Research Cultures in Germany – A Study commissioned by the Volkswagen Foundation

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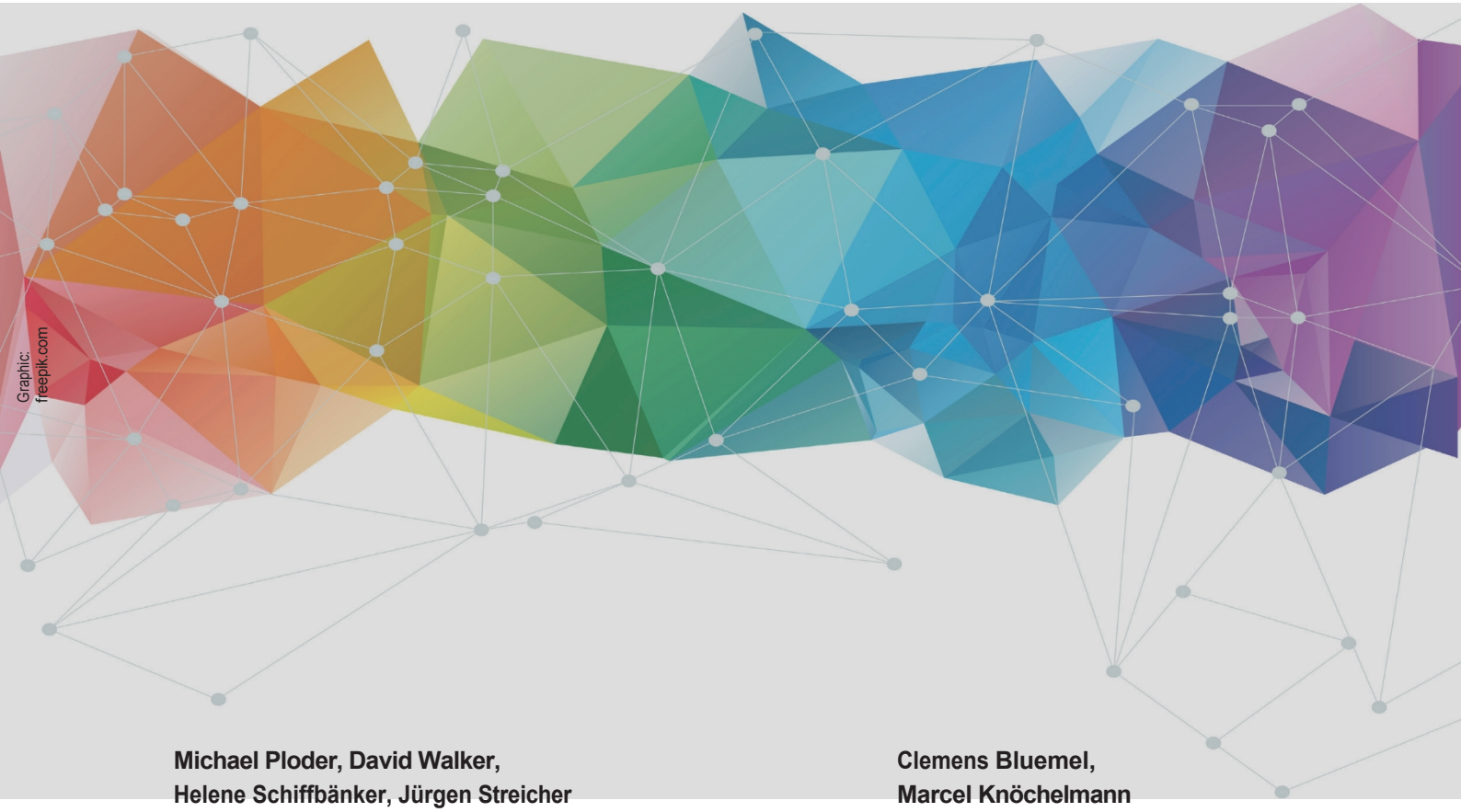
Research cultures in Germany

A study commissioned by the Volkswagen Foundation



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Dear reader,

The purpose of the Volkswagen Foundation is "to promote science and technology in research and teaching". We fulfil this mission not only by enabling high-risk research projects. As Germany's largest private and non-profit science funding organisation, we also view ourselves as a creative co-designer of the scientific landscape. We provide strong impetus to improve the framework conditions for research, teaching and transfer. And open up new career opportunities for researchers.

It was in this context that the idea for the study presented here was born: a qualitative survey on the topic of "scientific cultures in Germany". The aim was to generate specific recommendations for beneficial alterations, using an up-to-date analysis on current circumstances and issues. This is an endeavour that we believe has not yet taken place in Germany in this quality and scope.

Together with the participating organisations, we at the foundation closely supported the development of the study design, defined the thematic framework and introduced specific requirements, such as the integration of expert workshops to test the working hypotheses and qualitative interviews with focus groups from various scientific disciplines. We received expert support from a high-calibre advisory board.

The finished study is now available. As requested, the authors challenge our funding activities with a series of recommendations for action, which they have formulated as a conclusion. Reflection on this has begun and it will continue to occupy us in the coming months. We will report on this in our digital foundation channels.

We are already working on one specific adjustment: in the near future, we will take an even closer look at the employment schemes in the applications. For the Foundation, these are tried-and-tested management options to enable doctoral students and postdocs to plan their careers more reliably. Further impulses will follow.

I would now like to invite you to join us: Let yourself be inspired by the study "Research Cultures in Germany", reflect on the recommendations for action - and feel free to contact the foundation and me if you are interested in sharing your thoughts and ideas with us. I look forward to hearing from you.

Yours sincerely

Dr Georg Schütte

Secretary General of the Volkswagen Foundation

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Summary

Background of the study and research gap: The Volkswagen Foundation is currently establishing a new profile area "Knowledge about Knowledge", with which it will provide targeted impetus for the structural improvement of research in Germany. As part of the project "Research Cultures in Germany" (2022), we analysed how scientists in various research fields and disciplines perceive working and living in Germany as a research location and what opportunities and challenges they identify for research cultures in Germany. The aim was to develop a current description of the status quo and identify problems, from which ideas for the Foundation's funding activities and for a positive change in research cultures in Germany can be derived.

In the context of the project, we understand research cultures as multidimensional: they are made up of epistemic, social, organisational and societal dimensions. We therefore also speak of research cultures in the plural: while there are framework conditions at a societal and organisational level that apply to all scientific fields in Germany, some are field-specific, and research fields have their own epistemic and social practices and norms against which they interpret and negotiate organisational and societal framework conditions.

In Germany, questions of working and living in academia have gained attention in recent years, particularly in the wake of the #IchbinHanna and #IchbinReyhan protest movements (Bahr et al., 2022), which pointed to precarious employment conditions and the associated restrictions on quality, creativity, productivity and diversity in academia. These protest movements, the evaluation of the Academic Fixed-Term Contracts Act 2022 and attempts by some universities to establish new forms of employment, especially for postdocs, have led to an intensive discussion of the situation of early career researchers. What is largely missing, however, are debates and analyses that take a systemic perspective and, in this sense, look at academic cultures in Germany from the perspective of various actors and their interactions.

Approach and procedure: The term "research cultures" is at best vaguely defined in the literature. Much of the available research focuses on epistemic cultures,
i.e. how differently research fields approach their research objects. However, research cultures are significantly shaped by other framework conditions that are located at a societal and organisational level: Structures of research funding, career opportunities in and outside science, social reputation of the field, broader social and political changes. In order to capture the influence of these other framework conditions on various fields of research, our study, which was relatively short at twelve months, chose a methodological approach that involved a broad range of actors in the discussion and analysis on the one hand, and focused in depth on the other. To this end, we held several discussion events in 2022, firstly with a large number of stakeholders in the

German science system - from early career researchers to science policy makers - discussed their perceptions of research cultures in Germany. Secondly, we used qualitative case studies to analyse research cultures in four fields in the social sciences, humanities, natural sciences and technology in Germany in order to specifically identify differences. Thirdly, this empirical data was combined with interviews and workshops with national and international experts in science and technology studies and science policy studies. The result is a spotlight on research cultures in Germany that can provide impetus for new courses of action in science policy and funding.

Differences in scientific cultures in four selected fields in Germany: The fields analysed - sociology, environmental humanities, AI research and synthetic biology - have significantly different scientific cultures. While sociology and environmental humanities see a contribution to the positive development of society and to overcoming societal crises as central tasks of their fields, researchers in AI and synthetic biology define their mission more in terms of internal science and see positive societal effects indirectly or induced in the possible applications of their technologies in the future.
At the same time, sociology and the environmental humanities are realising that, despite their self-image, social and political relevance tends to be attributed to fields of science and technology.

In all four fields, social and epistemic dynamics are shaped by the field-specific labour market outside of academia: while it seems difficult for researchers in sociology and the environmental humanities to find fields of work in which they can apply their critical-analytical skills, AI suffers from a lack of talented researchers who want to stay in academic research due to the good working conditions in the private sector. In synthetic biology, a highly interdisciplinary field, the prospects of scientists vary according to their specific background. That is, it can be difficult to find competent data scientists for academic positions and easier to recruit biologists. In fields with a weak non-academic labour market, this leads to high competition between scientists, which primarily results in increasing publication pressure. This tends to lead to various negative effects: In synthetic biology, it is increasingly difficult to publish articles because the relevant journals receive too many submissions; in sociology, a field where empirical research usually takes some time, there are multiple publications of the same results.

The four fields also differ significantly in their understanding of originality. While in sociology originality can be justified on different levels, i.e. both in the development of concepts and methods as well as in the application of existing concepts and methods to new objects, AI researchers justify originality primarily in the development of new algorithms (i.e. methods). The application of existing algorithms to new topics (e.g. in cooperation with researchers in other fields) is hardly considered innovative for AI researchers, even if this is seen as innovation in the fields of cooperation. In the environmental humanities, the interdisciplinary integration of theories and methods from different fields and disciplines represents a major challenge.

In synthetic biology, technological innovations that facilitate the synthesis of organismic components are considered original.

The fields also exhibit varying degrees of internationalisation. While internationalisation is practised relatively smoothly in AI and synthetic biology, it is associated with different challenges in sociology and the environmental humanities. Sociology is strongly nationally oriented and German is largely the operational language; in Sociology internationalisation is a desideratum that is in tension with the attempt not to give up German as a working language. Environmental humanities, a highly internationalised and interdisciplinary field, suffers from the fact that it has difficulty gaining a foothold in the research landscape of the German social sciences/humanities, which continues to have a disciplinary and national orientation.

Common challenges regardless of cultural differences: All of the fields examined and discussed at the events rely heavily on third-party funding, but the **embedding of third-party funded projects** in scientific organisations is in need of improvement, especially at universities. There is a lack of competent support in the initiation and administration as well as in the systemic integration of externally funded projects. Scientific support staff are also inadequately remunerated in view of the higher requirements.

In addition to the case studies and events, it became clear that the current impossibility of forming **semi-stable research teams,** especially at universities, is the biggest obstacle to original and efficient research. This is where the Academic Fixed-Term Contract Act stands in the way. In particular, however, there is a lack of willingness on the part of academic institutions to share the risks of third-party research and to secure transitional funding between projects. This leads 1) to the departure of talented scientists, 2) to a disproportion between experienced and trainee scientists due to subsequent recruitment and 3) to group leaders and professors submitting more applications for third-party funding than is reasonable in order to avoid financial bottlenecks. This implicitly lowers success rates.

It is also clear in all subjects that people in **managing positions**, especially professors at universities, are **heavily overloaded.** Their range of tasks is diverse and new tasks have been added or increased over the last few decades (e.g. peer review) without other tasks being reduced. At the same time, the support structures or the recognition of qualifications have not increased with them. The instability of research teams often means that managers have little access to experienced employees who can relieve them. This overload reduces the quality of work and the opportunity to break new ground intellectually. The profession of professor is becoming increasingly unattractive for talented young people.

The need to develop attractive and long-term **career paths beyond the professorship is** clearly linked to the need to reduce the workload of people in managing positions. Senior Researcher positions with long-term contracts and various specialisations (e.g. specific methods, interdisciplinary collaboration, science communication) and Senior Lecturer

Positions that ensure excellence and innovation in teaching and study programme development are urgently needed to ensure higher quality and coordination of teaching and research.

Gender and diversity as a topic must be understood in a more complex way - gender is still often only thought of as a question of motherhood, while little attention is paid to cultural discrimination. A broad, intersectional approach to diversity, in the sense of ethnicity, language, dis/ability or sexual orientation, is not well established, nor is the understanding of gender and diversity as a dimension that should be systematically considered in research content.

With regard to **scientific reviews,** it is evident that the reviewers are overworked, while at the same time their activities are not recognised. For the assessment of highly interdisciplinary fields, there is sometimes a lack of important expertise in Germany, and more international recruitment is needed here, including the recruitment of younger researchers.

Following on from these and other challenges identified in the study, the project team has formulated a series of recommendations for the Volkswagen Foundation as a third-party funder and science policy actor, which are included in the report.

1 Introduction

The Volkswagen Foundation is currently establishing a new profile area "Knowledge about Knowledge", with which it will provide targeted impetus for the structural improvement of science in Germany. As part of the project "Research Cultures in Germany" (2022), we analysed how scientists in various research fields and disciplines perceive working and living in Germany as a science location and what opportunities and challenges they identify for research cultures in Germany. The aim was to develop a current description of the situation and problems, from which ideas and conclusions can be derived for the Foundation's further funding activities and, where necessary, for a long-term positive change in scientific cultures in Germany.

In the context of the project, we understand research cultures as multidimensional: they are made up of epistemic, social, organisational and societal dimensions. We therefore also speak of research cultures in the plural: while there are framework conditions at a societal and organisational level that apply to all scientific fields in Germany, there are also
Some are field-specific, and research fields have their own epistemic and social practices and norms against which they interpret and negotiate organisational and social frameworks. In this sense, analyses of scientific cultures attempt to capture this multidimensionality by adopting a systemic perspective that captures the positions and interactions of different actors.

In Germany, issues relating to working and living in academia have gained attention in recent years, particularly as a result of the #IchbinHanna and #IchbinReyhan protest movements (Bahr et al., 2022). The evaluation of the Academic Fixed-Term Contract Act attracted a great deal of attention in 2022. Voices from young academics have drawn attention to precarious employment conditions that would characterise working and living in academia for many and, in addition to the significant social and psychological effects on those affected, would also restrict the quality, creativity and productivity of academic work and diversity in academia. These protest movements, as well as the evaluation of the Academic Fixed-Term Contract Act 2022 and the efforts of some universities to establish new forms of employment, especially for postdocs, have led to an intensive discussion in the German context about the working conditions and prospects of young academics, and some universities are now also developing new practices and career prospects for postdocs that do not only relate to the issue of permanent employment contracts. What is largely lacking, however, are debates and analyses that take a systemic perspective and, in this sense, look at academic cultures in Germany from the perspective of various actors and their interactions within the system.

