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HAUPTBEITRÄGE

Reflections on the science society relationship. A mixed-methods study on science skepticism in Austria

Johannes Starkbaum · Erich Griessler · Peter Grand · Fabian Seiser · Thomas König

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Abstract A recent debate on science skepticism in Austria portrayed the country's population as highly skeptical of science. The actual extent of science skepticism remained unclear during the debate, and an explicit definition of it was never provided. This paper examines the phenomenon of science skepticism in Austria by reviewing studies on public perceptions of science and by applying a mixed methods approach, including secondary analysis of survey data and analysis of primary data from focus groups and expert interviews. Departing from different methodological perspectives, we show that degrees of criticism of science vary according to the way they are measured, that criticism can be observed in all societal groups, that individuals are not consistent in their attitudes towards science, and that critique is often directed at scientists' presumed motives or entanglements with politics rather than at science per se. We conclude that the dualistic perspective that dominates public debates on this topic does not resonate with the empirical complexity illustrated in this paper.

Keywords Science skepticism · Public perceptions of science · Trust · Mixed methods · Austria

✉ Johannes Starkbaum · Erich Griessler · Peter Grand · Fabian Seiser · Thomas König
Institut für Höhere Studien—Institute for Advanced Studies (IHS), Josefstädterstraße 39, 1080 Vienna, Austria
E-Mail: starkbaum@ihs.ac.at

Thomas König
FORWIT. Austrian Council for Science, Technology and Innovation (Rat für Forschung, Wissenschaft, Innovation und Technologieentwicklung), Vienna, Austria

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Überlegungen zum Verhältnis von Wissenschaft und Gesellschaft. Eine Mixed-Methods-Studie zu Wissenschaftsskepsis in Österreich

Zusammenfassung Eine aktuelle Debatte in Österreich über Wissenschaftsskepsis stellte die Bevölkerung des Landes als besonders wissenschaftskritisch dar. Das tatsächliche Ausmaß von Wissenschaftsskepsis blieb in der Debatte unklar und auch eine explizite Definition wurde nicht gegeben. Dieser Beitrag untersucht das Phänomen der Wissenschaftsskepsis in Österreich. Dazu werden zunächst Studien zur öffentlichen Wahrnehmung von Wissenschaft ausgewertet. Eine darauffolgende Methodentriangulation kombiniert eine Sekundäranalyse von Umfragedaten mit der Analyse von Primärdaten aus Fokusgruppen und Experteninterviews. Ausgehend von den unterschiedlichen methodischen Perspektiven zeigen wir, dass das Ausmaß der Wissenschaftskritik je nach Messmethode variiert, dass Kritik in allen gesellschaftlichen Gruppen zu beobachten ist, dass die Einstellungen der Menschen zur Wissenschaft nicht konsistent sind und dass sich Kritik vor allem auf vermeintliche Motive von Wissenschafter:innen oder die Verbindungen zwischen Wissenschaft und Politik richtet und weniger auf die Wissenschaft selbst. Wir kommen zu dem Schluss, dass die dualistische Perspektive, welche die öffentliche Debatte zu diesem Thema dominiert, der in diesem Beitrag dargestellten empirischen Komplexität nicht gerecht wird.

Schlüsselwörter Wissenschaftsskepsis · Öffentliche Wahrnehmung von Wissenschaft · Vertrauen · Methodentriangulation · Österreich

1 Introduction

In 2021, journalists, scientists, and politicians in Austria initiated a public discourse that portrayed the country's population as highly skeptical of science (Salzburger Nachrichten 2022; Taschwer 2021), accompanied by calls for political action (Nowotny 2021; Starkbaum et al. 2022). Proponents of the assertion of prevailing science skepticism in Austria used, as their main point of reference, a Eurobarometer survey in which Austrian respondents expressed relatively low interest in and expectations of science and technology in some items compared to other European countries (European Commission 2021). Advocates of this claim also supported their assertion by pointing at segments of the Austrian population that had loudly criticized the government's policies to combat the COVID-19 pandemic, which were based in part on the advice of scientists. That science skepticism was widespread, and had increased during the pandemic, became the dominant topos of public discourse. Although the actual extent of science skepticism in Austria remained unclear during the debate, and an explicit definition of the phenomenon was never provided.

In response to this, the Austrian Federal Ministry of Education, Science and Research (BMBWF) issued a call for tenders for a study to investigate skepticism towards science and democracy in Austria. The study, which was carried out be-

tween 2022 and 2023, explored the characteristics and extent of science skepticism in Austria, its relation to socio-demographic factors, as well as historical, socio-economic and structural aspects that may be relevant to understanding the situation (Starkbaum et al. 2023).

Based on this study, this paper examines the phenomenon of "science skepticism" in Austria applying a mixed methods approach including secondary analysis of survey data and analysis of primary data from focus groups and expert interviews. We address three main questions: (1) What public attitudes towards science can be observed and how are they distributed in Austria? (2) How can the critique of science and science skepticism be differentiated? (3) What are the implications for the public discussion on science skepticism in Austria? We start with a reflection on the science society relationship and different approaches to science skepticism, drawing on theoretical considerations and international research. Subsequently, we investigate perceptions of science in the population, how critical attitudes toward science distribute among different groups and in the population, how experts assess this, and the extent and characteristics of skepticism and other critical attitudes toward science in Austria.

The findings show that in Austria, positive views dominate the public perception of science. Yet, there are also different forms of science critique in the population, but their prevalence varies according to how critique and skepticism are defined and measured. In addition, disapproval mainly concerns selective parts of science or the relationship of it with other societal institutions, such as politics and economy. Furthermore, science critique is not restricted to particular social groups. The paper emphasizes that the discussion about science skepticism in Austria is yet another political controversy about the proper place of science in society.

2 Reflecting science skepticism

Luhmann (2024) conceptualizes science as one of several subsystems of modern societies. Born in the scientific revolution of the seventeenth century to generate solid knowledge in the midst of religious division (Rommetveit et al. 2013), and then pursued only by a few gentleman scientists from the upper echelons of society, science was professionalized in the nineteenth century (Weber 1946). It developed into a vast social subsystem and enterprise in the twentieth century that is central to the cultural and economic concept of modernity (Stehr 2023). Today, through an implicit social contract (Guston 2000), science contributes to societal subsystems such as the economy and politics by providing knowledge. In return, science receives public funding under this implicit social contract. Because of its central role for economic growth, governments around the world promote science (Durant 1994; Griessler 2024). However, science is not unchallenged, as the recent debates on science skepticism exemplify.

