DIVERSITY IN SCIENCE AND SCIENCE FUNDING

A MAPPING OF THE LITERATURE ON DIVERSITY WITH REGARDS TO GENDER, AGE, CAREER STAGE, NATIONALITY AND RESEARCH FIELD

Rapport

This background report presents a literature survey undertaken by the Think Tank DEA in connection with the project “Diversity in science and in science funding”. The project was commissioned and co-funded by the Independent Research Fund Denmark. DEA bears sole responsibility for the results and conclusions presented in this report.

The image on the cover page was downloaded from Freepik.com

Authors:
Maria Theresa Norn, Head of Analysis, Ph.D.
Jonas Krog Lind, Senior Consultant, Ph.D.
Lena Lindbjerg Sperling, Senior Economist, Ph.D.
Olav Stavnem, Project Assistant, DEA

May 2021

Published by:
The Think Tank DEA
Fiolstræde 44
1171 Copenhagen K, Denmark
www.dea.nu

Independent Research Fund Denmark
Danish Agency for Higher Education and Science
Asylgade 7
5000 Odense C, Denmark
www.dff.dk

Contents

1 Introduction and summary **6**
Summary of the literature on diversity with regards to gender 7
Summary of the literature on diversity with regards to age, career stage, and nationality 17
Summary of the literature on diversity with regards to research field 20

2 Methods **24**

3 The literature on diversity with regards to gender **27**
3.1 Arguments for why gender inequality in science matters 28
3.2 Gender differences in academic career trajectories 32
3.3 Gender differences in research patterns and performance 35
3.4 Gender differences in funding 42
3.5 What explains gender differences in career trajectories, research performance, and funding? 44
3.6 How is gender diversity supported? 67

4 The literature on diversity with regards to age, career stage, and nationality **77**
4.1 The precariousness nature of academic careers 77
4.2 What distinguishes those who stay in academia from those who leave? 79
4.3 Demands and expectations of international mobility 85
4.4 Research on foreign-born academics 86
4.5 Mid and late-career perspectives on an academic career 90
4.6 Is there bias in peer review related to age, career stage, or nationality? 91

5 The literature on diversity with regards to research field **94**
5.1 What does ‘diversity with regards to research field’ mean? 94
5.2 Why does diversity with regards to research field matter? 95
5.3 Can you have too much of a good thing when it comes to heterogeneity? 97
5.4 What makes researchers pursue divergent research paths? 98
5.5 Is there a bias against researchers with cognitively diverse research strategies? 102

References **104**

1

Introduction and summary

1 Introduction and summary

This background report presents the results of a mapping of the literature on diversity in science and science funding. The mapping forms part of a larger project on diversity in science and science funding. The project was undertaken by the Think Tank DEA in collaboration with the Independent Research Fund Denmark, which commissioned and co-funded the project.

The aim of the project and the literature mapping is to provide an overview of research on how diversity matters for science and which factors may hinder or promote greater diversity.

Diversity in science refers to heterogeneity among researchers or in research topics and approaches. Many factors can contribute to such heterogeneity, but this mapping focuses on diversity with regards to gender, age, career stage, nationality, and research field. These aspects of diversity were selected because they were highlighted in the 2018-2020 strategy for the Independent Research Fund Denmark. This does not indicate that other aspects of diversity are less important.

The literature mapping focuses on peer-reviewed academic research published primarily within the past decade. Where relevant, older contributions to the literature as well as selected policy reports have also been included, e.g. to provide a more comprehensive overview of themes addressed in the literature.

The mapping aimed to establish an overview of key themes and findings presented in the literature, to provide research funders and other decision-makers with insight into the state of the literature on the selected aspects of diversity covered. It was not possible within the scope of the literature mapping to critically assess the data, methods, or validity of the studies included.

Of the selected aspects of diversity, gender accounts by far for most of the research identified. All of the streams of literature that this report draws on are, however, fragmented across research topics and methods. Moreover, much of the evidence on key themes addressed in the literature is inconclusive, due in large part to variations in data and methods, but also due to the sheer complexity of the phenomena studied. To the best of our abilities, we have sought to draw out key trends and emerging areas of consensus. Given the mixed evidence identified in several parts of the literature, the findings reported here should be seen as tentative conclusions open to further discussion and interpretation.

The rest of this chapter presents a summary of each of the three main parts of the literature mapping: first, a summary of research on diversity with regards to gender, and then summaries of the literature on diversity with regards to age, career stage and nationality, and finally, research on diversity with regards to research field.