With this project, we want to make a contribution to such a systemic analysis and, together with the Volkswagen Foundation, initiate a broader debate on research cultures in Germany and their future prospects. In this sense, the core questions of the project were: Which factors significantly characterise research cultures in Germany? What challenges and problems do they currently face? And what impetus can be given to stimulate positive changes in German academic cultures?

As part of the study, which had a relatively short duration of twelve months, a methodological approach was chosen that involved a broad range of actors in the discussion and analysis on the one hand and focused in depth on the other. To this end, firstly, we held several discussion events in 2022 with a large number of actors in the German science system - from early career researchers to science policy makers - to discuss their perceptions of research cultures in Germany. Secondly, we used qualitative case studies to analyse research cultures in four fields in the social sciences, humanities, natural sciences and technology in Germany in order to identify specific differences in research cultures in different subject areas. Thirdly, this empirical data was combined with interviews and workshops with national and international experts in science and technology research and science policy studies. The result is a spotlight on research cultures in Germany that can provide impetus for new courses of action in science policy and research funding.

In this report, we present the results of the study. After an introduction to the core concepts of the study in Chapter 1, a brief summary of the most important insights from the (international) literature is provided in Chapter 2 as a background for the study. Chapter 3 describes the methods of the study and Chapter 4 presents the empirical analyses in two steps: Firstly, the case studies are presented in detail; secondly, we analyse specific challenges in German research cultures across the material, concerning the development of academic institutions, scientific communities and research funding. Chapter 5 summarises the results of the study and contains recommendations. The appendix of the report also contains a bibliography, a glossary and a list of abbreviations as well as a list of the people involved in the study through interviews, the provision of materials, advice and feedback as well as fruitful discussions at events, to whom the study authors would like to express their sincere appreciation.

2 Research cultures and their influencing factors

2.1 What are research cultures?

The term "cultures of research" is at best vaguely defined in the literature. Much of the available research focuses exclusively on *epistemic* cultures (Knorr-Cetina, 2005), i.e. how different research fields approach their research objects in different ways (Cambrosio et al., 2006). In addition to this central difference in content, research cultures are also significantly shaped by a number of other framework conditions that are located at a *societal* and *organisational* level (Lenoir, 1997; Whitley, 2007; Hammarfelt & de Rijcke, 2015). For example, the national and regional structures of research funding, evaluation practices, career structures and other social and political discourses on the role of science in society significantly shape life and work in science - as do broad social or political transformations, such as the recent COVID-19 pandemic, economic recessions, changes in political power or global societal challenges such as climate change. Science is thus to be understood as a sub-sector of society that follows its own norms and principles in many aspects, but is deeply embedded in society (Weingart, 2001; Jasanoff, 2004). While this is an established fact of science and technology research, there is still a limited number of studies that specifically explore these interdependencies in specific national, regional or disciplinary contexts. Ulrike Felt (2009; 2013) offers the concept of "epistemic living spaces" in order to provide a practical and empirically operationalisable definition of research cultures. She defines epistemic living spaces and thus scientific cultures as characterised by

> *"inextricable interdependence[s] of epistemic practices, institutional rationales, individual biographical decisions, as well as political and broader societal frameworks, which characterise the lived experiential realities of researchers today"* (Felt et al., 2013).

In our study, we follow this definition and our analyses aim to analyse the interdependencies of political and social framework conditions, field-specific working approaches and organisational contexts in Germany and to understand their effects on knowledge production. Our study is necessarily exploratory: firstly, its duration was limited to twelve months; secondly, the state of research on research cultures in Germany is extremely limited to date; and thirdly, Germany is a culturally and politically heterogeneous space that must be analysed in a differentiated manner. Nevertheless, the study offers important insights into the special features of German research cultures, which, against the background of the international state of research, provide important starting points for further research and recommendations.

The two events have already initiated a dialogue with relevant stakeholders and experts, which has been extremely well received by those involved.

2.2 Overview of the international state of research

In the following section, we provide an overview of the international state of research that sheds light on the relationship between the political, social and organisational framework conditions of science and working and living in science. It should be noted that this area of study is still relatively new. While there has traditionally been a strong focus in science and technology studies on the investigation of epistemic practices, e.g. in laboratory studies (Latour & Woolgar, 1986), which observe and analyse how researchers produce knowledge, these studies often do not sufficiently consider the broader framework conditions of research. As a result, the actions of researchers often appear relatively detached from e.g. funding, evaluation or career structures. At the same time, traditional science policy studies generally do not examine the effects of political instruments on epistemic processes, i.e. the effects on the priorities and decisions of researchers in their everyday research work. This means that there is currently a lack of studies that shed light on the epistemic effects of current social, political and organisational conditions on scientific work and scientific knowledge production in general. In the following sections, we summarise the existing literature along the following themes:

i. Evaluation of the research
ii. Research funding
iii. Career structures
iv. Originality
v. Interdisciplinarity
vi. Gender and diversity
vii. Social relevance
viii. Open Science

It should be noted that these eight topics are not at the same level: While the first three topics examine the effects of the three major steering instruments of evaluation, funding and career structures on research at a more general level, the literature in the following five sections sheds light on their effects on specific dimensions of academic working practice. In all sections, the focus is on exploring areas of tension in order to identify possible solutions. This overview does not claim to be an exhaustive account of all studies in this field. However, we believe that it summarises the most important lines of discussion and findings from the international debate.

2.2.1 Evaluation of the research

The evaluation of research has been a topic of intense debate in recent years, from commentaries (e.g. Alberts et al., 2014; Honneth, 2022) and empirical studies (see de Rijcke et al., 2016 for an overview). The interest was primarily rooted in a perception of change: The growth of certain research areas (e.g. the life sciences), changes in the science system (e.g. the shift from block funding to more competitive funding practices) and the resulting changes (e.g. more frequent evaluations of individuals, groups and institutions; more short-term contracts in science) are said to have changed the way research is evaluated.

It is often criticised that too much reliance is placed on quantitative performance indicators when assessing research quality, be it the number of publications, impact factors of journals, citation indices or the h-index (Biagioli, 2016; Flink & Simon, 2014; Simon, 2015; Supak Smolcić, 2013). The use of such metrics is problematic for four reasons: Firstly, it would steer the evaluation procedure away from a content-based evaluation towards proxy-based assessments (de Rijcke et al., 2016; Kun, 2018; Katchburian, 2008). Secondly, authors such as Butler (2003; 2005) argue that this would lead to practices of "goal displacement", as researchers would optimise their work practices towards these metrics and thus metric success would not have content criteria as its goal. This would have a significant impact on which types of research questions and topics are attractive to researchers and which receive little attention (e.g. de Rijcke, 2017; Flink & Simon, 2014; Rushforth & de Rijcke, 2015). Thirdly, recourse to metrics would penalise fields whose relevant performance is difficult to measure in quantitative metrics (Hamann, 2016; Marques et al., 2017). This is particularly true in contexts in which research or researchers from different disciplines are evaluated in competition with each other (e.g. in interdisciplinary review panels) (Simon & Knie, 2021) or in the context of decisions at institutional level (e.g. distribution of funds within universities). It is often argued that this effect penalises the social sciences and humanities in particular (Lange, 2007; Langfeldt et al., 2020). Fourthly, the focus on research metrics is viewed as part of a general "overvaluation" of research in relation to other activities, such as teaching and supervision, which leads to a growing disinterest in and organisational devaluation of these activities (Müller and de Rijcke, 2017).

It is important to note that most of the existing literature is based on empirical studies in the life sciences, biomedicine and social sciences. Little is known, for example, about evaluation and its effects in the technical and engineering sciences. It should also be noted that the available studies primarily reflect scientists' perceptions of assessment practices, as analyses of assessment practices themselves are still often difficult to conduct and are often considered taboo (Lamont, 2009; 2012; Müller, 2021; Brunet & Müller, 2022). Peer review studies, i.e. studies that analyse how reviewers make decisions about

The fact that the assessments of scientific quality are made in specific contexts thus represents a significant gap in the literature that needs to be filled in order to better understand how value judgements are made in science.

2.2.2 **Research funding**

The funding options available to scientists have a considerable influence on their working practices. The shift from block funding, i.e. the funding of scientific work via the budgets of the institutions themselves, to a competitive funding system in which the acquisition of third-party funding takes centre stage, is seen as one of the most important changes in science systems in Europe
(e.g. Reger & Kulhmann, 2012). In the literature, the shift towards third-party funding instead of block funding of science is identified as the driving force behind a process that is referred to as the "projectification" of science (Torka, 2012; Felt, 2017; Fowler et al., 2015). On an epistemic level, this means that, due to funding structures, scientists are increasingly thinking of their work in terms of "projects", i.e. in time-limited, consecutive units for which research objectives are formulated (Torka, 2018). At an organisational level, projects are the work units for which employees are hired and teams are formed. At both levels, researchers are increasingly concerned with putting together a larger whole from different projects, whether at the level of the individual's work biography, the working group or the institution (cf. Felt, 2017; 2021). This applies both to the possibility of enabling longer-term employment across individual projects and to linking content into longer-term research programmes in a meaningful way.

In the last two decades, person-centred funding has established itself as an alternative to classic project-oriented research funding (Williams, 2008; Honneth, 2022; Rosefeldt, 2015). It is often argued that this could overcome the relatively short time spans of typical research projects and the need for quite detailed project plans in order to fund more "ground-breaking" research (e.g. ERC Starting, Consolidator and Advanced Grants; DFG Emmy Noether Groups; DFG Heisenberg Programme). However, there are a number of unanswered questions regarding this funding format. Firstly, it is unclear whether reviewers can actually deviate from established patterns when reviewing such applications and select more open and riskier projects (Luukkonen 2012; Laudel & Gläser, 2014). Secondly, there are concerns that this type of funding could reinforce the Matthew effect in science (Merton, 1988) and contribute to the further centring of resources on already renowned researchers. Thirdly, person-centred funding could further exacerbate the gender inequalities that still exist in research. Numerous studies show that gender bias is particularly strong in the assessment of researchers' past research achievements and future potential,

less in terms of project descriptions (Wenneras & Wold, 1997; Moss-Racusin, 2012). Similarly, self-praise in applications is rated positively for men and is more likely to be sanctioned for women (Else, 2019; Kolve et al., 2019). Person-centred research funding could therefore reinforce inequalities in the research system, while at the same time it is uncertain whether it can achieve the intended effect of promoting riskier research, for example (Simon, 2022).

Similar questions arise with regard to large-scale research funding initiatives such as the Excellence Initiative. In the German research system, the Excellence Initiative has been criticised for widening the funding gap between wealthy and less wealthy universities by concentrating funding (Leibfried, 2010; Brink, 2018; Münch, 2007). In particular, the two-tier system, in which universities that have successfully acquired two or more "clusters of excellence" can compete for further funding to support the strategic growth and reorientation of the institution, is at the centre of criticism in this context (Ambrasat & Heger, 2020). It is also criticised that there is no clear plan for the development of those institutions that remain repeatedly unsuccessful (Massih-Tehrani et al., 2015). While stratification into research-orientated and teaching-orientated institutions is a characteristic of Anglo-Saxon research systems, this has not historically been the case in Germany. The question arises as to whether such stratification will be the result of the Excellence Initiative or whether other forms of institutional differentiation will develop, and if so, how such a transformation would have to be moderated and contextualised in order to be successful in Germany (Hamann, 2016; Sondermann et al., 2008).

2.2.3 **Career structures**

Debates about academic careers are closely interwoven with discussions about evaluation practices and funding structures. At the level of doctoral training, the main issue being discussed in Germany is how this should be organised. While other countries such as the USA and the UK organise doctoral training primarily in graduate schools, Germany still largely follows an individual model in which doctoral students are mainly supervised at individual chairs (Specht et al., 2017), although graduate schools are slowly gaining in importance in some areas. Similarly, supervisors continue to act as examiners of doctoral theses, which is critically discussed with regard to quality control on the one hand and the dependence of doctoral students on supervisors on the other (Bengtsen, 2021). The challenges for Germany also include the fact that students usually have to have a Master's degree before they can start a doctorate and that Bachelor's degrees with honours, which are common and sufficient in many countries to start a doctorate, are usually not accepted (Kehm, 2007).

Internationally, there is increasing debate about what the normative focus of doctoral training should be: should the doctorate be understood primarily as a period of training and learning or already as a period of academic productivity in terms of publications (Barnacle & Cuthbert, 2021)? There are concerns that doctoral candidates are already under increasing pressure to publish in high-impact journals, which could have a negative impact on their learning experiences - which also include failures (Müller, 2014a).

Internationally and also in Germany, the postdoc phase is the most discussed period of academic career development. Originally intended as a short additional training period between the doctorate and a longer-term academic position (e.g. a tenure-track position), more and more researchers in many disciplines are now working as postdocs for longer and longer periods of time, often without being able to remain in academia afterwards. This expansion of the postdoc phase is particularly true in research areas where the field-specific labour market outside academia tends to be weak, such as in the life sciences and many areas of the social sciences and humanities. In other fields, such as engineering or computer science, there are hardly any postdocs at universities, as the field-specific labour market outside academia draws doctoral graduates away (Kalten- brunner, 2018). With a few exceptions, however, studies on the working practices of postdocs have so far focused almost exclusively on subjects with a weak non-academic labour market. These studies therefore only offer insights into the experiences and practices of postdocs, who tend to work under highly competitive conditions and whose perceptions may differ considerably from those of postdocs in fields with a strong labour market. Nevertheless, the available studies point to a number of problems in the postdoc phase in those fields where there is high competition among postdocs for advanced positions. The results reflect the general concerns about the impact of metrics-based evaluation procedures and show that postdocs are particularly exposed to the pressure to align their work with research metrics (Müller, 2012; 2014a; Fochler et al., 2016; Müller & de Rijcke, 2017). Studies also point to a frequently high level of psychosocial stress due to long working hours and uncertain future prospects (Sigl, 2016). Some postdocs are also unsure how science that is largely focussed on internal scientific metrics can actually contribute to social welfare and consider their original motivation for working in science to be disappointed (Müller 2014b; Müller 2021).

In the German context, one step that has recently been taken to reorganise the postdoc phase is the introduction of tenure-track positions. These are positions based on the Anglo-Saxon model of an academic career: Scientists are appointed as assistant professors shortly after completing their doctorate (zero to six years) and are initially given a permanent position as an associate professor if they are positively evaluated after three to six years.

A further promotion to full professor is possible after a further evaluation after three to six years. The introduction of the tenure track in Germany was generally welcomed by interest groups of early career researchers, but also criticised as it could potentially create a "lost generation" of researchers, such as junior research group leaders and junior professors who joined the university without tenure track, as they would have to leave the university again after their contract expires despite comparable performance, unlike their tenure-track colleagues (cf. Open letter Initiative Zukunft Wissenschaft c/o German Scholars Organisation (GSO), 2005). Overall, it remains unclear whether the introduction of tenure-track positions will counteract the dominance of research-related metrics in performance evaluation or perhaps even reinforce it. To date, there have been no studies on the working methods of tenure-track professors in Germany or on the evaluation of their performance.