There is no unified definition of science skepticism in the academic literature and the term is used for a variety of attitudes. Although skepticism is often viewed negatively, it is also integral to scientific practice, known as "organized skepticism" (Merton 1957, p. 560). This is the fourth of the Mertonian norms, which also include

communism, universalism and disinterestedness. They describe an ideal version of science, emphasizing common ownership, inclusiveness, orientation towards the benefit of science and critical reflection of scientific work. However, this is not the kind of skepticism that dominated the Austrian discourse. We discuss various approaches related to science skepticism, sorting them broadly into three groupings: studies on negative attitudes towards science in general; studies that link identities and social positions to science skepticism; and studies that investigate criticisms of collaborations between science and policy.

Skepticism is often used to describe various negative attitudes towards science. Criticism of science has long been framed in European science and policy discourse as a deficit of the citizenry, suggesting in particular a lack of public knowledge and understanding that could be remedied through education and science communication (Royal Society 1985). From this perspective, science skepticism and other negative attitudes toward science are conceptualized as a deficit that is mainly located in segments of the population and is associated with a lack of knowledge or trust.

Many of the existing studies focus on populations that express critical attitudes aiming to investigate explanatory factors. Typically, these studies survey the prevalence of and explanatory factors for attitudes towards science and try to identify groups that hold sentiments such as low trust in science or science skepticism. The outcomes depend heavily on the wording of the survey questions and how they conceptualize negative attitudes towards science, such as science skepticism. In other words, the object of study is reified by its conceptualization in survey questions.

Contrary to the prevailing public discourse in Austria, several surveys show that in most countries, large parts of the population express high levels of trust in science (European Commission 2021; Cologna et al. 2025) and that science is one of the most trusted institutions (Ipsos 2023). Various studies, mostly quantitative, try to identify societal groups that are more prone to express negative attitudes towards science. However, several studies show that predictors of negative attitudes, such as political preferences, religiosity, or science literacy, are not universal explanatory factors, but vary by topic and field of science (Scheitle and Corcoran 2021). Philipp-Muller et al. (2022) find that while political "conservatives" are more likely to reject scientific findings (e.g., on evolution or climate change), this trend is not consistent across technological fields, as "liberals" are, for example, more critical in areas such as nanotechnology. Consistent with this, Rutjens et al. (2022) show, using comparative surveys, that predictors such as spirituality or political orientation differ among fields of science, such as climate change or genetic modification.

Other studies have looked at the actual rejection of science by segments of the citizenry, often referred to as science skepticism. This concerns a smaller but more critical group of the public. Partheymüller and Eberl (2023, p. 89) note that science skepticism refers to a general or fundamental criticism of science that is ideologically motivated and resists scientific scrutiny. Similarly, Starkbaum et al. (2023) operationalize skepticism "as a systematic and unjustified rejection of science," i.e., a rejection of scientific knowledge that spans several areas of science.

Several studies highlight the importance of mis- and disinformation to explain rejection of scientific knowledge. Aslett et al. (2024) conclude that online searches to evaluate misinformation can increase its perceived credibility, as respondents end

up in informational spaces with low-quality sources confirming wrong information. Thus, the authors call for increasing media literacy in the population and regulating search engines. Spampatti et al. (2023, p. 9) found "that climate disinformation influences how people feel about, think of and evaluate climate change and climate actions" and show that the exposure to disinformation cannot simply be countered by (psychological) mitigation strategies. Oswald and Bright (2022) demonstrate that beliefs of communities, who self-identify as climate skeptics, are characterized by long-term stability and these groups react with counterarguments to science-based knowledge.

Several studies examine identities and reasoning related to skepticism, rather than exploring attitudes toward science. Dissenting voices within the scientific community have criticized studies that frame criticism of science as a characteristic (or deficit) of certain populations. Already decades ago, this led to calls for more engagement of societal actors in research and innovation (R&I) to better understand different positions, rather than framing criticism solely as a problem (Wilsdon and Willis 2004). Furthermore, several studies challenge the role of science as a privileged form of knowledge production by highlighting the importance of considering different forms of local knowledge, such as that of activists or farmers (Epstein 1998; Wynne 1996). Research that aligns with this tradition is typically interested in understanding the social and cultural conditions that foster the emergence of critique or skepticism and how it is justified.

There is a body of literature—mostly qualitative—that actively and reflexively engages with groups critical of science. Haltinner and Sarathchandra (2023) show that people in the US who are skeptical about anthropogenic climate change are not homogeneous, but rather express many different beliefs. Several people with whom they interacted expressed overall confidence in science and expertise but rationalized their critical position by questioning the competence of climate scientists. Similarly, Neresini (2024) recommends avoiding exclusively negative framing when dealing with groups critical of science.

Other studies are more explicit about aspects of cultural and social identity as relevant factors in the explanation of negative attitudes towards science. Based on survey data, Stoetzer and Zimmermann (2024) see group identity as a plausible explanation for climate change denial, concluding that people may reject or downplay anthropogenic climate change because it is part of their political identity. Addressing this criticism, they suggest it would require a weakening or changing related group norms. Philipp-Muller et al. (2022), through a review of several studies, explore factors relevant to anti-science attitudes, all of which indicate a social and cultural distance between science and individuals or groups expressing anti-science attitudes. Such factors include a perceived lack of credibility of science communication and its sources, a sense of belonging to groups that identify with anti-science attitudes, or conflicts between scientific messages, personal values, and the preferences or epistemic styles of recipients.

The relationship between science and policy is a field related to skepticism that has gained particular attention since the start of the COVID-19 pandemic. In this context, selective consultation of scientific disciplines and a lack of transparency were pointed out by critics (Prainsack 2022). Indeed, much of the criticism that

has been labeled science skepticism in public debates refers to the involvement of science or scientists in policy making or an alleged entanglement with economic interests, which would mean the violation of another Mertonian norm of science, i.e., "disinterestedness" (Merton 1942).

Bogner's (2021) concept of the epistemization of the political provides a useful framework for conceptualizing this approach to science skepticism. He argues that there is a tendency for political debates to be framed by epistemic (evidence- or knowledge-based) claims. Thus, political decisions and their legitimacy are increasingly tied to scientific evidence and factual correctness, especially in times of controversy and crisis. Framing policy decisions as merely evidence-based encourages the neglect of issues of values, conflicting interests, and deliberation, while at the same time relieving policymakers of some of the responsibility for making decisions. Such evidence-based claims promote a policy of no alternatives, which is always in conflict with some political or societal interests. The political process may then appear to suppress alternative viewpoints.