The summaries do not include references to the literature; all references can be found in the subsequent chapters on diversity with regards to gender (chapter 3), age, career stage and nationality (chapter 3), and research field (chapter 4).

The approach taken in the development of the literature mapping is described in chapter 2.

Summary of the literature on diversity with regards to gender

An extensive but fragmented body of work yielding mixed evidence

Gender diversity in science is a long-standing issue in academia, driven in particular by observations of differences in the scientific performance and career trajectories of male and female researchers.

Research on gender diversity in academia is extensive but fragmented across a wide range of subtopics, disciplinary approaches, and publication outlets – and the results presented in this body of work are often inconsistent. Several explanations for the mixed results in the literature have been put forth. First, the complex and changing nature of gender differences that exist in academia makes it a difficult subject of study. Second, there is a high degree of variation in the types of data and methods applied to studies of gender differences in science. Some studies are based on qualitative data, while others draw on quantitative data. Some studies base their conclusions on an analysis of large numbers of observations, and in a few cases even longitudinal data, while other studies provide 'snapshots' based on a small number of observations, often drawn from the same local setting (e.g., a single institution or department). Finally, many studies focus on selected research fields or subfields, while studies that analyze data across research fields find substantial field-level gender differences in e.g., research behavior and performance.

Overall, the literature, therefore, provides many different lenses unto questions regarding gender diversity in science, which provide rich and nuanced insights. But it is generally difficult to point to clear answers to the questions explored in the literature. The authors of this mapping of the literature have therefore sought to present the key results and arguments put forth in the literature in a way as to reflect the diversity of approaches and findings in this body of work. To the best of our ability, we have tried to draw out some overall conclusions from the literature. Given the ambiguity of the existing evidence on this theme, the conclusions should however be seen as tentative – and as a point of departure for further dialogue regarding the state of knowledge regarding diversity in science.

Arguments for why gender equality in science matters

Given the highly polarized and often normatively driven debate on gender issues in academia, it is worth dwelling on arguments presented in the literature for why gender equality (or the lack thereof) matters for science. These arguments, generally speaking fall into one of two categories.

The first set of arguments call for equal opportunities for all qualified researchers to pursue and excel in an academic career, regardless of their gender. First, some researchers emphasize the importance of *increasing the representation of underrepresented groups* in academia (including but not limited to female researchers). The second set of arguments focus on how higher attrition rates for female researchers represent a problematic *loss of talent* for the academic research community. Meanwhile, the third set of arguments call for the removal of *unreasonable barriers* for female researchers to pursue or advance in a research career, regardless of whether these barriers stem from discrimination, conscious or unconscious bias, or structural barriers.

The next three arguments focus on possible benefits on research from diversity or heterogeneity among researchers. First, several studies have argued that a moderate level of heterogeneity among members of a research team or similar group is associated with *a higher degree of creativity and strengthened problem-solving ability*. Here, gender diversity has been identified as one of several possible sources of heterogeneity in groups, with gender being associated with e.g., heterogeneity in cognitive thinking styles and in communication styles, which can contribute positively to the overall performance of the group.

However, several contributions in the literature argue that there is a curvilinear relationship between heterogeneity and performance in research groups: while a moderate degree of diversity can be associated with greater variation and productive tensions within a group, high levels of diversity can entail conflict and lower degrees of performance. Moreover, research has indicated that team members' attitudes and beliefs may also influence the effects of gender diversity; for instance, a study showed that team members' openness to gender equality issues was positively associated with performance in gender-diverse teams. Overall, meta-studies indicate that diversity in teams may have positive or negative effects, but little is known about the specific circumstances, which determine whether effects are positive or negative.

Second, it is argued that diversity can *contribute to greater variety in research questions and approaches,* as researchers who differ from each other are more likely to pursue different types of research fields, research questions, methods, types of interaction with non-academic actors etc. For instance, there are indications in the literature that women and men may differ in their preferences for research fields and methods. Such variation implies that the full body of research covers a broader range of themes and approaches, which ultimately increases the responsiveness of research to the full set of societal needs.

Last but not least, a stream of the literature focuses on the role of diversity in *strengthening the relevance of research*. Research has shown that author teams with women authors are more likely to consider and report sex and gender-related factors. Researchers have long pointed to the importance of considering the role that gender and sex analysis may play in informing procedures and practices in healthcare, in light of well-documented differences in e.g., physiology and therapeutic response among men and women. Though the importance of including and reporting gender and sex analysis has been focused on the health sciences, it has been argued that incorporating gender and sex analysis into experimental designs is likely to improve science and engineering across disciplines (e.g., addressing known gender bias in algorithms or differences in sex-based responses to climate change), by promoting more rigorous and responsible research and, ultimately, greater social equity.