2.2.4 **Originality**

Originality is described in many studies as a quality of research that tends to be jeopardised by the current evaluation, funding and career structures. For example, a recent study by the British Wellcome Trust found that 73% of the 4,000 scientists surveyed on their perceptions of the field of science were of the opinion that originality is suppressed rather than promoted by the current organisation of science (Wellcome Trust, 2020). Studies from science and technology research come to a similar conclusion. Short funding horizons would encourage researchers to think in small steps rather than big leaps (Whitley et al., 2018). The pressure to publish continuously would lead to similar effects and additionally incentivise researchers to stay within the mainstream, where it is easier to achieve higher impact publications than in new or unorthodox fields (Fochler et al., 2016). Peer review would reinforce these conservative tendencies, as it is more difficult to obtain funding for unconventional projects because they would usually receive at least one negative review (Luukkonen, 2021; Brunet & Müller, 2022). In addition, some scientists have the impression that project evaluation procedures often reward superficial innovations, such as the use of new, "hip" technologies like AI, rather than working through difficult, subject-specific problems - especially when the evaluation is carried out in interdisciplinary contexts where non-experts must also be able to recognise the added value of a project (Falkenberg, 2021). This is not to say that it is impossible for researchers to conduct original research; however, they currently do so in part despite, rather than because of, the incentive structures of the scientific system.

In the German context, the success of funding programmes such as the Volkswagen Foundation's "Experiment!" funding line shows that scientists have the opportunity to develop original, risky and creative ideas.

to conduct research. A study of the funded projects has shown that although not all ideas work out - which should be normal for high-risk research - the projects often lead to other important findings, which in turn inspire new research ideas (Röbbecke & Simon, 2020; Simon, 2022).

2.2.5 Interdisciplinarity

Interdisciplinarity is often seen as the key to overcoming many societal challenges. Nevertheless, interdisciplinary research is still often difficult to realise in practice.[1] The most important limiting factors include aspects of the evaluation and funding of research as well as career structures that are still strongly discipline-oriented in some cases. It still tends to be difficult to publish interdisciplinary research in high-impact journals, as these are often organised and controlled on a disciplinary basis (Rinia et al., 2002; Lugosi, 2020). Similarly, research funding is often still mainly organised in disciplinary committees, which often find it difficult to evaluate interdisciplinary projects (Felt, 2021). Even if the committees are interdisciplinary, projects that involve more than one discipline are often evaluated more rigorously, as they are measured against more than one - and possibly divergent - disciplinary quality standard (e.g. Lindvig & Hillersdal, 2019). For this reason, ERC application coaches, for example, actively discourage applicants from applying to more than one panel (James & Müller, in preparation). When interdisciplinary projects are funded, they are at a disadvantage compared to disciplinary projects, as they are usually given the same time frame as disciplinary projects, but interdisciplinary work requires significantly more time, as a common language and heuristics must first be developed (Mittelstrass, 2018). For this multitude of reasons, researchers often shy away from interdisciplinary work as they perceive it as a threat to their own career (Müller & Kaltenbrunner, 2019).

2.2.6 Gender and diversity

Overall, the situation with regard to improving gender equality and diversity in science is described in the literature as tending to be paradoxical. On the one hand, there are numerous gender equality measures and special funding programmes to increase diversity in science, but on the other hand, the discussion about gender equality and diversity is largely isolated from a broader discussion about evaluation and selection practices in science

[1] Interdisciplinarity is often used as an umbrella term for different contexts in the sense of 'interdisciplinary', which were conceptually separated where possible in the context of the study's surveys: Interdisciplinarity in the narrower sense refers to the co-operative adaptation and further development of theories, approaches and methods from different disciplines. Multidisciplinarity refers to the parallel processing of an issue by different disciplines. Transdisciplinarity refers to integrative research that also actively involves non-scientific stakeholders.

However, as Dutz et al. (2021) and other studies convincingly demonstrate, evaluation and selection practices are still determined by male-coded values, i.e. values such as competitiveness, which are perceived as naturally congruent with the male gender and are evaluated positively in men, while they are considered acquired in women and are often evaluated negatively. A study by van den Besselaar and Schiffbänker (2014) illustrates this problem by showing that in the evaluation of ERC applicants, the important criterion of scientific independence is questioned much more frequently in women than in men. The values that guide research evaluation thus have a tacit masculine connotation (tacit masculinity, see Müller, 2013). Practical problems, such as the responsibility for childcare and housework, which is still disproportionately attributed to women in heterosexual relationships, even if they are more professionally successful than their partners (Perez, 2019), or the lack of childcare facilities for young children in Germany in general and at academic institutions in particular, further exacerbate the situation.

Programmes to promote diversity in a broader sense - social class, skin colour, religion, sexual orientation, disability, gender identity - are often still in their infancy in academia in German-speaking countries and there are few studies on the subject. However, it can be assumed that similar mechanisms of exclusion come into play as in the case of gender, as a difference to the traditional academic image (white, male, heterosexual, bourgeois) can also be assumed here (Haraway, 1997). In summary, it should be noted that significant progress in terms of gender equality and diversity in science must therefore go beyond specific programmes and requires a transformation of values and structures in science.

2.2.7 Social relevance and responsible research

Social relevance is a buzzword that has become an integral part of science policy discussions. At the same time, the term is vaguely defined, which, according to Flink and Kaldewey (2018), is a characteristic of many successful buzzwords in science policy. The level of research on social relevance and its interpretation in different science cultures tends to be low. In a study on interdisciplinary environmental sciences in Sweden, Müller and Kaltenbrunner (2019) show that researchers there equate socially relevant research with interdisciplinarity and transdisciplinarity. Due to the disadvantages that inter- and transdisciplinary research experiences in the current evaluation systems, they therefore see a focus on socially relevant research as potentially jeopardising their careers. Other research approaches the relationship between society and science via the question of the social responsibility of science, and finds that there is often little room for discussion on the social responsibility of science, especially in highly competitive fields such as the life sciences (Sigl et al., 2020). Further studies in the life sciences have shown that young people in particular

researchers would like research practices to be more focussed on their social relevance than primarily on internal scientific indicators (Fochler et al., 2016). This desire for reorientation has also been articulated by leading life scientists in scientific protest movements, such as Science in Transition in the Netherlands (https://scienceintransition.nl/english). However, these studies and internal scientific movements only provide snapshots of discussions in certain fields. What is currently lacking in the state of research is a systematic survey of the understanding of social relevance among scientists in various disciplines.

2.2.8 **Open Science**

Since the late 2000s, new digital platforms and technologies have changed the way scientists communicate, share or evaluate knowledge (Nielsen, 2012). Many of the tools and infrastructures developed in this process are designed to increase the opportunities for collaborative research. New forms of exchange with civil society have also developed, for example in the context of crowd science or citizen science (Franzoni & Sauermann, 2014). This is also accompanied by new objectives and requirements for scientific work. Driven not least by new digital technologies, movements have developed that increasingly demand openness, transparency and accessibility in research and are associated in the scientific and science policy world with the label Open Science or Open Scholarship. Openness is postulated in very different areas: in the field of publications (open access), teaching material (open educational resources), scientific software (open code), research data (open data), in the use of open metrics for the evaluation and measurement of scientific research (open metrics) and other areas (cf. Blümel and Beng, 2018; Foster Open Science, 2019). In addition to these practices, which are often focussed on the natural and life sciences, a discourse is also crystallising under the heading of open humanities, which develops open practices specifically for the humanities or seeks to anchor them beyond the digital humanities (Knöchelmann, 2019). All of the aforementioned opening initiatives not only aim to make the various artefacts in the research process accessible, but also to stimulate their reuse and academic exchange (Blümel, Leimüller & Fecher, 2019). In the meantime, a number of digital services have also been developed that enable the sharing of research artefacts: In addition to literature recommendations, presentations or field notes can now also be shared (e.g. Slideshare). How current positioning of the DFG or

of Science Europe[2] , the interactive use of such tools for the transparent design of research processes also aims to improve research quality, for example by improving the reproducibility of research.

However, it is also clear that the discussion about openness in research in the sciences and humanities is still very insularly focussed on certain areas of academic activity, particularly publication activities, while other areas are less discussed in this regard. The consequences that the more frequently articulated demands for greater professionalisation and more diverse knowledge production can have for the design of research processes seem to be reflected upon more strongly, especially where there is also the possibility of taking organisational risks.

The production and subsequent use of digital research data as well as communication via new channels also requires new skills that need to be learnt and acquired (EOSC, 2021).
This is particularly important in order to secure the value of open and digital research practices for a research culture that is geared towards increasing the quality of research and professionalising scientific work. These rely on broadly anchored competencies, not only with regard to technical aspects (e.g. the ability to program), but also with regard to organisational aspects (the joint processing of problems instead of competition). Solutions that take these aspects into account come from work groups such as the open source community, which place particular emphasis on strengthening collaborative aspects. In any case, there is still a need to address the diverse demands for openness in the various subjects and research disciplines as well as greater efforts and an examination of the possibilities and limitations of digital systems.

2.3 Research cultures in Germany: Important framework conditions

As a final step, before we move on to analysing the empirical research, we would like to discuss a few key characteristics that characterise academic cultures in the German context and are therefore particularly relevant for understanding the empirical analysis against the background of the international state of research. These are specific features of research funding, the disciplinary landscape, career paths and evaluation systems in Germany.

2 https://www.dfg.de/foerderung/info_wissenschaft/2022/info_wissenschaft_22_79/index.html

2.3.1 Research funding

Germany has a rich and diverse higher education landscape (universities, universities of applied sciences, private universities) and - compared to other countries - large and influential non-university research organisations. In addition, Germany has a diversified and, by international standards, well-equipped research funding landscape.

Germany is characterised by a diverse landscape of non-university research institutions with different tasks, ranging from basic research (Max Planck Society) to research strategically focused on major problem areas (Helmholtz Association) and applied research (Fraunhofer Society), with the Leibniz Association embodying a mixture of these (Heinze & Kuhlmann, 2008). Among these institutions, the institutional funding of the Helmholtz Association (90 %) and the Fraunhofer-Gesellschaft (80 %) is funded to a particularly high degree by the federal government. However, institutional funding for higher education institutions, such as universities, is provided exclusively by the federal states. Since the 1980s, the level of institutional funding for higher education institutions has been declining, a general trend that can also be observed in other European countries (Geuna, 2001; Braun, 2004), although attempts have recently been made to counteract this development, e.g. through the Higher Education Pact (BMBF, 2020). Project-related funding increased to 11% per year between 2006 and 2010, while institutional funding only grew by 5% per year during this period (Hinze, 2016: 419).
The intention to create a more competitive research environment has led to an increase in project-based funding in Germany, which has affected universities to a completely different extent than non-university research institutions, which have been able to achieve a continuous increase in their basic funding as part of the Pact for Research and Innovation.

In Germany, the German Research Foundation (DFG) is by far the largest and most dominant funder of basic research. The DFG's budget has increased considerably, but at the same time the demand from researchers for project-based funding has increased even more, which has led to falling approval rates, especially in the 2010s (DFG, 2015). Universities in particular are increasingly dependent on project-based funding in order to conduct basic research. Private foundations such as the Volkswagen Foundation or the Thyssen Foundation are becoming increasingly important for some research areas. Although the number of private universities has increased, their contribution to research is still small (albeit with a few exceptions). Furthermore, foundations based on the US model, where private funding is considered part of the basic funding structure of public universities, are uncommon or structurally underdeveloped (Schuyt et al., 2011:4).

In relative terms, funding from federal ministries has grown faster than the basic funding of research in Germany (Braun, 2004; Hinze, 2016). In particular, project-related funding from the Federal Ministry of Education and Research (BMBF) has increased, e.g. to support

specifically promote research in high-tech areas (e.g. via the High-Tech Strategy; see BMBF, 2006; 2014).

Since 2005, the German government has been trying to support and further accelerate investment in research and development through several pacts with major research institutions (Pact for Research and Innovation). By increasing investment in public research institutions, Germany has managed to invest around 3% of GDP together with the private sector (Stifterverband der Deutschen Wissenschaft, 2019). Critics note that the increase in public funding has mainly benefited non-university research institutions, which have been able to access funds more easily (Mayer, 2012). Government efforts were made to channel federal funds into universities and their research landscape. One example of such novel institutional arrangements are mergers between university and non-university research institutions, such as the merger between the state-funded Technical University of Karlsruhe and the Helmholtz Institute Karlsruhe to form the Karlsruhe Institute of Technology (Pruisken, 2012). Such new types of research institutions and mergers not only enable new modes of allocating financial resources, but also new forms of interdisciplinary and transdisciplinary research (Blümel, 2018).

A similar effect on knowledge production was expected from the implementation of the Excellence Initiative, which began in 2006 (Hornbostel et al., 2009). The aim of the initiative is to keep pace internationally and to provide selected universities with additional funding in order to achieve more than is possible with the funds provided by the individual countries. It can be observed that many of the research projects funded by the initiative are interdisciplinary research centres, some of which have little connection to their local faculties and the wider university environment and whose longevity therefore appears to be insufficiently secured.
Furthermore, the Excellence Initiative was criticised for introducing a two-tier society into the German research system (ibid.).

2.3.2 Disciplinary landscape

In terms of epistemic cultures, German researchers are active in all areas of the natural and technical sciences as well as the social sciences and humanities (Stephen & Stahl- schmidt, 2021), but with particularly internationally visible specialisations in chemistry, engineering and some areas of physics (Krull & Meyer-Krahmer, 1996; Powell & Dusdal, 2017). Germany is characterised by a strong disciplinary culture that is supported by established specialist and learned societies, some of which are among the largest in Europe. This strong disciplinary culture is also reflected in the organisational structure of universities, where chairs are relatively autonomous and independent units (Meier, 2009). The names of the

Chairs tend to reflect orientations and trends within the subject areas and disciplines rather than strategic decisions by university management (Krücken & Meier, 2006).

The strong influence of specialised cultures in Germany has created a relatively large and diverse landscape of epistemic styles within the disciplines (Stichweh, 1984). In the humanities and some social sciences in particular, some research fields are closely linked to local infrastructures such as museums, archives and cultural organisations (Wissenschaftsrat, 2006). Similar phenomena exist in the natural and engineering sciences, where proximity to natural phenomena (e.g. the sea), industries or large research infrastructures can also create strong ties to local contexts. For example, close ties to existing industries have led to a more local focus in German automotive engineering (Kaltenbrunner, 2018), which can limit the field's ability to react quickly to international trends and societal demands (e.g. the reorientation from a focus on combustion engines to electric motors).

More recently, however, a stronger trend towards internationalisation can be observed, which affects not only the natural and engineering sciences, but also the humanities and social sciences. This trend is also the reason for homogenisation tendencies within the disciplines with regard to evaluation criteria and publication practices (e.g. away from German-language books towards English-language articles; Engels et al., 2012). This is an international trend that can be observed not only in Germany, but also in other European countries such as Norway, Sweden and Austria. In Germany, however, there is also resistance to this trend against the backdrop of a developing reflexivity about the value of diversity in research. Recently, funding bodies, policy makers and scientific societies have also recognised specific potential for creativity in these rich and diverse epistemic styles.