At the same time, as Bogner (2021) argues, science in such constellations becomes a major address for criticism of political decisions and is thus subject to the same polarization and contestation as politics. Groups opposed to certain policies may then challenge the science (or scientists) involved, not necessarily because they doubt science itself, but because it is seen as political and elitist. They then bring in selective science-based claims or alternative expertise to challenge the (mainstream) science involved in policymaking, which brings us back to the issue of misinformation.

Finally, these reflections show that science skepticism encompasses a variety of things, including levels of public knowledge, attitudes towards science, rejection of scientific knowledge, as well as the engagement of science with economic interests or the political domain. Negative expressions of science, such as skepticism, are researched and conceptualized differently, which also leads to different conclusions about its prevalence and quality.

3 Methodology

This paper consolidates findings from the aforementioned study on skepticism toward science and democracy in Austria (Starkbaum et al. 2023). In order to provide a comprehensive understanding of science skepticism in Austria we analyzed polled public opinions, narratives in group context and expert insights. The data consisted of: (a) a secondary analysis of survey data which provided a basic overview of attitudes towards science; (b) focus groups exploring how criticism is reasoned and embedded in group settings; and (c) expert interviews. This methodological triangulation was implemented to increase the validity of the results and to arrive at a more comprehensive understanding of science skepticism.

(a) For the quantitative analysis, the paper utilized survey data from the Eurobarometer 516 (2021), European Social Survey (ESS) wave 10, the Austrian Corona Panel Project (ACPP) 2020–2022, the Citizens' Attitudes Under Covid-19 Pandemic (CAUCP) survey 2020 and the Wellcome Global Monitor (WGM) 2018 and 2020.

These surveys collect expressed opinions of members of the public and each of these include data on the Austrian population. We included only data from one survey wave in 2021 of the Eurobarometer and ESS but included multiple years from the other surveys. ACPP included data from March 2020 to August 2022. CAUCP data consisted of four waves collected in 2020, and WGM included data from 2018 and 2020.

Differences in data collection, sample size, the way these surveys conceptualize science, and which questions they include made a direct comparison more challenging. We thus did not combine these data at individual levels, but contrasted the findings for each survey, to generate a more comprehensive picture of attitudes towards science. The surveys allow longitudinal and comparative insights into public understandings of science and show how science, in return, epistemically co-creates the notion of science skepticism. Next to a critical and interpretive analysis, this study used a combination of descriptive and multivariate analyses, such as recoded data and items or logistic regression. For further details, see Starkbaum et al. (2023, p. 139 f.).

(b) In addition, five focus groups with a total of 39 participants from the Austrian population were conducted, with seven to ten participants per group. These groups were designed to facilitate conversation among a set of citizens to investigate how opinions emerge in group settings and how discussions evolve (Reed and Payton 1997). Participants were recruited through public advertisements, contacting institutions and via personal contacts. The focus groups were held in early 2023 in Vienna, Upper Austria, and Styria. Our overall sample was relatively balanced in terms of educational background, age, and gender, although there was a bias toward participants with higher education, and a stronger presence of older adults and younger people (Starkbaum et al. 2023, pp. 243–246).

The focus groups were conducted in a two-stage process. First, participants answered a questionnaire, which, in addition to socio-economic aspects, covered also nine survey-questions related to science and democracy, e.g. from the Eurobarometer 516. These assessed how participants scale (four- and five-point Likert) the importance of science, their trust in science, as well as how they perceive the impact of politics. The next step consisted of a facilitated discussion initiated by the moderator, relying on a semi-structured interview guide incorporating open ended questions. Each group thus discussed the survey items they answered in the questionnaire at the beginning, which covered their definitions of science, science in everyday life and its relationship to common sense, trust in science, the influence of politics on science, and a question addressing democracy. This two-stage process allowed investigating how participants evaluate and understand relevant survey questions. It also showed that the focus group sample was somewhat less critical of science and democracy in comparison to the overall Austrian population, although critical voices were also present, and, through that, it paved the way for the discussion.

The focus groups were transcribed and coded using Atlas.ti, following a grounded theory approach (Strauss and Corbin 1998) as we aimed to explore new knowledge inductively. Relevant phenomena were coded in an open coding process, in which the coding structure was developed by selective and axial steps working towards theoretical saturation and a common red thread. As we were interested in shared

meanings and the emergence of opinions in group context (Reed and Payton 1997), phenomena, i.e., coded segments of data, were not restricted to expressions of individuals but also included narratives and parts of discussions involving several participants.

Additionally, we identified participants particularly critical of science and their contribution to the discussion. These 14 people were identified by clustering those participants who either expressed an opinion contrary to the scientific consensus (in knowledge-related questions) at least twice or did not explicitly express trust in science in the questionnaire at the beginning of the focus groups. This group includes persons with different educational backgrounds and is gender balanced with seven male and six female participants. Seven people stated an age of more than 60 years, while three people were under 30 years old, with the remaining three people aged between 30 and 59.

(c) The 12 semi-structured expert interviews aimed to cover the discourse on skepticism towards science and democracy in Austria (Bogner et al. 2002). The selected interviewees were well-informed about the topics of "science" and "society", and had engaged in public debate at events or in the media or, in one case, were recommended by one interviewee. Experts had a wide perspective on the topic and came from a broad range of professions. The sample of seven men and five women consisted of three natural scientists, two humanities scholars, one social scientist, two journalists, one psychologist, one lawyer and administrative scientist, one science official, and one person from a science communication background. Interviews were conducted from 2022 to 2023 and lasted between 23 to 90 min; the average was about 45 min. Most interviews were conducted in person; a small number of interviews were conducted online. Interviewees answered open questions which were derived from the central objectives of the study and were intended to clarify what the experts understand by science, science skepticism and society, how they evaluate and assess these, what evidence or experience this assessment is based on, what they perceive as the causes of science skepticism in Austria, what the ideal relationship between science and society would be, and what measures would be necessary to establish this relationship. Like the focus groups, the interviews were transcribed and coded following grounded theory (Strauss and Corbin 1998) and by using Atlas.ti.

4 Results

This chapter explores science skepticism by considering (a) general perceptions of science, (b) the distribution and prevalence of critique in the Austrian population, and (c) the multi-faceted character of such critique. Each aspect is addressed separately with data from surveys, focus groups, and expert interviews, except for (b) as this was not subject of the interviews. This structure was chosen to differentiate the various perspectives on science skepticism that come with these epistemic approaches.