Gender differences in academic career trajectories

The starting point for many studies of gender issues in academia is the observation that *women are more likely to leave academia*, a phenomenon which has been referred to as the 'leaky pipeline'. Essentially, this refers to the observation that the proportion of women in science decreases along the academic career ladder. Despite growing proportions of women in early career stages, the proportion of women in senior academic positions remains low. A study from Sweden, for instance, found that that women's prospects of becoming professors have not improved over time, despite the growing number of women in the early stages of their academic career.

Studies show that women are particularly likely to 'leak' out of the academic pipeline in connection with personal events such as marriage and childbirth or connection with major career events, e.g., completion of the Ph.D. degree, or connection with the transition to researcher independence or a tenure-track position. Studies indicate that women are not only less likely to hold a tenure-track position than men; they may also less be likely to apply for one.

Several studies have found that women *advance more slowly in their academic careers* – and that women researchers' careers tend to plateau at the mid-rank level (e.g., associate professor) while mens' careers tend to accrue towards the highest rank (i.e. professor).

Reviews of prior research have found that women researchers are not only more likely to leave academia; they are also *more likely to be employed in part-time, time-limited, and non-tenured positions*, and less likely to work in university management. Moreover, data indicate a persistent gender pay gap between male and female researchers, though a review of the literature indicated that observed gender differences in pay are partly explained by the underrepresentation of women in leadership positions and by differences in working time for men and women, pointing to the complexities involved in understanding the causes of gender differences in pay.

A 2019 report on career paths among scientists in Denmark from the Danish Council for Research and Innovation Policy echoed many of the findings in the international literature within the context of Danish academia, including that career progression has slowed for both genders, and that men (particularly if they have no children) are more likely to be hired as a full professor than women (particularly women with children). The same report showed that researchers with children – and women with children in particular – have become more likely to leave academia, while the proportion of childless researchers leaving academia today has remained relatively stable over the past two decades in Denmark, for both women and men.

It is worth noting that some recent studies have suggested that gaps in career advancement between men and women in academia may be narrowing or disappearing among younger generations of researchers or emerge in later career stages.

Finally, there are large *differences in women's participation and career trajectories across both disciplines and sub-disciplines.* With regards to disciplines, studies indicate that the underrepresentation of women is most apparent in mathematically intensive fields, such as geoscience, engineering, economics, mathematics/computer science, and the physical sciences, while the proportion of women is much higher in other scientific fields such as psychology, the life sciences, and the social sciences. With regards to sub-disciplines, several studies indicate that women appear to specialize in different sub-fields than their male colleagues do. For instance, while the proportion of women is higher in the humanities overall, it is lower in philosophy; similarly, while women are more common in the social sciences, they are less common in economics and political science. Subfield specialization may have implications for career trajectories; for instance, a study found that women in sociology are represented in some subfield specializations that are associated with a lower likelihood of achieving publication in prestigious journals. A large-scale study also found gender differences in methodological approaches: women were more likely to use exploratory and qualitative methods, while men were more likely to use quantitative methods.

Whether differences in field and sub-field specialization are explained e.g., by differences in male and female interests, by the availability of alternative (non-academic) careers, or by gendered norms in some fields, which may be off-putting to researchers of the opposite gender, has not been established.

Gender differences in research patterns and performance

Several studies have described gender differences in how men and women undertake research and in their scientific performance; some key findings from this literature are outlined in the following.

Women tend, overall, to have fewer academic publications than men. Several studies have found that female researchers are less productive than their male counterparts, meaning that they produce fewer publications. Gender differences in productivity are however reduced when studies control for factors such as career length, academic rank, and time devoted to research; that is, the gender differences in productivity are likely smaller than they have often reported being. In particular, the higher attrition rate of women researchers appears to be key to understanding gendered performance differences. For instance, a recently published longitudinal study found that gender differences in scientific productivity and impact were largely explained by differences in publishing career lengths and dropout rates for men and women.

Nonetheless, findings regarding the lower productivity of women researchers remain largely consistent across a wide range of disciplines, geographical areas, and measures of researchers' productivity.

The evidence is however mixed, as some studies find few or no productivity differences among women and men. Moreover, the gender gap in productivity varies in magnitude across research fields, being non-existent or even in favor of women researchers in some fields. All in all, it is important to keep in mind that the results of studies on gender differences in productivity are highly sensitive to the methodologies applied.