Due to the strong disciplinary orientation and the role of disciplines in funding, interdisciplinary and transdisciplinary research is more difficult to realise in Germany than in other countries. As early as 1999, the German Research Foundation (DFG) was criticised for not enabling enough interdisciplinary research (Krull, 1999). Since then, new funding instruments such as priority programmes have been developed to overcome these obstacles. Major funding programmes of the Federal Ministry of Research and Education have also established interdisciplinary funding programmes, for example in the health sciences (BMBF, 2010), biotechnology and human-computer interaction (BMBF, 2006). However, the new structures that emerge from these funding programmes often lack long-term institutional anchoring (Woiwode & Froese, 2020). Some institutions have interdisciplinary research programmes with specialised courses, often supported by collaboration with non-university research institutions (Simon et al., 2016). However, there is still a lack of support for more problem-oriented, internationally focused research programmes, such as Cultural Studies, Science & Technology Studies, Gender

Studies, Omics Studies, Neuroscience, etc., which are less institutionalised in Germany and therefore less attractive as career paths.

2.3.3 Career paths

Some aspects of the German career system have already been discussed in section 2.2.3. Career paths in Germany are generally strongly discipline-orientated. Germany is also one of the few countries, along with Austria for example, where a habilitation is still important for an academic career, especially in the social sciences and humanities. Doctoral graduates usually seek academic employment as research assistants at a professorship in order to habilitate and then apply for a full professorship. In order to reduce the dependence of young researchers on the research agenda of professors, funding formats have emerged in recent decades to support independent research during this period, such as the DFG's Emmy Noether Programme or junior professorships. Only recently have tenure-track positions become part of the German career landscape. The impact of these new opportunities on the German career and research system has not yet been sufficiently analysed. However, they are a response to a growing debate in the German research system about the precariousness of academic employment. Recently, the "#IamHanna" movement ("#iamhanna") has drawn public attention to the working conditions of many researchers in Germany. Due to the chair model still prevalent in Germany, researchers often work as postdocs for long periods of time while hoping to qualify for a professorship. Although this is an international problem, it is particularly relevant in Germany, as there are only a few tenure-track positions available and the total number of professorships is low in relation to the high number of short-term researchers employed at each chair. The German Academic Fixed-Term Contract Act is also specific to the German situation: employees at academic institutions are allowed to work for up to twice six years (before and after the doctorate) on the basis of fixed-term contracts (with the exception of fixed-term employment on the basis of third-party funding contracts), whereas employers in other professions are generally only allowed to hire employees for a maximum of two years on a fixed-term basis. As a result, scientists sometimes work in temporary positions for a very long time before leaving academic research.

2.3.4 Evaluation systems

Since the late 1980s, evaluation procedures have become an important part of the institutional framework in German science. However, the procedures and criteria differ considerably between the three main objects of evaluation (Hornbostel, 2016: 250): Individual researchers,

institutions and research systems. Evaluation procedures also differ in terms of the methods used, such as bibliometric analyses, self-reports or peer review panel consultations.

Institutional evaluations are an important part of governance in the sciences (ibid., p. 252), especially for larger organisational units or sometimes even institutes. An important player in the implementation of institutional evaluations in Germany is the German Council of Science and Humanities (WR), which is highly recognised and has a good reputation. It is no coincidence that major reforms and initiatives in science and research systems are also initiated by the WR (Hornbostel & Möller, 2015). As a rule, the members of this body or specially appointed working groups (peer review) evaluate on the basis of a systematic and specified set of criteria and indicators. Due to this credibility, the WR is often asked to evaluate not only institutions, but also funding bodies, research programmes or research systems (e.g. the integration of GDR research institutions; cf. Meske, 1993), whereby the proposals are often largely accepted and usually implemented by the ministry or the state governments.
Some of the non-university research institutions have developed their own evaluation procedures, of which that of the Leibniz Association stands out, as it also appears to be widely accepted in the international community of research evaluation scientists.

In the university sector, for which the federal states are responsible, evaluation is less standardised and organised. Monitoring and reporting are also very different between the individual universities, which leads to major difficulties in comparing activities. A centralised and nationwide evaluation-based funding instrument, comparable to the Research Excellence Framework (REF) in the UK, does not exist in Germany. Rather, the landscape of evaluation procedures is confusing, which has recently led to efforts to define at least some common standards for reporting for universities and research institutions (Biesenbender & Hornbostel, 2016). The extent to which these standards are implemented is left to the federal states and ultimately the individual universities. The effects of evaluations are therefore difficult to assess, partly because evaluations pursue different and sometimes even contradictory goals. Due to this diversity and the lack of coordination, institutional evaluations in Germany have direct control effects at the level of the respective organisation, but little effect on the research system as a whole. However, effects can be observed at the level of individual performance assessment for funding programmes such as scholarships, fellowships or junior research group leader positions (Neufeld et al., 2013).

The newly established types of professorships (junior professorships and tenure-track professorships) are evaluated much more regularly in Germany than traditional professorships (Zimmer, 2018). To summarise, it can be said that evaluations are an integral part of the German academic system, as in other Western countries, but have so far been characterised by relatively little coordination and possibly also comparatively less systematic effects on publication strategies and other aspects.

scientific activities than has been described for countries such as the UK or Australia.

2.3.5 **Summary**

Based on these considerations, the German research system can be described as a system with the following characteristics:

- a highly diversified, adequately funded research landscape with a large number of intermediary organisations;
- a highly developed university research landscape and a non-university research sector that is large and influential by international standards;
- Dominance of disciplinary cultures, which affect funding and career structures, and a less developed interdisciplinary research landscape;
- attractive research conditions in terms of infrastructure and funding opportunities, However, difficult and unclear career paths despite recent attempts to overcome these deficits;
- No overarching evaluation framework for all research institutions; comparatively low systematic control effects of evaluation measures.

3 Methodological approach of the study

The exploratory study had a duration of twelve months. In order to achieve results that could lead to recommendations within this period, a methodological approach was chosen that involved a broad spectrum of actors in the discussion and analysis on the one hand, and allowed for focused, in-depth field analyses on the other. After an in-depth analysis of the research literature relevant to the study at the beginning of the year, the following research activities were carried out for this purpose in 2022:

i. Two discussion events at which different actors in the German science system - from young researchers and established scientists to actors in research funding and science policy - discussed their perceptions of research cultures in Germany.

ii. Four qualitative case studies in which interviews and focus groups were used to analyse the research cultures in four fields in the social sciences, humanities, natural sciences and technology in Germany and to specifically identify differences.

iii. Interviews and workshops with national and international experts in science and technology research and science policy studies, in which current challenges for life and work in science were discussed internationally and in Germany and interim results of the project were presented.

The two events - digital in Hanover in April 2022 and hybrid in Leipzig in July 2022 - were each organised in cooperation with the local universities. The invitations to the events were both targeted and broad, i.e. relevant stakeholders from science, research funding and science policy were explicitly addressed and the event announcement was widely distributed via relevant social networks. The first event served to discuss the current state of research and to analyse different dimensions that should be considered and addressed in the context of research cultures. The second event attempted to take a closer look at disciplinary similarities and differences. The discussion followed keynote speeches on research culture(s) in the fields of literary studies, process engineering and psychology in order to contrast field-specific characteristics and challenges of disciplines that could not be covered by the case studies and interviews.

The four case studies addressed research fields that were expected to have significant differences in their research cultures. Sociology, environmental humanities, research into artificial intelligence and synthetic biology were selected. The research fields each represent sub-areas of the social sciences, humanities, natural sciences and technical sciences and also differ in a number of relevant dimensions (see Table 1).

Table 1: Similarities and differences between the research fields of the case studies

Research field	**Research area**	**Orientation towards a guiding discipline**	**Specialist labour market**	**Dependent on technical infra-structures**	**Inter- national orientation**	**Understanding science: reflexive or positivist**
Sociology	Social science	high	Weak	low	low	reflexive
Environmental Humanities	Humanities	low	Very weak	low	Very high	reflexive
Artificial intelligence	Technical science	medium	very strong	medium	high	positivist
Synthetic biology	Natural science	low	medium	high	Very high	positivist

In the life sciences and qualitative sociology, two institutes at different locations in Germany were analysed, while in the environmental humanities and AI, one research hub each was highly relevant to the overall landscape in Germany. In the selection process, attention was paid to a balanced relationship between theory-based, experimental, basic and application-oriented science across the disciplines, as well as to different location conditions (e.g. new/old federal states) and organisational forms (university, non-university research).

Despite the short time window for the empirical research, it was possible to conduct interviews with a total of 37 established researchers and other leaders in the fields, as well as interviews with a total of 29 early career researchers. Interviews and focus groups were conducted in a semi-structured manner and aimed to openly discuss the researchers' perceptions of research cultures in their fields with as little input as possible from the interviewer/moderator. For this reason, topics that the interview should touch on were roughly defined in advance - such as perspectives on research funding, evaluation, career paths, originality, (inter)disciplinarity, gender and diversity, etc. - but no detailed catalogue of questions was worked through in the interview situation so that the scientists could each give space to the perspectives from their field. This also minimised any normative influence as far as possible. All data from the interviews and focus groups were recorded, transcribed and analysed using qualitative content analysis. The researchers interviewed were promised strict anonymisation: all quotes and other results were therefore anonymised so that no conclusions could be drawn about the person or the institution.

The interviews with national and international experts in science and technology research and science policy studies were also conducted in a semi-structured manner and were based on the researchers' areas of specialisation. These interviews served to validate the literature analysis and identify research strands that had not yet been considered.

At the first workshop with international experts in March 2022, the design of the study was presented, discussed and refined. At the second expert workshop in October 2022, the initial results of the analysis were presented and relevant dimensions of the analysis were discussed.

A synopsis of the various types of material provides an important snapshot of research cultures in Germany, which can form the basis for new courses of action in science policy and research funding.

4 Analyses of empirical research

In this section we present the results of our empirical analyses. The section is divided into two subsections. In section 4.1, we present the results of the case studies in four fields - sociology, environmental humanities, artificial intelligence and synthetic biology. In section 4.2 we will then discuss subject-specific and interdisciplinary challenges for research cultures in Germany.

The brief summaries of the case studies in section 4.1 focus on outlining the central characteristics of the research cultures of the fields analysed. With the help of these brief summaries, we want to convey a picture of what the analysis of the interviews, focus groups and discussions with researchers in the four fields revealed in terms of characteristic features that characterise working, thinking and living in these fields. We discuss the following particularly relevant dimensions for each case study: researchers' academic self-image; definitions of originality and quality; the relationship between disciplinarity and interdisciplinarity, basic and applied orientation, teaching and research, and national and international orientation; particularities of publication cultures and third-party funding; and the perception of employment opportunities and conditions for young researchers in the field.

These dimensions are discussed in different sequences in the following brief summaries, as they are interwoven differently in the various fields and a coherent summary is to be created for each field. The summaries are deliberately kept brief and are primarily intended to serve as a background for the analyses of the challenges in chapter 4.2. We deliberately omit a discussion of the following dimensions from the summaries: Gender and diversity, social responsibility and organisational embedding of the fields. These are particularly articulated as challenges and are therefore discussed in chapter 4.2.

Chapter 4.2 then takes an interdisciplinary perspective and discusses challenges for research cultures in Germany with regard to the development of scientific institutions, scientific communities and research funding.

4.1 Presentation of the case studies

4.1.1 Sociology

It became evident from the sociology case study that the respondents consider their discipline to be a significant authority on society in terms of critical analysis and reflection. Sociology should contribute to a better understanding of society as such.

to understand, visualise grievances and outline spaces for intervention. According to the interviewees, in order to fulfil this role, it is crucial that sociology has a self-reflective understanding through which researchers reflect on their own integration into social contexts. This critical attitude also characterises social interaction and forms of communication within the discipline. Furthermore, from the perspective of the interviewees, sociological research not only wants to and should make a contribution to science, but also to society. Ideally, researchers should therefore also be "public intellectuals".

In this sense, "originality" and "quality of research" in sociology are measured in two ways: firstly in relation to the methods and theories used, and secondly in relation to the object of research. As a field of research with a constructivist perspective on knowledge - i.e. a perspective that assumes that knowledge is constructed in social processes depending on the methods and theories used instead of simply depicting objects and processes neutrally - theory and a reflexive approach to methods are of great importance. Many different theoretical and methodological schools exist in sociology, which sometimes leads to strong divisions in the field (e.g. between quantitatively and qualitatively orientated researchers, but also within quantitative and qualitative traditions).[3] In this sense, quality is often defined within relatively small epistemic groups and is disputed between these groups. The same applies to definitions of originality, which can be expressed through theoretical or methodological innovations and through the exploration of new research topics with known methods. Both quality and originality are also partly defined - in contrast to the other three fields analysed here - within national research contexts, as publications in the national language are still accepted and respected in Germany, but also in other national contexts (e.g. France, Scandinavia). Books play an important role in the publication culture of the field. Metrics such as publication numbers and other indices are perceived as inappropriate tools for quality evaluations - reading publications takes centre stage.

It is important to note that all interviewees define themselves as sociologists, i.e. they clearly feel that they belong to a discipline. In contrast to the other three fields analysed, disciplinary affiliation - not a common research subject - is the central object of identification for the interviewees. Most of the research also takes place in institutes and departments that are labelled as "sociological".

Although the majority of respondents perceive the results of sociological research to be directly relevant to social debates and issues, and individual institutes and sub-disciplines are very successful in commissioned research, sociology still sees itself as a discipline that is not directly relevant to society.

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[3] The case studies analysed involved both a unit with a more theoretical, qualitative focus and a unit with strong roots on both sides.

as a basic research area and concrete applications tend to take a back seat. In the area of research funding, this means that research funders with a basic research portfolio are of particular interest. The sociologists surveyed are experienced in acquiring third-party funding from national and, in some cases, European sources.

Interdisciplinarity plays a minor role in sociology: although the sociologists surveyed are used to working together with other social sciences and humanities in multidisciplinary collaborations, interdisciplinary practices in which the focus of their own work could move outside of sociology are not common.

Teaching and research are generally well connected in sociology: Research staff have access to teaching and contribute to the methodological and theoretical training as well as to the content-related development of students (e.g. through seminars that are thematically close to research projects).

The degree of internationalisation of researchers in sociology in Germany appears to be low, which also has to do with the existing importance of German as a research language. This also makes it difficult for the few international researchers in sociology to gain a foothold in Germany in the long term.

The sociologists surveyed are critical of the labour market for academics: the field is not perceived as a growth area, as the relevance of sociological research for social issues and change is not perceived politically enough. The researchers are therefore aware that only a few of them will be able to stay in research in the long term. While there are clear ideas that methodological expertise can also be used in the private sector, e.g. in market and public research, it is unclear where the acquired skills for critical reflection on social conditions, which are central to the self-image of many researchers, could be usefully applied outside of academia.