4.1 Perceptions of science

4.1.1 Survey data

Across the investigated surveys and most items, the Austrian population supports positive statements about science more strongly than negative ones. ACPP, Eurobarometer, CAUCP, WGM, and ESS data indicate that trust in scientists, and more generally in science, is almost always higher over time and across countries than in other institutions and groups, such as political parties, the parliament or the police (Starkbaum et al. 2023, p. 141 ff.). Exemplary descriptive data from the ESS round 10 in Fig. 1 shows high trust in scientists in Austria, which is comparable to the levels of trust of the police and the judicial system. Trust towards any institution even loosely connected to the political realm is considerably lower than trust in scientists. Political parties and politicians themselves experience the lowest level of trust.

There are pronounced negative perceptions of science from Austrian respondents, particularly in relation to specific items and topical domains, such as nuclear energy. However, in comparison to other countries, Austrians are overall no more negative about science (e.g., Fig. 2).

The left panel in Fig. 2 shows general trust in scientists in Europe, based on ESS data. Here again, the mean trust values are plotted and the associated confidence intervals are shown. The vertical line marks the average trust in scientists with a value of 7.06 across all countries displayed. In the countries with average trust values to the left of this line, the total of all responses is below average trust in scientists. The right panel shows the mean values of agreement and disagreement regarding the statement, that "groups of scientists manipulate, fabricate, or suppress evidence in order to deceive the public". The higher the values, the stronger the rejection of this statement. The average approval/disapproval score among the countries presented here is 3.42. In countries whose mean approval ratings lie to the left of this line, respondents agree more strongly with this statement. Thus, the Austrian respondents show a comparably high rate of disagreement with the statement, which indicates

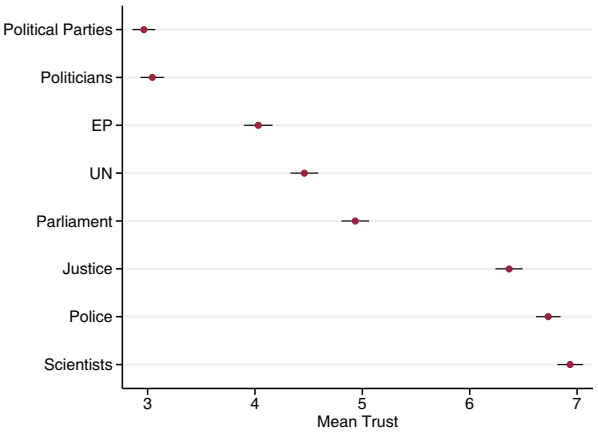

Fig. 1 ESS: Trust in different institutions in Austria 2021 (mean values). (Own calculations using data from ESS 10 (2021, $n = 1931$, weight = dweight). The mean confidence and the 95% confidence interval are displayed)

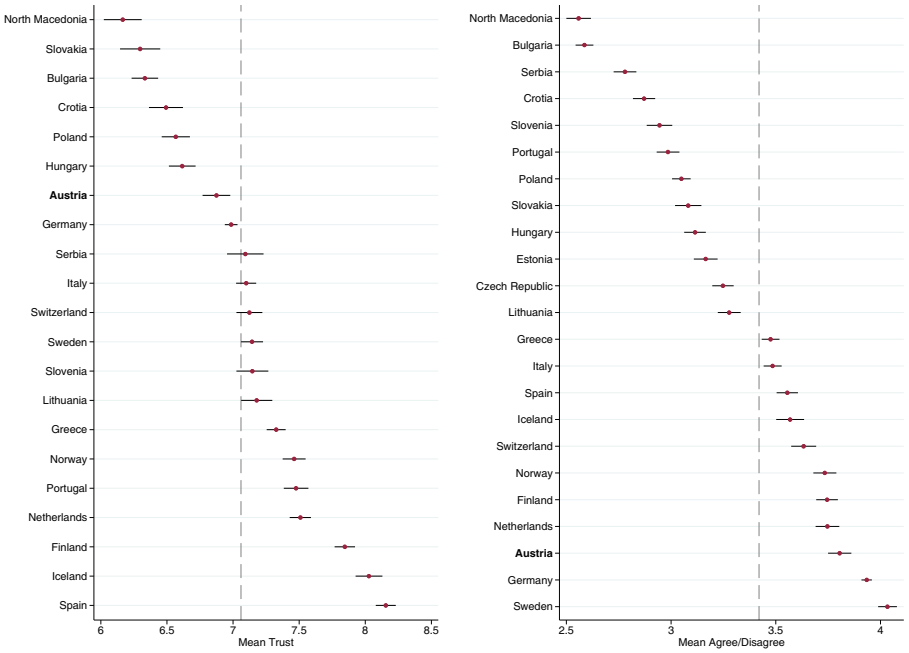

Fig. 2 ESS: Mean trust in Scientists over countries (left panel) and Mean Agreement/Disagreement that Scientists deceive the Public (right panel) 2021. (Own calculations using data from ESS 10 (2021, weight = dweight * pweight). The mean confidence and the 95% confidence interval are displayed)

wide rejection of the idea that scientists deceive the public. While Austrian respondents show slightly lower confidence in science than the average of all countries, most Austrians express trust in science and scientists, which we also observed in the focus groups.

4.1.2 Focus groups

The discussions in the focus groups about science are consistent with the high levels of trust reported in the surveys; as one participant pointed out: "*I trust science completely, because they are specialists, they know what they are doing. If not them, then who if not them?*" (FG3). In all groups, discussions about science started from a positive perspective and highlighted the systematic and structured production of knowledge. One participant, for instance, defined science as the "*unbiased pursuit of new knowledge*" (FG2). Such statements show that a somewhat idealized image of science was present in the groups, paired with lower awareness of the inherently contradictory aspects of research. To describe the merits of science, discussants repeatedly distinguished it from different forms of knowledge production, such as reasoning based on personal opinions. As one participant stated, "*science is certainly not an opinion*" (FG1). In this way, phenomena such as homeopathy were repeatedly criticized and described as *esoteric* and *pseudoscientific* in discussions, often with reference to medical topics and the COVID-19 pandemic.

However, the boundaries between science and non-scientific forms of knowledge became blurred during the discussions. Several focus group participants emphasized that common sense and science would not be necessarily opposed to each other. Participants described how common sense would be "*often based on science*" and it would be meaningful to "*rely on scientific results and studies as well as on common sense*", or, as another participant put it: "*relying on science is common sense*" (FG2). This is important because reliance on common sense has been repeatedly interpreted in the Austrian public debate on science skepticism as being in opposition to science. The question of trust in science is also more nuanced. While trust in science was primarily debated as reasonable, discussants also put unconditional trust in perspective by pointing out the heterogeneity of science and its entanglements with other institutions and parts of society.