Moreover, some researchers have argued that there is a tendency towards declining gender differences in productivity, i.e., that gendered performance differences are becoming smaller over time, possibly even disappearing in the younger generations of researchers. Other studies find that gender differences in productivity are most pronounced in early career stages, as women researchers 'catch up' with male peers later in their careers.

It should be noted that scientific productivity is neither an indicator of the quality of a researcher nor of the researcher's contribution to science or society. For instance, studies have shown that researchers are likely to have fewer publications when they engage in interdisciplinary and/or highly novel (and thus typically more time-consuming and more risky) research; nonetheless, scientific productivity is widely used in e.g. in connection with hiring, advancement and funding decisions. As such, gender differences in productivity may play an important role in understanding gender differences in academic career paths.

Women are less likely to be listed in first or last author positions, i.e. prestigious positions often indicating the main or most senior author. Several studies have found that female researchers are underrepresented as first or last author on publications, even in fields with equitable gender distributions. Being listed as first or last author has long been known to strengthen researchers' visibility, regardless of whether the position in the author list reflects their actual contribution to the study reported. Research moreover indicates that being listed in 'in between' author positions may be associated with slower career advancement for female researchers.

Women are less likely to publish in the most prestigious journals. Some studies have found that women researchers are more likely than men to publish or be listed as first-author in lower-impact or lower-prestige journals within their field. This may reflect a generation effect – as there are more men in senior academic positions than women, and senior academics are more likely to be able to publish in high-prestige journals. It may also indicate that women researchers are less likely to submit publications to high-impact journals, or that they have lower success in achieving publication in high-impact journals due to gender bias or topic bias (given that women tend to specialize in other sub-fields than men) in peer review processes.

Gender differences in citation rates appear small or non-existent and do not appear to be a salient factor in understanding gender inequality in academia. Much of the literature on gender issues in science has focused on the question: are womens' publications cited less? Some studies have concluded that women researchers' publications receive fewer citations than those of their male counterparts, while other studies have found no evidence of gender differences in citations to publications, and some have even found evidence of higher citation scores for women than for men. Yet another study found marginal differences which were largely explained by differences in the tendency to cite one's work and by the impact of the journals in which articles appeared – and not by gender differences in citation rates per se. Overall, while the evidence is thus mixed, the emerging consensus in the recent literature seems to be that gender differences in citation impact, to the extent that they can be documented, are not a key factor in explaining gender differences in academic career trajectories.

Women collaborate less with domestic and international researchers. Collaboration among scientists is common in science and associated with, among other things, increasing levels of research specialization and the growth of team science. Gender differences in collaboration patterns may help to explain gender differences in scientific productivity because collaboration has been linked to enhanced productivity, and subsequent career advancement. Studies have found that women are less likely to engage in collaboration, and particularly in international research collaboration. However, studies have also indicated that observed gender differences in collaboration and co-authorship frequency are partly explained by women's lower publication rate and shorter academic career length, and partly explained by differences in the degree of international collaboration in research fields where there are high proportions of male or female researchers.

Women are less likely to patent, to start a company, and to collaborate with industry. Relatively few studies have examined the role of gender in academic entrepreneurship; however, the studies that do exist find rather consistently that women researchers are less likely to take out patents, to start a company based on their research findings, to serve on the scientific advisory boards of biotechnology companies, or to engage in collaboration with private firms. Studies have also indicated that women researchers were more likely to be involved in applied research or to start a university spin-off driven by their ideals of finding broader application for research results and thereby making a social difference, while male academic entrepreneurs often pursued more personal, practical goals such as financial success and recognition.

Gender disparities in funding

Part of the literature on gender issues in science investigates the existence of gender differences in research funding. Research funding is here sometimes viewed as a performance parameter for researchers, and sometimes as a resource in enabling performance.

Overall, the literature points to the existence *of clear disparities in the number of grants awarded to female and male researchers*. These differences however are to a large extent explained by differences in the number of women across research fields. Moreover, the lower proportion of female recipients of the largest grants is at least partly explained by the lower proportion of women in senior positions eligible to apply for such grants and by gender differences in scientific productivity. As such, it is difficult to assess the actual level of gender disparities in grants based on the current literature.