4.1.2 Environmental Humanities

The environmental humanities are also defined by a contribution that is both scientific and social in nature. The interdisciplinary field of research is held together by a common object of research: the environment and current environmental crises, such as climate change and the loss of biodiversity. The Environmental Humanities aim to add a social science and humanities perspective to the natural and technical science approach to these crises, which the field believes is absolutely necessary in order to overcome these socio-ecological challenges in a sustainable way. Theoretically and methodologically, the field is pluralistic: Researchers from the social sciences and humanities

Fields such as history, philosophy, anthropology, sociology or linguistics come together to better understand human-environment relationships and to develop new concepts and approaches to problem areas. In this sense, the various methods and theories are in a synergistic relationship rather than in competition with each other. Many researchers do not have a clear disciplinary identity, but rather see themselves as fluid researchers in the interdisciplinary field of environmental humanities.

Similar to sociology, the environmental humanities have a more reflexive and social constructivist approach to theories and methods. They try to incorporate this understanding into their collaboration with the natural and technical sciences, with which they sometimes jointly address environmental topics in multi-, inter- or transdisciplinary projects. However, this often leads to tensions with the thoroughly positivistic understanding of science in many natural and technical sciences. At the same time, the interviewees report that the value of contributions from the social sciences or humanities to overcoming environmental crises is often called into question in these collaborations. This limits the possibilities of collaborations with the natural and technical sciences.

Against the backdrop of these restrictions, the still strongly discipline-orientated university landscape in the social sciences and humanities weighs heavily on the environmental humanities. Researchers fear that only recourse to a disciplinary anchoring can lead to a long-term academic career (e.g. in the subfield of environmental history, environmental sociology, etc.). This, in turn, is in tension with the definitions of quality and originality in the field, which are consistently characterised by an appreciation of scientific innovation across disciplines. The theoretical debate - certainly with theories from different fields of research - is an important aspect of scientific quality in the environmental humanities. Due to the interdisciplinary orientation and methodological plurality, ideas of methodological quality are more flexible than, for example, in sociology, which is characterised by a disciplinary focus; methodological innovation, e.g. through the combination of methods from different fields, is desirable.

In general, research in the environmental humanities is more internationally oriented than in many other social science and humanities fields in Germany, which is also reflected in the fact that research in this field in Germany often takes place in internationally recognised interdisciplinary research centres rather than in university institutes. However, this has an impact on career opportunities in the field, as interdisciplinary research centres usually cannot offer long-term career prospects. At the same time, researchers in these centres are often only marginally integrated into teaching, which firstly means that the new research content of environmental humanities is only accessible to students to a limited extent, and secondly that young international researchers in particular are denied access to teaching experience.

Similar to sociology, book publications continue to play a major role in the environmental humanities, although these are primarily English-language books published by international publishers; journal publications are also very important. Although the environmental humanities see themselves as part of a response to current environmental crises, they are nevertheless more strongly orientated towards basic research funding in the area of third-party funding. German research funders with an interest in environmental topics play just as much of a role here as funders who are particularly focussed on basic research.
European research funding also plays an important role, both in the Horizon 2020 programme and through the ERC. As there are few established institutes and chairs, the field is heavily dependent on third-party funding.

Representatives of this field are critical of the labour market for academics: there are few long-term positions within academia and unclear perspectives on how the knowledge gained can be used outside of academia. The fact that international researchers often find it very difficult to gain a long-term foothold in Germany is seen as particularly critical because, with a few exceptions such as the environmental humanities, the German social sciences and humanities continue to be strongly nationally orientated. International researchers would lack the necessary expertise and networks to pursue a career in Germany, despite their high achievements.

4.1.3 Artificial intelligence (AI)

The research field of AI is both a dynamically developing and an established field of research within the computer sciences. Breakthroughs within AI are predicted to be cyclical and are always accompanied by an upswing in the field and its social visibility, followed by so-called "AI winters" in which research in the field continues but receives less attention. Recent innovations in the field of machine learning have led to a strong upswing in the field over the last two decades. AI researchers see their contribution as being located on two scientific levels: firstly, in the further development of AI algorithms, i.e. in the area of innovations within computer science, and secondly, in the application of existing algorithms in other, broadly diversified fields of research. Social impact is primarily seen as an effect of this second level, for example when AI contributes to solving problems and developing new applications in fields such as medicine, environmental science or risk assessment.

Researchers in AI have scientific backgrounds in computer science or related fields such as mathematics or physics. AI researchers often specialise along the two levels mentioned above in those who develop AI algorithms within computer science.

The two groups are characterised by the further development of algorithms and those that primarily use existing algorithms to solve problems in other fields. Originality within AI is primarily attributed to the further development of algorithms, whereas the application of AI is often seen as innovation in and for the respective fields of application. Quality terms vary in this sense and range from the further development of algorithms to the thematically appropriate use of existing algorithms.

In addition to journal publications, conference proceedings also play an important role in the publication culture of AI. Due to the current AI boom and the high demand from other fields, the majority of researchers in AI work in the field of application, which makes the innovative further development of algorithms a smaller and elitist field. In principle, established researchers believe that the quality of academic AI research is jeopardised by the high number of AI companies - it is not necessarily the best researchers who remain in science.

AI as a field is highly internationally orientated; there are no national schools or nationally varying concepts of quality. Research funding for AI research is available from a wide variety of sources, with an overhang in the direction of application-oriented research.

The integration of younger AI researchers into teaching is limited: Usually, only those researchers who hold corresponding university positions teach, whereas teaching activities are not very attractive for project-funded researchers, as they are hardly career-relevant.

4.1.4 Synthetic biology

Synthetic biology is a subfield of the life sciences that can be seen as paradigmatic for the modern life sciences in various respects. The field is interdisciplinary in its orientation - molecular biologists, biochemists, biophysicists, material scientists and data scientists work together in this field. The common goal is the de novo synthesis of molecular building blocks, cells or organisms. The research is therefore organised around a common research object that is highly specific (in contrast to the broad common research object of the environment in the environmental humanities), but is researched using very different methodological approaches. Researchers with different backgrounds work together to synthesise these new building blocks of life or to learn more about the origin of biological life in the process of constructing these building blocks. The self-image of researchers in this field varies greatly: while some research is focussed on scientific breakthroughs such as the construction of a minimal cell, other contributions are more socially oriented.

needs such as the development of vaccines (e.g. malaria) or tackling ecological problems. Despite minor successes, applications tend to be discussed in review articles or project proposals, but are located in the more distant future. In this sense, originality and quality are defined by multidisciplinary steps towards the synthesis of organisms - similar to the development of prototypes in the engineering sciences. The reproducibility of results by other laboratories plays a major role in the understanding of quality. Methodological developments play a role insofar as they enable new synthesis steps; they are often linked to the use of new technologies or their further development and are often interdisciplinary in nature.

Synthetic biology has a strong international focus; international competition between laboratories is high. Like a growing number of life science fields, the field is strongly technology-driven and data-intensive. As a result, national and international data infrastructures are playing an increasingly important role in the field, making the role of data scientists in synthetic biology - e.g. as a field of application for AI - more relevant.

In terms of attracting third-party funding, synthetic biology ranges from basic research-orientated to application-orientated, with the latter focusing more on steps towards possible applications rather than concrete applications. As in almost all areas of the life sciences, competition for third-party funding and publications is very high. Success is strongly measured by publications in certain journals with a high impact factor. The career pressure among young scientists is also high, although the assessment of career prospects outside of science varies greatly depending on the person's specific scientific background (e.g. there are fewer opportunities for molecular biologists to work outside of science close to their training than for data scientists).

Similar to AI research, the integration of younger synthetic biologists into teaching is limited: Usually, only those researchers who hold corresponding university positions teach, whereas teaching activities are not very attractive for project-funded researchers, as they are hardly career-relevant. However, regardless of their form of funding, young researchers contribute significantly to the supervision of master's and doctoral students, and sometimes also to practical courses.

4.2 Challenges for research cultures in Germany

In the following section, we analyse the challenges for academic work in the academic cultures examined, which arise from the specific conditions in the German academic system (organisation of universities and non-university research institutions, research funding landscape, values practised within (research) organisations, and the specific conditions in Germany).

scientific communities, labour law, cultural specifics). The following chapter is divided into three parts: (1) challenges for the organisational development of scientific institutions, (2) challenges for scientific communities, i.e., challenges that
(3) challenges for research funding organisations. Due to the organisation of science, in which scientists also hold numerous leading positions in research and research funding organisations, these areas overlap. However, this subdivision allows the main addressees for change to be identified more clearly. In addition to the findings of the case studies, this chapter also incorporates the results of the public events, the expert workshops and the expert interviews.

4.2.1 Challenges for the organisational development of universities and non-university research institutions

Four central challenges are discussed in this chapter: The embedding of externally funded projects in the respective organisation, the possibility of forming semi-stable research teams, the need to anchor heterogeneous job profiles at research institutions, and an increased service orientation in administration.

4.2.2 The organisational embedding of third-party funded projects

The importance of third-party funding for the financing of science has increased over the past decade in all the case studies analysed in depth, but also in the case of all the disciplines examined as part of the events carried out. The researchers in all four of the project's case studies were active and successful in acquiring third-party funding, regardless of their discipline.
The participants in the events also repeatedly emphasised the importance of third-party funding for their academic work. This speaks in favour of the heterogeneity of the German research funding landscape and a mixture of open-topic and topic-focused funding opportunities. In this context, all interviewees emphasised the importance of being able to use open-topic funding formats (e.g. DFG research grants) to provide their own impetus and further develop their discipline beyond scientific trends and political agendas.

At the same time, however, all interviewees described the relationship between externally funded projects and their anchoring in the respective university or non-university research institution as problematic, especially when it comes to universities (wiss_Prof_Soziologie_5) (wiss_Prof_Sozio- logie_8). Although organisations would encourage the acquisition of third-party funding, they only provide limited structures that ensure the smooth embedding of third-party funded projects in the organisation.

Firstly, third-party funded projects are associated with high administrative and organisational costs, which are currently borne to an undue extent by the researchers themselves at many institutions. As a result, scientists are entrusted with tasks for which they are not trained (e.g. in the financial management of projects) and the intellectual capacities of scientists are tied up with administrative tasks. Particularly successful academics are sometimes able to negotiate additional administrative positions with their institutions due to their high level of third-party funding. However, this does not change the fact that, from the researchers' perspective, there is often a lack of continuous support, especially in the handling of externally funded projects (wiss_Prof_Soziologie_8).

Secondly, due to the consistently relatively low basic funding per full-time equivalent of researchers in German scientific institutions and the low return of overheads to the research groups/professorships, there are often too few financial resources to cover those costs that cannot be financed by third-party funds. Third-party funded research groups/professorships therefore often find themselves in a situation where the basic budget is limited when it comes to financing computers and other research equipment that is not paid for by third-party funding. In addition, the procurement processes, e.g. for equipment, are so lengthy in some institutions that they do not fit in well with the faster timelines of externally funded projects. At the same time, there are often no funds or personnel available after the end of the project to continue looking after and maintaining equipment and databases: technologies therefore sometimes remain unused in the long term.[4] The need to call up basic funding on an annual basis is also not commensurate with the acquisition of third-party funding: If research groups/professorships are able to cover large parts of their costs with third-party funding in some years, they are often deprived of unspent funds, which penalises good housekeeping.

Thirdly, universities and other institutions lack mechanisms to protect research units against the volatile nature of third-party funding. On the one hand, there is often a lack of "start-up" funding to develop the basis for project applications; furthermore, and even more importantly, there is a lack of bridging funding to continue research in the event of project rejections.[5] Ultimately, this leads to researchers continuously submitting more project applications than they can meaningfully work on projects in order to avoid the risk of having no or too little funding for research. This also leads to an overload of research funding organisations, which receive an ever-increasing number of project applications that are less and less likely to be funded. It also leads to an overload of renowned scientists, who are increasingly asked to review projects and, if applications are successful, often too many projects per research group / professorship.

[4] "So the devices are there, but the people who should have the expertise, who should use them and introduce them, there is a lack of them." (wiss_Gruppenleiter_Life Sciences_5)

[5] in the case of one institution surveyed, a small part of the basic budget has recently been used to grant potential externally funded employees three-month salary stipends and coaching during the application phase for personalised academic funding. Even if the employment relationship is terminated after an unsuccessful application, networking opportunities and the institution's email account can continue to be used for a limited period (leit_Prof_Soziologie_1).

In many cases, this leads to a decline in the quality of supervision for doctoral students and postdocs and creates unrealistic standards for how many projects a group leader/professorship can reasonably lead. In many cases, this reduces the quality of supervision for doctoral students and postdocs and creates unrealistic standards for how many projects a group leader/professorship can reasonably manage. At German universities, this is exacerbated by the fact that professors hardly ever receive a reduction in their teaching obligations for leading externally funded projects, even though individual funding programmes now subsidise the costs of replacing professors. This often leads to overburdened professors having their teaching unofficially carried out by staff in order to be able to cope with the multitude of tasks they have to fulfil. This in turn leads to a deterioration in the working conditions of junior academics.

4.2.3 The (im)possibility of forming semi-stable teams

The inadequate organisational embedding of third-party funded projects also results in problems at the level of division of labour and team formation in research groups. As is clear from the above analyses, the risks of acquiring third-party funding are currently almost entirely outsourced to the individual research groups and professorships, which attempt to create a stable research environment by over-acquiring third-party funding. The lack of institutional willingness to take on risk is most evident at the team level. Institutions currently do not provide funds to systematically finance transitions between project appointments. They are also unwilling to issue open-ended contracts, even if the employees concerned are employed in research groups/professorships with a high level of third-party funding and experience, where there is a high probability that new third-party funding will be acquired regularly (wiss_Prof._Life_Sciences_8). Since this risk would have to be borne individually by group leaders/professors, de facto no fixed-term contracts are issued for researchers who are financed by third-party funding. This means a constant loss of experienced researchers, combined with the need to constantly recruit new people for the research organisation, mostly doctoral students (wiss_Prof_Life_Sciences_2). This tends to lead to inefficient research practices, as knowledge and expertise is continuously lost, and makes it difficult to divide work or build up substantive, theoretical or methodological specialisations and long-term research agendas within research groups; it also contributes to the existing imbalance between experienced and trainee scientists in many groups. Where scientific work by individual scientists and thus also the spreading or shifting of risk is more conceivable, e.g. in the field of theoretical rather than experimental science, this also tends to slow down the division of labour, the exploitation of synergies and the implementation of longer-term and larger projects. Some of the interviewees at universities therefore stated that the establishment of research institutes

to retain particularly competent academics.[6] In extreme cases, professors have individually assumed the risk of issuing open-ended employment contracts. Neither option can be seen as a sensible solution for working at academic institutions: Here, institutions are called upon to share the risk that comes with increasingly externally funded research and to enable the formation of semi-stable teams. Semi-stable teams are research groups in which there is a sufficient number of long-term employees to (1) keep knowledge loss relatively low, (2) enable specialisation in terms of content, methodology or theory and (3) create a sensible ratio of experienced and trainee researchers that enables high-quality supervision. The interviewees in the study, both at management and staff level, cited the current impossibility of training such semi-stable working groups as the biggest obstacle to efficient and high-quality research, regardless of their field of work. In addition, they also see the current situation as the main reason why more and more excellent researchers no longer want to work in academic science under these conditions, but are looking for (and finding) alternatives. In the technical disciplines, such as AI, but also in civil engineering (event contribution), this is already leading to a shortage of suitably qualified workers. Calls for proposals often have to be repeated and scientists often leave the working group before the end of the project because the future prospects are uncertain.[7] This leads to considerable additional work for group leaders/professors and to difficulties in maintaining the quality of research.

