforts should attempt to clarify these results.

Regarding the effects of advocacy on scientists' credibility, our results support previous findings in that advocating for policies does not always affect perceptions of a scientist being trustworthy and honest in reporting their findings (Beall *et al* 2017, Kotcher *et al* 2017, Palm *et al* 2020). However, we do find that advocacy negatively affects perceived objectivity. This suggests that scientists are conflating objectivity and trust, assuming that a perceived loss of objectivity entails a loss of trust; our results call that assumption into question. Namely, our results show that even though perceived trustworthiness and objectivity are strongly correlated ($r = 0.71$), advocacy negatively affects objectivity, while it has no effect on perceived trustworthiness. Thus, the concept of objectivity might be understood differently by scientists and the public.

Perceptions of objectivity, as well as engagement expectations, might further be contingent upon scientists' epistemic proximity (Oppenheimer *et al* 2019). For example, advocacy of taxes might be considered more legitimate if undertaken by scientists researching taxation policies than if undertaken by scientists researching sea level rise. The fact that we did not differentiate between researchers of different disciplines is a limitation of our study. However, it allowed us to better compare scientists' and public responses (as public understanding of disciplines likely differs from that of scientists). A second limitation relates to the fact that we did not test to what extent scientists' political affiliation and values influence their perceived level of credibility when advocating for a specific policy. As previous studies have shown, trust is contingent upon a certain degree of value similarity (Siegrist *et al* 2000) and in some cases transparency about personal values can negatively affect a scientist's perceived credibility, depending on the values espoused by scientists and the public (Elliott *et al* 2017). A further limitation is that we did not specify policies in our experimental design. As we observe in our study, expectations related to scientists' advocacy depend on the policy in question, thus on the level of value similarity related to preferred climate policies. While we find that scientists' credibility does not suffer when advocating for policies they support (in general), their credibility might be affected if advocating for policies with low public support. This leads us to a fourth limitation of this study, namely that we did not control for public support of the policies that were presented in the advocacy items. This would have allowed us to better understand the degree to which the public's support for a policy increases acceptance of a scientist

advocating for that policy. A main limitation of this study is the possibility of a self-selection bias of participating researchers. As we cannot prove the representativeness of our sample in terms of their engagement levels, readers should consider that our sample might be more intrinsically motivated than the overall climate change research community. Future studies should consider and possibly address these limitations.

All in all, some of our findings appear to challenge common assumptions in the scientific community. We identify three surprising findings: (a) the majority of the public agrees that scientists should advocate for climate-related policies; (b) the majority of the public expects scientists to be more engaged; (c) in the context of policy advocacy, a loss of perceived objectivity does not entail a loss of perceived honesty and trustworthiness. Our study thus provides empirical evidence that can help scientists researching climate change to better understand the public's demand for and reactions to engagement, and to consider the role that regulative ideas, such as the value-free ideal of science, play in widening the perception-engagement gap. That said, we appreciate constraints to further engagement related to instrumental barriers in a 'publish or perish' academic culture. We hope this study sparks a wider debate on the role of the scientific community researching climate change outside of ivory towers.

Data availability statement

The data that support the findings of this study are openly available at the following URL/DOI: [10.17632/fnj2b4dvfr.1](https://doi.org/10.17632/fnj2b4dvfr.1). Data will be available from 05 March 2021.

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Author contributions

VC, RK and MS conceptualised the idea for this paper and developed the questionnaire, V C conducted the data analysis, V C led the writing with contributions from R K, N O and M S

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