4.1.3 Expert interviews

Perceptions of science vary among the interviewed experts. So did their definitions of science skepticism. Some experts defined the latter as dismissal of science, its method, and legitimacy, while a second group perceived skepticism as an integrated part of science and differentiated between positive skepticism and denial of science. A third group understood science skepticism partly as a critique of the utilization of science by politics and business.

Experts also disagreed about whether science skepticism is unique to Austria. Some did not consider it inherent to Austria (I5, I7). Rather than science skepticism, I12 observed a "*crisis in the understanding of science*", and I3 saw it as a "*confusion*" in public discourse. Other interviewees emphasized specific features of science skepticism in Austria. I1 highlighted the Austrian tradition of technology controversies, such as the ones on nuclear energy and genetic engineering, whereas I4 observed among Austrians a general resistance and critical attitude towards innovation. Interviewee I8 associated science skepticism in Austria, especially in the context of climate change, with fear, a desire for a comfortable life, and excessive demands on people in their everyday lives. Some experts saw specific and pronounced skepticism towards science in Austria (I9, I10 and I11). I10 emphasized a higher valuation of art, nature, and sport in Austria, coupled with a general disdain for science, a poor understanding of, and mistrust in applications of science, particularly in genetics. I11 provided several historical explanations for science skepticism in Austria, including a tradition of skepticism about progress, lack of capital for technological infrastructures as early as the 19th century, little tradition of patronage in science, dismemberment of a once shared economic area with the end of the Habsburg Empire, primacy of teaching over research at Austrian university, a lack of understanding among the population of what science is, the sometimes deliberately difficult comprehensibility of scientific language, the disdain for and suppression of education after the Counter-Reformation, the expulsion and murder of scientists after 1934 and 1938, and the prevention of the return of emigrants after 1945.

Overall, science was consistently described as something positive and trustworthy. Desirable images of science were demarcated from other institutions and forms of knowledge creation or, as became visible in the expert interviews, from criticism

of science. While participants attempted to explain existing negative perceptions toward science in the Austrian population, they themselves were also critical of science and exhibited a low level of trust in science. This is further explored in the next section.

4.2 Distribution of critique across the population

4.2.1 Survey data

Descriptive visualizations of survey data from Austria may, at first glance, suggest that there is only a distinct group (of citizens) that is particularly skeptical about science. Yet, criticism of science is not restricted to specific groups but rather can be found in all segments of society, e.g., no matter what education or geographic location. Moreover, a lack of knowledge of or disinterest in science does not necessarily equate to skepticism or a lack of trust in science, as both Eurobarometer and WGM data illustrate. Those who express low trust or skepticism toward science do not necessarily express lower interest or less interest in knowing more about science (Starkbaum et al. 2023, pp. 119, 158).

While particular groups of the population are more critical of science than others, most often, the differences to the overall population are within one scale point. In all five examined survey studies, we see somewhat similar patterns in the socio-economic profiles of those groups that tend to express negative attitudes towards

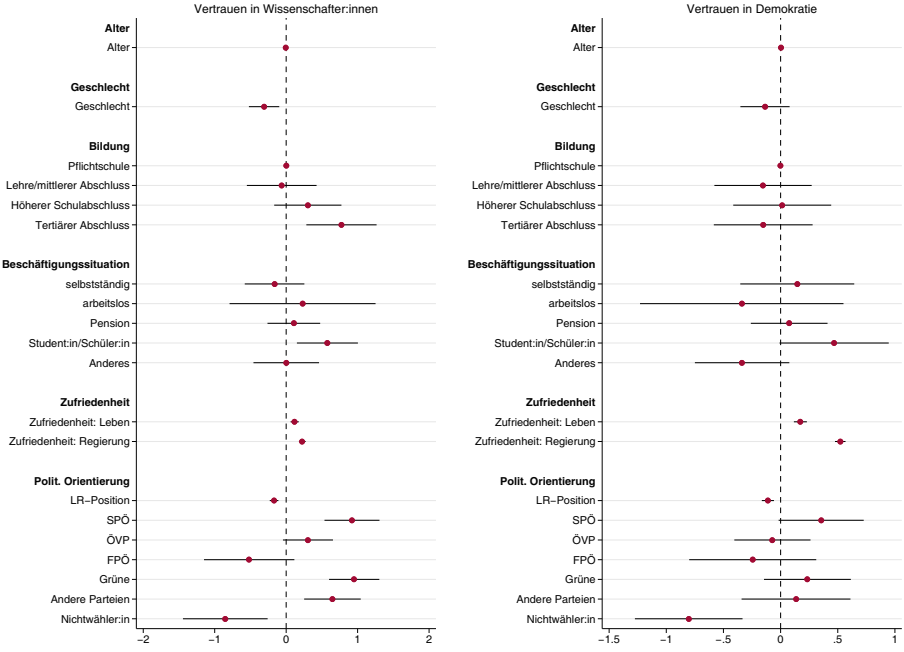

Fig. 3 ESS: Regression on Trust in Scientists—Socio-economic predictors. (Own calculations using data from ESS 10 (2021, AV: trstsci, $n = 1782$, weight = dweight))

science. The regression on trust in scientists using ESS data displayed in Fig. 3 shows that for all groups, deviations from the average score of the population are less than one scale point, thus, close to the overall average.

Figure 3 shows that women express slightly less trust in scientists than men and individuals with a higher educational level are comparably more confident in science. People who are self-employed express slightly less trust than people in other employment situations, but the differences are small. People leaning toward the political left are more likely to express trust in scientists, whereas non-voters and voters of the right-wing Freedom Party (FPÖ) are more critical. Consequently, self-identified voters of left and centrist parties show on average higher levels of trust. Satisfaction with life and the government are positively associated with trust as well. While many approaches to understanding science skepticism aim to locate specific groups and explanatory factors, framing selected individuals and societal groups as skeptics (see Chap. 2), this data indicates that it is a phenomenon observable in all segments of society.

4.2.2 Focus groups

Criticism of science emerged in all focus groups as discussions progressed. While some participants made comparably more negative statements about science than others, critical statements about science were not limited to particular discussants but were expressed by participants with various socio-demographic characteristics. This also included participants who expressed positive attitudes towards science in the survey that preceded the group discussion.