4.2.3.1 The need for heterogeneous career paths in academic organisations

There is currently a lack of specialisation opportunities within research groups and within larger units in academic institutions. This is all the more surprising as the number of different scientific tasks that academic institutions, and thus their employees, have to cope with is growing at the same time.

At present, long-term careers in academic research are almost exclusively possible via the professorship route. Professors today are expected to be all-rounders: excellent in research, excellent in teaching, talented in science communication and transfer, diligent supervisors and mentors, science managers with large, externally funded groups

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[6] "We try to support people who are already at the company and have proven themselves in the projects so that they can perhaps continue working in other projects and the like. So we try to ensure that career paths are as seamless as possible and to promote this." (leit_Prof_Soziologie_1)

[7] "[It is] rather the standard [in the natural sciences] that you switch to industry because the paths at university are also so uncertain and at some point you also want to have a good employer who also offers you prospects and not just always these fixed-term research grants and then you don't know whether you will find a job again after two years or have to move." (wiss_Praedoc_Life Sciences_6)

and involved in academic self-administration. This job description is increasingly perceived as unrealistic. Young academics experience how overburdened professors are - also because they rarely have an established team to fall back on - and how both their quality of life and work suffers from this overload and they often have little time to be intellectually active themselves.[8] The job profile and goal of "professor" is thus becoming increasingly unattractive, especially in areas where there is a strong labour market and good earning opportunities outside academia. At the same time, young academics surveyed across the disciplines emphasise that it is extremely strange and unattractive that it is only possible to remain in academia via a professorship - academia as a regular profession would virtually not exist as a result (wiss_Postdoc_Soziologie_7).

Both established academics and early career researchers see the introduction of heterogeneous career paths in academic institutions - combined with other changes - as a way to ease the burden and make science more attractive as a profession again (wiss_Postdoc_Soziologie_5). There is strong demand for the position of senior researcher, i.e. a long-term research position that does not also include a management position, possibly combined with certain methodological specialisations, special tasks in research management, science communication or interdisciplinary collaboration (wiss_Geschäftsführung_10).[9] In the life sciences and technical disciplines, there is a high demand for scientists who manage research infrastructures, equipment and databases and work together with researchers from various fields to use these technologies for research.[10] These tasks require a great deal of scientific expertise and in this sense cannot be carried out by auxiliary staff. They can also only be partially centralised, as they require an understanding of the specific research content of a department (wiss_Group Leader_Life_Sciences_2). Career opportunities in teaching are also in demand: many young academics find it incomprehensible why there are no opportunities to pursue a career focussing on innovative teaching and degree programme development at institutions whose main tasks include teaching (wiss_Postdoc_Soziologie_7). Overall, it can be stated that

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[8] "The professorial privilege and academic self-administration are not features that distinguish Germany positively. This system consumes resources of people who could have been more productive." (verw_Science Manager_AI_12)

[9] One institute in our case studies reports a very successful reorganisation in this direction: "In comparison, the administrative apparatus was much larger than the scientific apparatus. Now the basic budget (...) has been increased and we now have four posts (...). So three people have been hired and they all have one functional task each - public relations, publications and events (...) and are also academically active at the same time. This enables to communicate the content of the museum to the outside world."

[10] The experience from a case study is positive here, where there are well-trained, long-term technology experts who work together with researchers from different fields of work: "There are also experts in the core facility. Especially people who have a lot of technical experience and different microscopy techniques and how to approach certain issues. And for more complex problems, you go there and say, okay, how can we solve this problem? Is there a sensible approach to solving it? Do you have an idea? And then appropriate projects are developed together with the core facility and then implemented jointly." (wiss_Managing Director_Life_Sciences_8)

although academic institutions recognise that they are being given a variety of new tasks, these are currently being added to the role of the professorship as "add-ons" (quote from the event in Hanover). It would make more sense to have structural personnel planning that provides for heterogeneous academic roles and offers long-term academic careers and development opportunities in these different roles. This could relieve the burden on the professorship job profile and keep it viable for the future, as well as create attractive role models for excellent academics who do not want to take the professorship route. To ensure that this type of "specialisation" is also attractive for academics, the different roles and associated tasks should also be given appropriate recognition in the German academic system and not be seen as "second best" (see section 4.2.4.4).

Another way to promote heterogeneity in academic organisations would be to consistently pursue the course away from the chair model towards the Anglo-Saxon/Scandinavian faculty model, which some German universities are already pursuing. Our case studies clearly show that too few professors are responsible for too many tasks in Germany, regardless of the discipline in question. The pressure to constantly acquire third-party funding sometimes results in research groups that are too large, in which regular academic exchange with and good supervision by professors is no longer possible. At the same time, professors are required to fulfil a variety of other tasks outside of their research units, such as in academic self-administration, peer reviews or various committees, advisory boards and specialist societies. Too much work rests on too few shoulders. Researchers who have experienced the faculty model with more professors and smaller working groups in the USA, for example, report much better supervision situations than in Germany and, above all, that the professors themselves had more time to conduct research.[11] It should be noted that questions of funding cannot be ignored here and that, at least at public universities, no tuition fees are charged. In this sense, a model of the future could be a department with a larger number of professors, with smaller working groups, as well as a number of specialised scientists who take on long-term tasks in teaching, research, communication and technical infrastructures and work together with the various working groups.

As a final point, it should be noted that the tenure track as a path to professorship was supported by all interviewees - although it was repeatedly emphasised that the tenure track is not a panacea for the problems of the German academic system and that at the same time there is an urgent need to establish career paths beyond the professorship (wiss_Prof_Soziologie_5).

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[11] "Sometimes I would like to see more Americanisation. [...] The structures in Germany are simply too big. More professorships that supervise fewer large groups and thus improve the conditions." (wiss_Gruppenleiter_Life Sciences_2)

4.2.3.2 **Increased service orientation in administration**

The majority of the researchers surveyed feel insufficiently supported by the administration of their institutions. Many managers have the impression that they have to be overly involved in non-scientific tasks to ensure that these are implemented correctly (wiss_Prof_Soziologie_2; wiss_Prof_Soziologie_5; wiss_Prof_Soziologie_8). A common example is the recruitment process for researchers from outside the EU. Such processes can take a very long time and often require intensive dialogue with the relevant authorities. There is often no one in the central administrative departments who is willing to do this work, and group leaders/professors have to follow up themselves to ensure that the processes are successful. Overall, many researchers experience that non-scientific problems cannot be passed on to the administration and solutions cannot be expected. Interviewees who work at universities repeatedly express the impression that administrations do not see themselves as service centres for researchers, who take on concerns and deal with them independently, but would often rather see themselves in a controlling role towards researchers.[12]

At the same time, administrative units often appear to be understaffed and/or underperforming, especially at universities: Researchers report very long waiting times, even for urgent enquiries (e.g. legal questions in the context of project initiation), or a complete lack of answers. There is also a high turnover of staff in many administrative offices and new staff often do not appear to be sufficiently familiarised, which means that working relationships have to be rebuilt again and again. Many researchers are aware that this is also due to the salary level and limited promotion opportunities for administrative staff in academic institutions (verw_Soziologie_7). Especially in cities with a high cost of living such as Munich, Berlin, Hamburg or Frankfurt, this means that universities and state research institutions are unattractive employers. This applies in particular to areas with a high proportion of female staff, such as general administrative activities or personnel administration, where there are often strict limits on the categorisation of activities, although the tasks are becoming increasingly extensive and, for example, English language skills are required in practice even at the lowest salary level. Efforts are being made to raise salary levels in more male-dominated areas, such as IT, which have previously also been poorly paid in comparison to the private sector. This could further exacerbate the already problematic salary distribution between the sexes in academic institutions.

Another frequently mentioned point in relation to administrative processes is the lack of digitalisation of the administration. It is generally known that Germany tends to lag behind in the digitalisation of

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[12] "Administrations see themselves less as service providers for science than as service providers under the leadership of the administration." (wiss_Prof_Sociology_8)

public institutions internationally. At German universities, this applies in particular to administration. Many work processes that could be significantly simplified by digitalisation - from travel management to personnel procedures - are still processed in Germany using paper files and tie up the working time of both academic staff and administration. A professionally organised digitalisation of these processes is desirable.

4.2.4 Challenges for the further development of research communities

In this section, we summarise challenges that primarily concern the values in scientific communities. These challenges inevitably overlap with the need to further develop scientific institutions and/or research funding. What they have in common, however, is that these changes are most likely to be achieved through changes in the values of scientific communities. In this section, we will discuss nine central challenges: Science as a profession, not a vocation; gender and diversity; scientific leadership; cultures of evaluation; societal relevance; Inter-)disciplinarity; (inter-)nationality; open science; and the relationship between teaching and research.

4.2.4.1 Science as a profession, not a vocation

Across all research fields and disciplines that we have analysed, there is a difference in the understanding of science between the generations. While researchers of the older generation see science as a vocation - i.e. as a completely engaging life task that defines the person's identity - younger researchers increasingly desire to be able to pursue science as a profession, under working conditions that are similar to those of other professions.[13] Interviews and events reveal a normative resistance among currently established scientists to pay attention to the idea of "science as a profession, not a vocation". The myth that excellent science can only be achieved through complete dedication to the work persists. Difficult working conditions are normatively reinterpreted here as a selection criterion for those who "nevertheless" prevail. In reality, however, selection is not only based on talent, but on people who are able to successfully navigate the system for long enough due to a variety of attributes (social fit, socio-economic resources, values). This has a significant impact on the reproduction of the scientific system and its diversity.

[13] While this could primarily be interpreted as a difference in the value orientations of generations, a look at the careers of the older generation in our case studies also shows that many biographies were characterised by significantly simpler working conditions (e.g., permanent employment relatively early in the career, multiple job offers).

4.2.4.2 **Gender and diversity**

Social mobility in Germany is still weak and even declined after reunification (Pollak R. 2004) and in the first years after the millennium.[14] The academic strata reproduce themselves to a considerable extent and the advancement of women into academic leadership positions continues to be slow.[15] Broad concepts of diversity, which also include somatic features (e.g. skin colour), sexual orientation, religion or gender, have hardly arrived in Germany. In short, although frequently invoked, issues of gender and diversity in German academia still tend to be handled with little competence and dynamism, apart from a few universities and research institutions that are particularly active and can demonstrate success, especially when the senior management is involved in this field. This has a lot to do with the fact that it is often not recognised that a comprehensive change in values must be carried out and implemented in order to move towards a more inclusive science.

Firstly, the above-mentioned transition from science as a vocation to science as a profession is necessary for the systematic inclusion of socially disadvantaged groups. Our case studies and events show a significant awareness among younger generations in all fields of the barriers that this myth creates, some awareness among established scientists in reflexive science fields[16] and little awareness among established scientists in technical and scientific disciplines. It is evident in the lack of knowledge and awareness among scientific leaders about the barriers and pathways to inclusion. While one institute in our case studies has very actively discussed the topic of equality in science and has developed a detailed, multidimensional guideline for inclusion and diversity in a bottom-up process[17] , diversity in the natural and technical sciences is often still seen firstly as synonymous with gender and secondly as a question of motherhood (e.g. pregnancy and childcare). Cultural dimensions of discrimination and exclusion through working conditions - of women and other socially disadvantaged groups - are rarely discussed. There is also little awareness of the fact that the implementation of the equality plans that are now being pushed forward

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[14] https://www.bpb.de/kurz-knapp/zahlen-und-fakten/datenreport-2021/sozialstruktur-und-soziale-lagen/330070/social-mobility/

[15] https://www.forschung-und-lehre.de/management/maenner-leiten-drei-viertel-der-deutschen-universitaeten-1486

[16] "It is easier for immigrants to get into traditional professions such as law, engineering and medicine, but it is much more difficult to get into the humanities and social sciences - you have to come from the upper middle class." (wiss_Postdoc_Sociology_5)

[17] "We have a 'mission statement' at the centre which covers everything, every element of diversity including things like who puts stuff in the dishwasher or linguistic diversity, making allowances for people working the languages that are not their first language. It's a cultural norm which you can try and unpick and rethink. So, this is all in the diversity statement with non-harassment and all the rest of it. We tried to put every little thing in it when we wrote it." (wiss_Postdoc_Environmental Humanities_14)

expertise is necessary, i.e. the reform of institutions and processes requires the involvement of people with specific training in the field of gender and diversity.

Questions of gender and diversity at the level of research content are also hardly discussed, except in a few fields. The increasing requirements to address gender and diversity in research proposals are primarily understood as promising the compatibility of family and career for female researchers. Interviewees reported that in large-scale proposals, such as DFG SFBs, the "gender topic" is often assigned to younger female researchers without specific subject expertise because no one else wants to deal with it (wiss_Postdoc_Soziologie_7). Once again, it is clear that there is a lack of awareness of the fact that, firstly, expertise is needed to deal with gender and diversity, and secondly, that in most fields there is an urgent need to examine research questions and designs to determine the extent to which gender and diversity dimensions need to be included for adequate and implementable research results (e.g. in biomedicine, urban planning, technology development; see Criado-Perez, 2019). This would require research institutions to build up corresponding capacities and research funding organisations to define standards that could have a steering effect on the allocation of funding.[18] At the same time, reviewers need subject-specific expertise to assess the integration of gender and diversity into research content.

Overall, our case studies show a significant need to catch up in the conceptualisation and implementation of gender and diversity in German academic cultures, as well as a lack of awareness that a significant cultural change is necessary for an actual shift towards inclusion.

4.2.4.3 **Scientific management**

Leaders in the German academic system are overworked: This is reported by both established academics from all disciplines and the early career researchers they supervise. The reasons for this are manifold: from the persistence of the chair model and the resulting low overall number of professors and inadequate administrative support to the acquisition of third-party funding and the high number of review tasks that weigh on a relatively small number of people due to the pressure to publish and the low success rates in acquiring third-party funding. At the same time, managers have to fulfil complex leadership tasks for which they have hardly been trained. Universities are endeavouring to increase the number of further education

[18] The SNSF research programme SPIRIT can serve as an example of such standards, which places "gender awareness" on an equal footing with other criteria such as originality and feasibility as a clearly defined evaluation criterion: https://www.snf.ch/de/nlghrhyzbD90TM9D/foerderung/programme/spirit

The universities offer training programmes in the area of leadership, but these are only accepted to a limited extent by already overburdened scientists. Basic requirements, such as annual staff appraisals, in which a development plan should be drawn up for each individual member of staff in the group, are not always met. Discussions on the values and practices of good academic leadership are lacking in most professional communities. However, such debates are urgently needed to raise the profile of good academic leadership. This would also make it possible to articulate more clearly what forms of support researchers in leadership positions need in order to fulfil these tasks appropriately.

4.2.4.4 **Evaluation cultures**

All interviewees see the evaluation of scientific achievements as challenging, although there are significant differences in the various disciplines. What all researchers have in common is that when talking to the project team, they primarily discuss evaluation in the context of research funding and, for example, in the context of the research process.
Evaluation in the context of journals is discussed less frequently, with the exception of the life sciences, where it is stated that many journals receive so many submissions that articles are rejected directly despite good data and results and often do not find an adequate publication venue for a long time.

In the discussion of evaluation in the context of research funding and employment, the evaluation of academic CVs is discussed above all. Here, quantitative metrics such as the journal impact factor, the h-index or the number of publications in certain conference proceedings are established in the natural and technical science fields of our case studies - even discussions about and accessions of institutions to DORA (San Francisco Declaration on Research Assessment) have changed little so far. In the social sciences and humanities, it is above all the names of journals and publishers that are regarded as recognised proxies of quality, even if the reading of publications is cited as the ultimate quality control in discussions. The acquisition of third-party funding has now established itself as a sign of quality in all the subject areas analysed. Another challenge for all subject areas is how research achievements should be weighted in relation to other academic achievements and obligations, e.g. teaching, editorships, peer review or other forms of involvement in academic communities. While it is generally accepted in the natural and technical sciences that such activities beyond publication and third-party funding acquisition should be minimised in early career years, scientists in the social sciences and humanities tend to value them positively, but are unsure whether they can actually be considered on an equal footing with research performance. Overall, a narrow focus on publishable research output and third-party funding as quality characteristics can be recognised in all disciplines. Forms of more heterogeneous assessment would have to be explicitly instructed in all disciplines.

With regard to the evaluation of project ideas, researchers in all fields realise that there will always be disagreement among different experts as to what can be considered an innovative research idea. However, very few researchers see this as a problem - evaluation is mainly discussed as problematic with regard to the evaluation of scientific biographies. However, early career researchers state that they are increasingly selecting research ideas so strategically that rapid publication success can be expected (wiss_praedoc_Life Sciences 6). This is now common practice, particularly in the life sciences, and is increasingly being adopted in other fields. Therfore, assessment processes have a direct impact on the selection of topics in the subjects.

In the social sciences and humanities, it is often perceived as problematic in the context of peer review, especially for funding, that reviewers from schools with different basic views of research are consulted (e.g. quantitative sociologists for the evaluation of qualitative-sociological projects; philosophers of science for the evaluation of projects from empirical science and technology research). A lack of expertise in research funding institutions is often suspected here.

In highly internationalised sub-fields in the social sciences and humanities, which are new in Germany, it is noticeable that reviewers from abroad are rarely consulted, even if there are established researchers with more suitable expertise. The strongly national nature of peer review in Germany is an obstacle for these fields. In addition, cases were described in which projects were submitted by international researchers in English and they received German-language reviews that were uncomprehensible for the researchers. This is perceived as a personal affront and a rejection of Germany as an international centre of research in the social sciences and humanities.

For contexts of interdisciplinary peer review, it is noted that review cultures in various disciplines are very different, especially in terms of how much criticism is levelled even at excellent projects. Researchers from the social sciences and humanities state that criticism in their fields should not only be seen as negative, but also as an appreciative engagement with a research endeavour.[19] While it is assumed that this is known and balanced out in the context of subject-specific review, e.g. at the DFG, researchers see that in the context of calls for proposals that are open to different disciplines, this can lead to disadvantages for their fields if the differences in review cultures are not sufficiently reflected. There is also still a lack of reviewers who can adequately assess interdisciplinary applications. This should be reflected upon in the research funding organisations and, if necessary, addressed.

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[19] "People in sociology - including the reviewers and review board members - take their work very seriously, like to discuss and argue, and are very critical of each other. Criticising each other is also specific to the subject. And in case of doubt, they may even promote too little rather than too much, they don't praise each other highly, but are actually very critical. And I'd say that's where the subject comes in with this self-reflexivity. The subject is a particularly critical one and also reciprocal." (wiss_Prof_Sociology_2)

It would be advisable to make greater use of scientists from abroad who have many years of experience in this field. It would also be advisable to sensitise younger experts to interdisciplinary research projects (see also 4.2.2.6).

A fundamental problem for assessment cultures in Germany is seen in the overburdening of the people who carry out assessments, as well as the now large number of contexts that require assessment. At the same time, assessment is largely invisible work that is only of minor importance for career development and for which, in contrast to tasks in institutional academic self-administration, no time compensation, e.g. through a reduction in teaching hours, has been provided to date. The same applies to editorships; in particular, new modes of evaluation beyond proxies and metrics, such as those sought in DORA, are only possible if reviewers have sufficient time for these activities. Compensation models would have to be created for this.

4.2.4.5 **Social relevance**

The concept of social relevance was discussed controversially both in our case studies and at all events and workshops. In principle, it is unclear what exactly is meant by social relevance and who defines what is socially relevant. For example, a representative of sociology stated in one event that the question of social relevance is often used in public discussions as an argument against the promotion of social sciences, although the objects of study in these fields are largely contemporary society and its problems. At the same time, other fields, such as AI, are ascribed relatively unrestricted social relevance, even though the benefits of much research for society in general are still unclear. Contextually, it should be noted that studies have found that a gradual shift in the interpretation of the concept of relevance has been observed in EU research policy in recent decades, with private-sector relevance increasingly standing in for social relevance (Müller, 2012; Rueß et al., n.d.). In the German context, too, the extent to which the discussion about social relevance is increasingly dominated by implicit private-sector relevance, i.e. the development of specific products and applications or the increase in economic competitiveness, instead of a broader concept of social relevance, needs to be analysed. For example, the social sciences and humanities often produce action-relevant knowledge that could improve the lives of many people, but are dependent on whether, for example, politicians and other social actors are willing to implement this knowledge. A differentiated discussion about what social relevance means, in which scientific actors from different fields are involved, would be desirable and could lead to new definitions of social relevance for universities, non-university research institutions and research funding.

In the context of the discussion on social relevance in our project, it is important to note that there is a range of research approaches in all of the fields we investigated, ranging from more basic to more applied. Regardless of their specific orientation, it was important to the researchers that there is a research funding landscape in which there is room for a variety of orientations along the spectrum from basic to application-oriented, as is currently the case in Germany, according to the interviewees. If, according to our interviewees, one research strand should be expanded, then it should be the open call for proposals (as is the case with DFG research grants).

4.2.4.6 **(Inter-)disciplinarity**

In the four case studies of the project, (inter)disciplinarity has a completely different status in each case. While the interviewees in sociology define themselves by their affiliation to a discipline in which they are usually also trained, in environmental humanities and AI, researchers with different educational backgrounds come together around a common research object (e.g. environment, AI), thus forming a community of researchers and largely adopting a new disciplinary identity. In synthetic biology, on the other hand, researchers with different backgrounds work together in a multidisciplinary way, but largely retain their previous disciplinary identities (e.g. as biochemists, data scientists). While interdisciplinarity is generally seen as unproblematic and desirable among our interviewees, there are two practical points at which it becomes a problem: firstly, when there is a lack of relevant expertise for reviewing articles and third-party funding applications for journals and research funders; secondly, when certain fields, such as environmental humanities in our case, are only weakly institutionalised in a national research context, and therefore long-term careers only seem possible with recourse to traditional disciplines. Here, the social sciences and humanities in Germany prove to be particularly organised along disciplinary lines, while the natural and technical sciences are more permeable. The problem of reviewing interdisciplinary research could be addressed by recruiting more international reviewers and by recruiting younger reviewers. The second problem area of the lack of institutionalisation is more difficult to address, but could possibly be mitigated by endowed professorships for interdisciplinary future fields that have not yet been able to gain an institutional foothold in Germany.

4.2.4.7 **(Inter-)nationality**

In terms of (inter)nationality, i.e. international scientific collaboration, mobility and publication, our case studies and the contributions to the events also highlight very different aspects.

While sociology is strongly nationally organised, especially in the qualitative sub-areas, and largely uses German as the language of research, the environmental humanities are highly internationalised. In the life sciences and AI, internationalisation is the standard. In psychology, research has a strong international focus, although the field is also organised in strong national specialist societies (Leipzig event). In engineering, there are sub-areas that are strongly internationalised and in which publications are the central currency, whereas other sub-areas focus more on national and local cooperations with companies and place the development of situated problem solutions and prototypes in the foreground (wiss_Postdoc_Engineering_9). Both national and international orientations create specific added value. However, a national orientation and a focus on German as a research language should be questioned where it leads to international developments not being recognised or not being contributed to. In this respect, researchers from non-German-speaking countries experience some areas of the German social sciences and humanities as isolated and barely penetrable for them.[20]

It is also important to note that internationalisation is seen by the majority of researchers as an orientation towards the western Anglo-Saxon scientific area or the English-speaking EU research area. These geopolitical developments are increasingly being discussed, particularly in the course of opening up research and publication practices (Knöchelmann, 2021; Paasi, 2015). Researchers, especially from the environmental humanities, critically point out that an orientation towards the Global South or the European East, for example, is usually seen as intellectual development aid rather than intellectual enrichment. A critical discussion of the understanding of internationalisation in Germany in various specialist communities would be desirable.

4.2.4.8 **Open Science**

Open science is a term that is as familiar as it is opaque. In conversations with researchers from various fields, open science is often equated with open access to publications. Open access is desirable for all researchers in our study, but is discussed critically in terms of costs, as this would create new national and international hierarchies along financial lines.[21] In the data-intensive sciences, open data and the urgently needed, well-curated, openly accessible databases are discussed. It is noted here that

[20] "If your professor does not take you by hand and walk you through the German academic culture, then you are not going to make it here." (verw._Managing Director_Environmental Humanities_16)

[21] "It comes at a price because publishing Open Access, there is this processing fee, which is significant. And that is something that must be dealt with" (discussion event Leipzig)

the work behind these databases is not sufficiently promoted and rewarded.[22] The same applies to reproduction studies, which would actually be made possible to a greater extent by open science and which could raise the quality of research in general.[23] A somewhat complex concept of open science becomes clear here: as a collaboration of researchers not under the sign of competition and self-interest, but under the sign of collaboration for the purpose of jointly improving research results. Here, however, Open Science, especially in the natural and technical sciences, is currently in tension with the dominant values of the international and German science system, which are geared towards competition, securing competitive advantages and, in some cases, securing patents. A change in values in academic science is also necessary for the implementation of Open Science, leading step by step from a competition-based system to a collaboration-based system. To this end, a reformulation of career paths in science is essential in order to reduce individual dependencies on competitive advantages (see 4.2.1.2, 4.2.1.3 and 4.2.2.1).

4.2.4.9 **Teaching and research**

All of the subject areas that we analysed as part of this study reported that teaching is valued far too little in relation to research. Young academics take on various teaching and supervisory tasks - to varying degrees depending on the subject area. In the life sciences, for example, they are heavily involved in the supervision of master's students and doctoral students at postdoc level, while in sociology they often provide basic teaching. At the same time, however, they are advised to spend as little time as possible on teaching and to use it instead for publication-relevant tasks.[24] This is surprising advice for employees in organisations whose main tasks, as far as universities are concerned, include teaching. A change in the perception of teaching can be achieved by valorising teaching activities in peer review situations: As long as it is primarily research that counts for careers in academia and there are no attractive career paths at universities that focus on teaching, teaching will remain undervalued, much to the chagrin of its quality and many who wish to engage in this field.

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[22] "(...) I think it is also important that this is further promoted and that this can also be further expanded, that people who are involved, who engage in community building, who make scientific data available to the general public, that these people must also be better supported. Because at the end of the day, so much research is being done and so much data is being collected, but only a fraction of it is being utilised, for example." (wiss_Postdoc_Sociology_7)

[23] "So I would consider quality to mean that experiments have been carried out in such a way that they are firstly significant and (secondly) reproducible. So I think that's actually the most important criterion for quality. That these really are experiments that can be reproduced again."

[24] "Teaching is recognised through student feedback, but on the other hand you should publish as much as possible. I try to spend only one day a week on teaching, as I need the time for things that help me get ahead." (wiss_Postdoc_Sociology_5)

4.2.5 Challenges for research funding organisations

4.2.5.1 More funding opportunities for the postdoc phase

In general, both the researchers surveyed in our case studies and the participants in the events were satisfied with the German research funding landscape. The only point of criticism, across the fields, is that there are relatively few opportunities for funding postdoctoral projects.[25] In recent years, funding programmes for early career researchers have been increasingly initiated in some federal states and via the BMBF. What is missing in comparison to other countries, however, are postdoc funding programmes that are not yet geared towards funding research groups, but rather enable postdocs to work on an independent project for two to three years after completing their dissertation. Such funding would enable researchers to become scientifically independent more quickly after their doctorate, without having to take on supervisory tasks immediately, and to qualify for further steps (junior research groups, tenure-track professorship).

4.2.5.2 Recruit experts more broadly

As already indicated in previous sections, researchers in Germany, especially in new, internationalised and interdisciplinary fields, sometimes perceive a narrow focus in the recruitment of reviewers. In some cases, the selection process appears to be too national, penalising fields that are not yet established in Germany, as well as focusing too heavily on highly established researchers and leaving out younger researchers who are more familiar with new fields. A broader recruitment of reviewers could increase the range of research fields that can establish themselves in Germany and reduce the pressure to "re-discipline" that researchers in interdisciplinary fields - especially in the
Social sciences and humanities - experience, minimise.

4.2.5.3 Establishing new evaluation cultures

Research funders have an important role to play in the transformation of assessment cultures. Our study makes it clear that evaluation along proxies and metrics is an integral part of the research process.

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[25] "There seems to be a lot of money for early-career researchers in graduate academies, mentoring programmes etc., but then from the post-doc phase onwards it becomes very narrow. There is an imbalance. As an early-career researcher, you still get a lot of funding and then it's suddenly gone. If you're lucky, you still get a project. Scholarships are also much more limited from a postdoc onwards. A budget position is a privileged position and not representative in sociology, where most people do their doctorate on scholarships." (wiss_Praedoc_Soziologie_6).

of current assessment cultures in Germany. This is not least the case because too many assessment tasks are falling on too few shoulders and researchers need to find time-efficient ways to manage their assessment tasks. If new, multidimensional ways of reviewing are to be adopted, then concrete guidance and newly designed processes are needed that allow reviewers to rethink quality. Research funders could develop and test such processes together with researchers in the field of peer review. Time-saving processes, such as partially randomised procedures, should also be considered in some contexts. At the same time, however, in the medium term, the reputation of peer review work in science must also be upgraded, both in terms of the relevance of peer review tasks for careers and the opportunities to receive time compensation for these tasks from scientific institutions. Research funders could, for example, release reviewers who regularly review for them from teaching activities to a certain extent by paying substitutes. In this way, research funders could provide impetus to transform assessment cultures in the long term.