To better understand how these attitudes emerge in discussions, we identified focus group participants, who supported counter-consensus opinions or expressed lower trust in science in the questionnaire that preceded each discussion (see Chap. 3). Interestingly, many of these 14 participants, who might have been considered science critics based on the survey results, also described science in positive terms during the discussions. At the same time, criticism of science was not restricted to these 14 persons but was shared, in different aspects and intensity, by many discussants in the groups, such as criticism of a lack of transparency: "*I think, like most people here, that scientists stand in a laboratory and do something in secret [laughs]. Nobody knows what they are doing, and then it comes out and they get a Nobel Prize.*" (FG1). Other critiques concerned suspected unethical behavior.

Using the COVID-19 pandemic as an example, another group discussed the assumed malpractices at the interface between science and other parts of society. This debate involved one participant (B5) who expressed critique of science in the pre-focus group survey as well as participants (B3, B1 & B6) who had initially expressed a high level of trust in science. Critique of science and its role in society is thus not limited to discussants who initially expressed critique or low trust in the pre-focus group questionnaire. During the conversation, several other discussants took up and intensified critical arguments.:

B5: [...] it has not really been reported honestly in that time regarding Corona. A lot has been lied about. [...] because you said pharmacy [...], also there has been lied very much [...]
B3: That's clear.
B1: Of course, they made a lot of money with that.
B6: But who has lied here? Pharmacy? [...] Science?
B5: [...] how many hundreds of millions of vaccine doses were ordered? I certainly can connect the dots; much has been manipulated. (FG4)

Survey and focus group data emphasize that there is not a clearly recognizable group of science skeptics, but criticism of science is, although more prevalent in some groups, a phenomenon present in all parts of society. Moreover, being critical of science is not a fixed characteristic of individuals but rather emerges in discussions, even among people who express, on a general level, positive attitudes towards science.

4.3 Multi-faceted character of science critique

4.3.1 Survey data

Specific criticism of science, such as, critique of scientists' motives or competence, can be observed in various surveys in 20 to 30% of respondents, depending on the item and data set (ACPP, WGM). People who express negative attitudes towards science also tend to criticize entanglements with other institutions and areas of society across different surveys. In the 2021 wave of the ACPP survey, up to one third of the Austrians agreed that science is in cahoots with politics (Starkbaum et al. 2023, p. 147).

The group of people who reject science more fundamentally and on a broader level is comparably smaller than the ones that criticize particular aspects or the practical and institutional implementation of science. According to the approach to science skepticism as systematic and unwarranted rejection of science (Chap. 2), we identified the scope of this specific group. The quantitative analysis focused on people who responded to four statements in the Eurobarometer in a way that

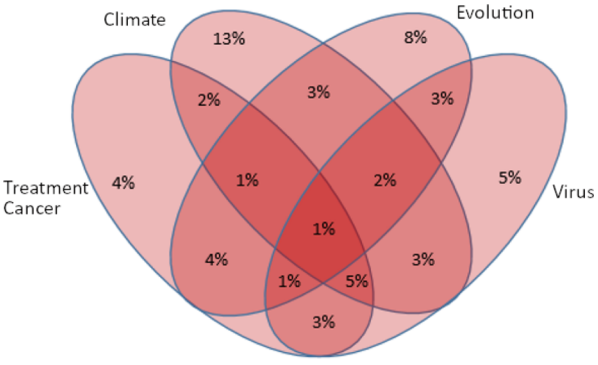

Fig. 4 Eurobarometer 2021: Expression of counter-consensus statements (in % of population). (Own calculations using data from EB 516 (also see Endbericht 2023, p. 109). The Venn diagram shows data for four questions and the share of individuals expressing attitudes that contradict scientific consensus)

went against scientific consensus or that tended towards conspiracy theories. These fields included anthropogenic climate change, evolution, cancer research, and virus generation (European Commission 2021; Starkbaum et al. 2023; see Fig. 4).

The Venn diagram shows the percentages of individuals who expressed counter-consensual attitudes in the four mentioned areas. Each overlapping ellipse shows combined percentages, i.e., individuals who expressed two or more skeptical attitudes. Between 21 to 31% of the Austrian population, depending on the statement (visualized through the ellipses), agreed with at least one of the four counter-consensus statements (Fig. 4). The share of respondents who supported counter-consensus statements more often than once, i.e., in three or four of the questions, is much smaller and encompasses 10% of the Austrian population. This discernable, yet comparatively small group expressed attitudes contrary to common scientific knowledge in several areas, thus a systematic rejection of science.

4.3.2 Focus groups

When science was critically commented on during focus group discussions, participants perceived some parts of science and specific forms of research as problematic and non-objective, while they idealized others. Often, the connection between science and politics became topical. One discussant of the group that was critical about science in the pre-questionnaire, claimed that science was only funded if it is "*favorable to politics or if it is aimed at winning votes*" and that "*in principle, nothing is heard or seen of the other scientists*" (FG5). Repeatedly, participants described political support for science as selective, this also included participants who were not critical about science in the pre-survey. One focus group participant, who had expressed no negative attitudes towards science in the focus-group-questionnaire, stated loudly that it "*depends on the outcome*" (FG3) whether politics support research. During the discussion about a mineral oil company and their patents, a participant who had not expressed criticism of science in the pre-questionnaire, considered contract research as a problematic element of science.

> B6: "[...] much of what we call science is actually contract research. They also have white coats [general agreement], they do completely new things. They are the extended arms of industry. [...] They are bought, [...] they are not even traitors, they are just bought forces." (FG4).

Participants who were most critical about science rarely rejected scientific conduct per se but considered presumed practices and institutional entanglements with other areas of society as problematic. Conversely, as already shown, criticism of science also came from participants, who had stated high trust in or support of science in the pre-questionnaire. This group also highlighted positive aspects to emphasize which science they reject, describing the stereotypical scientist, as a man who "*is in a chamber and works for himself and does his work uninfluenced by shouts from others*" (FG5), "*fights against resistance*", and "*creates knowledge for all of us*" (FG4). Another person, of this group of 14, took the example of Albert Einstein, whom he assumed had no intention of making a profit, to emphasize that financial gain should not drive scientists: "*I don't think Einstein thought that way, that he*

might eventually get a lot of money for what he […] discovered or invented" (FG1). These quotes follow a similar pattern: The noble, male scientist in an antagonistic relationship with dishonest parts of science and external forces that corrupt science.

During the focus groups, skepticism and other forms of science critique were also labelled as a problem that originates from the population. Especially the 14 people, who expressed reluctance towards science in the pre-questionnaire, were engaged in discussions about how too few people in society would ask critical questions. Some participants portrayed parts of the population as ignorant and miseducated. One participant emphasized: "*humanity is becoming more and more stupid and nobody [emphasis] has any common sense anymore […] nobody [emphasis] has a decent level of education any more*" (FG3). Others concluded that scientists are not appreciated enough in Austria (FG3) and another participant pointed to the ignorance of the population regarding many (technological) impacts of science: "*I use everything, but I don't think about it anymore, it's just there. I think you must make people a bit more aware of how it all came about, where it comes from*" (FG1).

Some focus group participants explained the assumed lack of critical thinking and education in Austria as the outcome of a deliberate strategy employed by politics, the media, or other seemingly powerful fractions of society. The next sequence exemplifies how focus group participants perceived the performance of COVID-19 experts in television programs in the Austrian Broadcasting Corporation (ORF) as selective and manipulative. Only two (B3 and B7) of the 14 people, who expressed criticism in the pre-questionnaire, were involved in the four-person discussion about media below.

> B7: […] I believe he [the expert] was the least qualified person in the world to say anything about it, but he said something about everything [emphasis] and the ORF steered it that way.
> B9: yes
> B5: And politics […]
> B7: The ORF has an educational mission.
> B9: Would have. Would have [emphasis]
> B3: Would have.
> B7: Would have. We pay for that. And, I mean, I am saying this almost maliciously, but there is hardly any other broadcaster that manipulates like the ORF.
> B9: Yes, that's right, that is not malicious, that is realistic. (FG3).

Consequently, negative expressions towards science emerged in various ways during the discussions. This included criticism of specific parts of science, selected scientists, or the institutional entanglements of science with other fields such as politics, media and economy. In the groups, a lack of critical thinking was also brought up, once again illustrating the heterogeneity of what is referred to as skepticism.

4.3.3 Expert interviews

In line with the data presented above, the expert interviews revealed different approaches to and understandings of science skepticism. Experts either saw skepticism as a rejection of science, as an essential part of science, or as a critical attitude to-

wards the utilization of science. Experts mentioned social conflicts about science and technology such as the COVID-19 pandemic, genetically modified organisms, nuclear energy, and the climate crisis. Indeed, survey data confirms that certain of these technologies or science-areas are negatively viewed by Austrians (Starkbaum et al. 2023, p. 111). The controversy about these areas is not only about different assessments of technological risks, but includes issues concerning freedom of expression, the right to self-determination and autonomy, different conceptions of economy, justice, society, what relationship between science, society and nature would be "appropriate" and competing conceptions of societal futures in social and ecological terms. At the core, these are also conflicts about the role of science in society.

In addition to different understandings and definitions of skepticism, there are also differing explanations for its incidence. Some arguments address a perceived distance between science and society, which is said to arise due to the separation between science and the lifeworld of the population and the difficulty of understanding and grasping research. Another expert narrative focuses on the increasing complexity of society and the resulting increased demands on the individual, which is also linked to the education system that is blamed for failing to communicate the workings of science and its importance to prosperity. Consistent with the findings from surveys and focus groups, we see explanations for science skepticism based on an assumed general skepticism towards elites, including politicians but also scientists, and issues of trust in institutions more broadly.

In summary, science critique appears in different forms and intensities. While a smaller segment of 10% of the population rejects science across different domains, other forms of criticism, concerning the motives of scientists or entanglements with politics are a concern to a much wider group. Focus groups and expert interviews also show that criticism and presumed causes are varied.

5 Discussion

The current public debate on science skepticism gathers, under this term, quite different forms of science critique. There is also no clear definition in the academic literature or in empirical studies. This paper discusses different approaches to science skepticism and provides empirical insights into this multifaceted phenomenon. It shows that most Austrians have a favorable view of science and that there is no clear evidence of a recent increase in negative attitudes toward science (Starkbaum et al. 2023, p. 261 f.). Exploring different forms of criticism in the population can contribute to an understanding of science skepticism.

Operationalizing science skepticism as a (systematic and unwarranted) rejection of science, focuses on a smaller but more critical group. Secondary analysis of data from a recent Eurobarometer study (European Commission 2021) shows that about 10% of the Austrian population can be considered science skeptics according to this definition. Based on different survey data, Partheymüller and Eberl (2023) arrive at slightly higher numbers and identify a share of 14% of Austrians who express

moderate interest and low trust in science or reject its findings as science skeptics. This proportion is not insignificant, however, far from being the majority.

The secondary analysis of survey data emphasizes how the share of critics or skeptics differs depending on how skepticism is operationalized in surveys. 20 to 30% of the respondents in Austria, depending on the items and survey we analysed, are critical of scientists' motives and competences or criticize perceived interlinkages between politics and science. Most often, criticism addresses certain areas of technology or scientific disciplines, perceived malpractices, or links between science, politics, and economic interests. In line with Bogner's (2021) concept of the epistemization of the political, our focus group data showed that within our sample, there was little rejection of science, however this was framed by a critique of perceived political or economic meddling in science. An idealized image of science, close to the Mertonian norms (Merton 1942), was seen, in this line of argument, as threatened by elitist control of science and a disinterested public. Correspondingly, based on survey and interview data with an Austrian sample, Partheymüller and Eberl (2023) found that science skepticism is also an expression of a comprehensive world view that includes a broader skepticism towards democratic and political institutions. The authors conclude that the assumption that science lacks independence from politics and business contributes in a particular way to its rejection. Findings of a related dialogue process with Austrian citizens show transparency and independence of science from political and economic interests as a key recommendation of the discussants (Bechthold et al. 2023). The BMBWF study confirms that people with higher normative expectations of democracy and who perceive democracy as working better in Austria express higher levels of trust in scientists (Starkbaum et al. 2023). Consequently, criticism of science also stems from conflicts over the supremacy of certain forms of knowledge and from broader critique of politics and democratic institutions.

Many international studies try to identify factors explaining why individuals or groups hold anti-science attitudes or have little trust in science. However, depending on the field or topic, these studies also show that criticism of certain areas of science is more pronounced in different groups, therefore, there is no single group of science skeptics (Rutjens et al. 2022). Similarly, Frei and Nachtwey (2022) show that protests against measures to contain COVID-19, which have been backed by scientists, included people from all social and educational strata of society. This study confirms that science critique is not limited to specific social groups. Our data also show that individuals are not consistent in their attitudes towards science. Focus group participants who had previously expressed generally positive attitudes towards science, were also among those who stated science critique in the discussions. In line with these findings, Neresini (2024) highlights that communities that refuse certain scientific knowledge are not homogeneous nor exclusively ignorant and irrational minorities.