4.2.5.4 **Doctoral students: Equal pay for equal work**

One form of inequality is surprisingly evident in the German academic system: the unequal pay of doctoral students in different research areas. While the majority of doctoral students are paid TVL-13, the full-time equivalents fluctuate in some cases between 50% and 100%. Especially in interdisciplinary collaborations, this increasingly leads to tensions when the work of doctoral students from different disciplines is remunerated differently and thus certain disciplines are (monetarily) devalued. At expensive locations, this makes it increasingly difficult to recruit doctoral students in disciplines that are not remunerated at 100%. It is also striking that disciplines with a high proportion of women tend to be remunerated at lower percentages than male-dominated fields. The practice thus contributes to the gender pay gap in science. Research funders can play a central role in turning away from this unfair system.

5 Conclusions and recommendations

In this final chapter, we present conclusions and recommendations from our study on two levels. Firstly (5.1), we make suggestions as to how the Volkswagen Foundation itself could take action to address the problems in German research cultures that our study has identified. Some problems can be addressed directly through changes in research funding. In many cases, we see the Volkswagen Foundation more as an actor that can play an important role.

discourse in the German science system and thus achieve gradual change together with other stakeholders.

Secondly (5.2), building on the current international state of knowledge and the results of this study, we make recommendations for topics for treatment in the area of "knowledge about knowledge", which can make an important contribution to the empirical analysis and reflexive further development of scientific cultures in Germany.

5.1 Recommendations for the Volkswagen Foundation as a provider of third-party funding and science policy actor

5.1.1 Initiate a discourse on the embedding of externally funded projects in research institutions

Our study has shown that the embedding of externally funded projects in research institutions, especially universities, is in need of improvement and that many scientists receive too little institutional support in the realisation of externally funded projects.

- While these changes are largely outside the sphere of influence of third-party funders, we nevertheless recommend making them the subject of discussions with research organisations in order to improve the efficiency of third-party funding for scientific knowledge production. increase.

5.1.2 Promoting semi-stable teams

As explained in the report based on the results of the case studies, too little attention was paid to the working conditions and working cultures of researchers as part of the profile development and institutional differentiation of universities. The results of the analyses indicate that in order to enable the long-term processing of research topics and ensure the continuous development of expertise, more importance should be attached to structures for improving the working environment.

- A central structural condition for this is the establishment of semi-stable teams that can ensure the collection and provision of data, monitoring and the transfer of findings in the long term. The need to support semi-stable teams should also be recognised in third-party funded research projects and therefore find resonance with funders. Research funding organisations should therefore also consider the extent to which they systematically integrate transitional funding into their programmes (between third-party funded projects or between third-party and institutional funding).

- Research funders should launch an initiative for a dialogue with universities, non-university research institutions, ministries and project sponsors on the question of how to ensure that semi-stable research teams can be set up in university structures.
  The challenge is that "risky" research questions and methods, long-term orientated research with a broader thematic horizon and the provision of research results in the form of data for third parties could suffer from the short- term nature of current issues and application requirements. Framework conditions are needed so that universities and non-university research institutions can actively contribute to shifting the risk of third-party-dominated research from researchers, including leaders, towards the institution (e.g. with the help of bridging funds).

5.1.3 Promoting heterogeneous career paths for scientists within and outside academic research

The analyses of the study make it clear that the current academic research system is biased towards the professorship as the only long-term career path. This is to the detriment of professors, who lack experienced scientists with specialised work profiles in their teams and institutions as employees and collaboration partners, to the detriment of scientists who wish to specialise in roles in science beyond the professorship, and to the detriment of the entire science system, whose efficiency is weakened by the continuous loss of talent and expertise.

- Research funding organisations have only limited influence on personnel development in research institutions. However, they can provide impetus and make it clear that they would welcome a discourse on career paths in the academic sciences beyond the professorship.

It is also clear that scientists in fields with high competition for academic positions (e.g. life sciences, biomedicine, social sciences and humanities) are inadequately or not at all prepared for careers outside academia. However, since the majority of scientists currently working in third-party funded projects in these fields will work outside academia in the long term, it would be beneficial for these individuals and for society if they were prepared for such roles as part of their academic engagement.

- As part of the description of the mentoring plan for early career researchers, research funders could ask for descriptions of the measures taken by the project management to prepare their employees for non-academic positions. Career options for doctoral candidates and postdocs outside academia could be promoted, for example, through internships in non-academic, thematically relevant organisations or through other interactions with project partners outside academia during the project period.

5.1.3.1 Promoting (independent) research in the postdoc phase

In Germany, compared to other European countries, there are only a few funding formats for independent postdoc projects below the junior research group. This creates a gap that makes it difficult for postdocs to pursue independent projects and sharpen their own profile without taking on a direct group leadership and supervision role.

- We recommend developing new funding formats for postdocs. Structurally, these could be similar to a Marie Curie Fellowship (employment for three years, application with a specific institution, own research funding). However, they should not (only) be aimed at stays abroad, but should rather be attractive for postdocs who are already working in Germany or want to work in Germany. Funding formats that focus exclusively on stays abroad tend to exclude people who want to stay in Germany for family reasons or for other reasons (e.g. physical limitations, civic engagement).

In general, German research funding often implicitly or explicitly favours the employment of doctoral candidates over postdocs (more cost-effective, promotion of training). However, this leads to some negative consequences. In some fields, too many doctoral students are trained and fewer talented people are recruited for research. At the same time, there are too few positions for qualified postdocs. Often, doctoral students are also appointed to positions that actually require the skills of postdocs, which reduces research efficiency.

- Third-party funders should explicitly promote the use of postdocs in research projects. While Today, it often has to be argued why an (expensive) postdoc is employed instead of a doctoral candidate, the choice should have to be justified in both cases. The employment of doctoral candidates should not be an implicit or explicit standard.

5.1.3.2 Doctoral students: Equal pay for equal work

One reason why doctoral students are often more attractive as employees in externally funded projects than postdocs is the low salary level in some research areas. Different pay for researchers in different fields is tantamount to a significant devaluation of these research areas and can no longer be justified, especially in the age of interdisciplinary research. At the same time, low pay primarily affects research areas with a high proportion of women, thereby widening the gender pay gap in science.

- Third-party funders should support full-time employment (100%) of doctoral students in all subject areas as the norm. Project managers who submit applications with a lower full-time equivalent should have to justify this or demonstrate how they can still achieve full-time employment.

5.1.3.3 **Promoting Responsible Academic Leadership**

Scientists in leading positions (professorships, research group leaders, etc.) are generally not trained as managers and are therefore not or only slightly familiar with current standards and practices for responsible leadership. The high competitive pressure in the scientific system leads to the responsible fulfilment of the leadership function being neglected. Young researchers should be given the opportunity to receive professional training in this area, which would also serve their career development in non-academic areas. However, experienced management staff should also be continuously supported in the fulfilment of their management function.

- "Responsible Academic Leadership" should become a relevant topic in the academic communities.

  The Volkswagen Foundation (possibly together with other research funders) could initiate an important discourse here in Germany that shows what constitutes responsible academic leadership and how it should be practised, supported and funded.[26] It would be expedient to integrate supportive measures into funding initiatives and programmes, also in order to reduce the burden on management staff. Another possibility is to promote networking opportunities for scientific leadership, for example in the form of a peer-to-peer mentoring programme. In this way, the foundation could support the exchange between (future) managers and sensitise them to the field- and organisation-specific needs of employees.

5.1.4 **Promoting responsible reviewing**

Assessment work is an essential task in the reproduction and control of the scientific system. Nevertheless, peer review work is currently not valued enough. Reviewing is often done "on the side", as the renowned scientists who do the majority of this work are often highly overloaded. Active reviewers have few opportunities to receive compensation - financial or in terms of time - for their activities. In the German academic system, there is also a dominance of German reviewers and researchers at full professor level.

- Comparable to the necessary discourse on Responsible Academic Leadership, there is a need for a Dialogue about "responsible reviewing" in the scientific communities: Research funders should increasingly enter into a dialogue with universities, non-university research institutions and ministerial authorities on how the activity could be more highly valued and in what form reviewers could be relieved and compensated for their commitment (possibly also financially, but above all in terms of time). This is all the more important if, as part of the implementation of DORA (Declaration of Research Assessment) or COARA

[26] Here it is also possible to draw on the experience of the AUFs with their practices and activities, e.g. the Helmholtz Academy for Executives (Helmholtz Academy for Executives - Helmholtz Home).

(Agreement on Reforming Research Assessment), the path from metrics-based to qualitative review procedures is to be taken.

- For new and innovative fields in particular, it would be essential for German third-party funders to provide expert opinions.
  The university should recruit more field-specific and international researchers and make greater use of younger academics (postdocs with relevant research experience; tenure-track professors).
- Studies indicate that reviewers in the transition from the current, often metrics-based peer review practices to new, qualitative forms of peer review need more support. Third-party funders could work together with peer review researchers to develop new review settings and training programmes that actively promote a pluralistic understanding of excellence. The Volkswagen Foundation has already provided important initial impetus here, particularly with its "Experiment!" funding initiative. Scientific monitoring of a changed assessment practice is recommended for a systematic evaluation and possible further development.

5.1.5 Open Science: new ways to open up science

Our study makes it clear that, while practices such as open access have already found their way into German research fields, a broader vision for open science is largely lacking. Open science is too strongly opposed to the dominant values of current scientific cultures such as competition and competitive thinking.

- We recommend initiating a broader debate on Open Science that asks questions about this in particular, which framework conditions scientists would need in order to work more openly and collaboratively. This could provide important impulses for science policy and for institutions on how to achieve an actual opening of science.

5.1.6 Specialist cultures in an international context

Internationalisation is seen by the majority of researchers as an orientation towards the western Anglo-Saxon scientific area or the English-speaking EU research area.
Interviewees point out that an orientation towards the Global South or the European East is usually seen as development aid rather than intellectual enrichment. A critical discussion of the understanding of internationalisation in Germany in various specialist communities would be necessary.

- Internationalisation cannot be an end in itself in research funding, but should be part of research projects and therefore should be specifically explained and justified. Conversely, research funders could pay more attention to ensuring global inclusion in international projects and that internationalisation is not merely understood as a Western partnership.

5.1.7 Excellent teaching: an area of activity for third-party funders?

Our study shows that respondents in all areas analysed perceive that teaching is devalued in relation to research. While universities themselves must do a great deal to correct this imbalance, third-party funders can also provide impetus.

- In the case of project applications, the extent to which applicants are actively involved in communicating research content to students could be asked more frequently and taken into account in the review process.
  (concept for the transfer of project content into teaching).
- Excellent teaching performance could also be rewarded by providing opportunities to apply for third-party funding. On the other hand, there could be research funding formats where funds for research are approved on the basis of excellent teaching performance (e.g. funds for release from teaching, for which an application is submitted with a specific project, but where the basis of the evaluation is both the project idea and the teaching performance to date).

5.2 Recommendations for topics for the area "Knowledge about knowledge"

5.2.1 Deepen knowledge of disciplinary differences

Our study points both to common problems in different research fields and disciplines and to differences in their research cultures and in the way they react to changes in their framework conditions. It is clear that the level of research on scientific cultures in the life sciences and social sciences is significantly higher than in technical, engineering and humanities fields. As a result, the discussion among experts is sometimes dominated by assumptions that are not based on a systematic analysis of different science cultures in the German context.

- We therefore recommend the comparative analysis of different knowledge cultures in the context of "knowledge about knowledge". Such knowledge would make it possible to set steering impulses in a way that can take differences in the fields into account accordingly.

5.2.2 Strengthen empirical research on evaluation practices

The current state of research on the practices and values of peer reviewers is extremely limited. The existing studies indicate that many of the goals of research funders are currently not being realised in the practices of peer reviewers, or in some cases do not appear to be realisable for them.

- Empirical research on peer review can make a decisive contribution to a change in the current organisation of peer review (formats, timeframes, criteria, etc.). This is especially important now, as many research funders want to guide reviewers away from traditional practices (e.g. the use of quantitative metrics). However, it often remains unclear how peer reviewers can and should proceed without these tools. Peer review research can provide insights that can empirically support the transformation of peer review practices.

5.2.3 A broad understanding of knowledge about knowledge

Knowledge about knowledge should be viewed as a multidimensional subject area that is concerned with the conditions of knowledge production in science, but also with the relationship between science and society. These two areas are interdependent: working conditions in science have a decisive influence on how scientists (can) relate to society; the relationship between science and society also determines who participates in scientific knowledge production at all, for whom science appears to be an attractive field of work and which research is regarded as legitimate.

- We therefore recommend that the Volkswagen Foundation should broadly expand the topic of "knowledge about knowledge" and to promote research ideas that investigate the scientific system as well as projects that shed light on the relationship between science and society.

5.2.4 Understanding and considering gender and diversity in science in a new way

Questions of gender and diversity in science continue to be an important topic. Our study shows that there are often still short-sighted ideas about the social mechanisms of inequality (e.g. that gender discrimination is primarily seen as an effect of motherhood) and that categories of inequality that are already more strongly examined in other national contexts (e.g. social class, skin colour, disability, sexual orientation or non-binary gender identities) are still little considered in the German context. At the same time, there are few studies on the experiences of academics with marginalised status in the German academic system.

- We recommend funding projects that promote new knowledge about gender and diversity in the German-speaking world.
  This can serve as a basis for new measures to promote social justice and inclusion. Such projects also have the potential to anchor a more complex concept of diversity in the German research system.

Diversity can also be an important dimension in the tendering and evaluation of projects in the "Knowledge about Knowledge" funding line and in other Volkswagen Foundation funding lines.

- We recommend using "Gender and Diversity Awareness" as a review criterion for research projects. projects in the "Knowledge about Knowledge" funding line and in the Volkswagen Foundation's funding lines in general. The quality of the research and its applicability can be significantly increased through the thematically appropriate consideration of gender and diversity dimensions in the research question, study design and interpretation of results. The SNSF funding programme SPIRIT can serve as an example of the systematic and interdisciplinary implementation of this criterion.[27]

[27] https://www.snf.ch/de/nlghrhyzbD90TM9D/foerderung/programme/spirit

6 Attachments

6.1 Empirical foundations - participants, experts and dialogue partners involved:

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were taken:

i. Sociology (two case studies): Early-career researchers (8 people), postdocs (4 people), professors (5 people), management (5 people), administration (2 people)
ii. Environmental Humanities (one case study): Early-career researchers (3 pers.), postdocs (2 pers.), professors (1 pers.), management (1 pers.)
iii. Life sciences (two case studies): Early-career researchers (in 2 group interviews: 6 in total), postdocs (1), group leaders (3), heads (4), administration/coord. (2)
iv. Artificial intelligence (a case study): Early-career researchers (12), postdocs (2), professors (5), the management (2 pers.)

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