A lack of knowledge about science is repeatedly named as a factor relevant for skepticism (Bromme 2022), also in our expert interviews and focus groups. Thus, science and politics often address science skepticism with efforts to increase science literacy, i.e., to improve the level of scientific knowledge of the population. However, our survey and focus group data show no clear link between the extent of

scientific knowledge and negative attitudes towards science. Accordingly, Ten Kate et al. (2021) reveal that well-educated people reject scientific knowledge as well, drawing on the example of vaccine refusal. The idea that increasing the knowledge and engagement of citizens will raise, in a linear way acceptance of science, has existed for decades and has been challenged ever since (Suldovsky 2016). A study by Lackner et al. (2023) emphasizes the complex role of knowledge by showing that overconfidence about knowing answers about science issues peaks at intermediate knowledge levels and that this group also expresses the least positive attitudes towards science. The authors thus conclude that increasing science literacy will not simply lead to increased support of science.

However, distance between science and society exists to some extent. Focus groups suggest that many citizens know little about how science works in practice, which was also discussed in the expert interviews. Also, there is a high level of agreement (53%) in the Austrian population that knowledge of science and research is not relevant to everyday life (European Commission 2021). Some research suggests that this has to do with people's social identity, which might conflict with the institution of science and its epistemic style (Philipp-Muller et al. 2022; Oswald and Bright 2022; Spampatti et al. 2023). This viewpoint speaks in favor of making science more participatory and anchoring it more firmly in everyday culture of different social groups (Dawson 2018).

At the same time, science is more present in most people's lives than ever. Over the centuries, science has moved to the center of Western societies, challenging religion as a core value, and driving economic growth, health, and education. Strengthening innovation capacity has also been a consistent goal of Austrian federal governments for decades and has led to remarkable developments like comparably high expenditure on R&I (Janger and König 2020). And yet, science's role is not without challenges.

While science is modern societies' best approach to generate and validate new knowledge, it is also a human endeavor and thus subject to biases and error (Kuhn 1962). Some researchers call for avoiding idealized images of science and "promising less" (Collins and Pinch 1993, p. 142), as failed promises might foster anti-science attitudes. The same authors suggest that science should engage with criticism rather than acting like a "nest of ants with an intruder" (Collins and Pinch 1993, p. 142). While addressing science criticism is essential, a critical view on science is required as well. Science has historically also harmed groups and contributed to sexual identity discrimination and racial inequality (Graves et al. 2022).

The Austrian public debate on science skepticism is in many ways driven by a dualistic perspective on attitudes towards science, which divides the population into a group of science supporters and a group of science deniers. The dominant discourse in the media, which is primarily shaped by journalists, politicians, scientists and science functionaries, characterizes a considerable part of the Austrian population as skeptical of science, i.e. as irrational in comparison to the other part and to themselves. While this is true, as we show in this paper, for a specific, but considerably smaller part of the population, and for some forms of radical critique, it is certainly not the case for all forms of critique of science. And it is certainly not the case for the majority of the population in which trust in science dominates.

Moreover, the claim that science skepticism prevails is based mainly on quantitative research, which constitutes a specific perspective on this topic. Also, researchers' underlying and sometimes unconscious assumptions about science skepticism affect the results and their interpretation. This paper critically reviews relevant quantitative surveys and adds qualitative data from focus groups and expert interviews. These data show that science skepticism is held by different groups, and partly even by groups that are generally positive about science. This mixed-methods approach broadens the perspective on science skepticism and brings into focus those larger groups of citizens and experts who are central to the public discourse.

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Johannes Starkbaum is a sociologist and political scientist and received his Ph.D. from the University of Vienna in 2019. He has been researching the interaction of science and society in the fields of medicine, mobility and science policy for more than 10 years. His current research focuses on science for policy as well as on socio-economic energy communities. Recent publications: "Navigating care: understanding cancer patients' experiences with systemic radionuclide therapy", 2025, Supportive Care in Cancer, https://doi.org/10.1007/s00520-025-09380-2, with S. Thircuir et al. | "Responsible Innovation across societal sectors: a practice perspective on Quadruple Helix collaboration", Journal of Responsible Innovation, 2024, https://doi.org/10.1080/23299460.2024.2414531, with Braun et al.

Erich Griessler studied sociology and history in Vienna and Maastricht and holds a PhD in sociology. Before joining the IHS in 1999, he conducted research at the University of Vienna, the AIT and the Ludwig Boltzmann Society. In 2016 he started a research group on science, technology and social change at the IHS, which he led until 2023. His research interests include social studies of science and technology, ethical, legal and social aspects of research and innovation and democratic participation. Recent publications: "The Regulation of Assisted Reproductive Technologies in Europe. Variation, Convergence and Trends" (2022) with L. Slepičková et al. (eds.). Routledge | "Improve alignment of research policy and societal values", Science, 369 (6499), pp. 39–41, 2020, with P. Novitzky et al.

Peter Grand is project leader of the European Social Survey (ESS) in Austria at IHS since 2017. His research interests focus on the analysis of behavioral and attitudinal data, welfare attitudes and electoral behavior as well as on the interactions between ecological and social attitudes. Recent publications: "Deservingness als Heuristik oder als Automatismus?" Österreichische Zeitschrift für Soziologie, 48, 2023, 11–36, with M. Fink et al. | "Welfare solidarities in the age of mass migration: Evidence from European Social Survey 2016", Acta Politica, 56(2), 2021, 351–375, with M. Fink et al.

Fabian Seiser is student Assistant at the Institute for Advanced Studies and a master student in the field of Science and Technology Studies at the University of Vienna. His interests are oriented towards participatory methodologies, democracy, and deliberative formats as well as memory work and Serious Game Design.

Thomas König is managing director of the Austrian Council for Sciences, Technology, and Innovation (FORWIT). His fields of expertise are on the interplay of science and politics, scientific research organisations, and the historical and epistemological foundations of the social sciences. Recent academic publications: "A Case of Scientific Policy Advice in Austria During the Pandemic" (2025, https://doi.org/10.1007/s11024-025-09572-4, with M. Stampfer) | "Multi-layered sampling strategy for qualitative interviews" (2025, https://doi.org/10.1080/13645579.2025.2453935, with E. Mohammadi and B. Zimmermann).