Several studies have investigated *gender differences in success rates* on applications for research funding. While some studies find that women have lower success rates, most of the literature reviewed in connection with this mapping finds no clear evidence of such differences (or in one study, that observed gender differences in success rates could be explained by a lower percentage of women applicants). However, it is worth noting that a study found based on data from Quebec that grant application success rates for men and women were comparable until the late 30s, at which point men's success rates remained unchanged while women's success rates either plateaued or increased more slowly. Overall, no clear indications of gender differences in funding success rates emerge from the literature, but this is likely to be a fruitful area for further study.

Some studies indicate however that women *apply for fewer grants*, *hold fewer grants*, are *less likely to renew grants,* and are *less likely to reapply if rejected*. The latter is significant, as repeated applications to the same funder have been associated with increased chances of obtaining funding. Also, women appear to *receive smaller amounts of funding*, though, as mentioned above, some studies indicate that gender disparities in the amount of funding received may be explained by gender differences in academic rank (i.e. there are more male researchers in senior positions, particularly among those eligible for the very largest grants) and research productivity.

Women take longer to receive key grants. As mentioned earlier, several studies indicate that women academics advance more slowly in their careers; on a related note, several studies find that women take longer to receive key grants, e.g. grants allowing them to transition from the postdoc stage to becoming a principal investigator. According to one study based on US data, part of this difference could be explained by gender differences in scientific productivity, but about 40 percent of the difference remained unexplained. Moreover, a study based on Danish data found that male grant recipients were more likely to advance in their career within the first four years after receiving a grant, during which time female grant recipients showed the same level of career advancement as rejected male applicants.

What explains gender differences in career trajectories, research performance, and funding?

Much of the literature on gender diversity in science focuses on possible explanations for the gender differences observed in e.g. career trajectories and research performance.

Two of the big questions examined in the literature is, first, whether observed performance differences are a result of or an antecedent to gender inequality in academia, and second, whether women researchers' higher attrition rates are the results of bias or structural barriers in academia or individual factors, including e.g. personal priorities and preferences and performance. While individual factors are likely to relevant in understanding observed gender differences, there are many indications in the literature that bias and structural barriers also play a role.

Gender differences in ability. Several studies have since the 1980s explored whether evidence could be found for significant differences in men and women's biological or psychological abilities, but the emerging consensus in the literature appears to be that no convincing evidence has been found of differences that could explain gender differences in researchers' performance or career trajectories. Indeed, the authors of a recent review study argued that capacity-based explanations for gender differences in e.g. STEM participation have lost power, as gender gaps have narrowed on the lower rungs of the academic ladder. Instead, they point to social-psychological and socio-cultural perspectives – i.e. the importance of stereotypes, preferences, and expectations among e.g. teachers, family, and peers in shaping actions directly or indirectly via bias – which may play a small role in any given single decision, but which may have been argued that have accumulative effects over the course of individuals' lives, contributing to substantially different outcomes for women and men.

Many authors point to the importance of *stereotypes* (e.g. in reducing the likelihood that women will pursue a STEM career or disciplines associated with 'raw talent' or 'brilliance' – both of which are more likely to be associated with men's abilities and interests rather than with those of women) or bias in shaping even small decisions and events, the combined effects of which over time contribute to different academic career trajectories for men and women, with men more likely to pursue research-oriented trajectories and women more likely to pursue lower-prestige e.g. teaching-oriented trajectories, leading to higher gender differences in performance.

Indeed, several studies point to *the importance of early-career decisions and events* for understanding gender differences in career trajectories. For instance, a Swedish study found that male and female researchers had the same probability of achieving a prestigious postdoctoral fellowship and that men and women who had received this fellowship had equal opportunities to become professors. However, in the group of young researchers who were not awarded a postdoctoral fellowship, women were substantially worse off than their male counterparts.

Some researchers have also investigated the role of *research specialization* in understanding gender differences in research performance and trajectories. Insights on this topic however are few and mixed. For instance, while one study found that women researchers tend to specialize less than their male counterparts, thus missing out on an important means of increasing their scientific productivity, another study found that gender differences in the degree of specialization all but disappeared once controlling for research productivity. Most of the limited body of work on this topic finds small or no differences in scientists' propensity to focus or diversify in their research, suggesting that this is not a key factor in explaining the gender gap in research performance.

Studies have found that women are *less visible* in the academic community, which may affect their ability to build networks and advance in their academic careers. For instance, a handful of studies have found that women are less likely than men to speakers at academic symposia and colloquia, even after controlling for the gender and rank of the available speakers. With regards to visibility, a recent study based on publications from clinical research and the life sciences found that men and women differ in how they frame their research findings: articles with a male first or last author were more likely to describe their findings using positive words such as e.g. "novel" or "excellent" (compared to articles in which both first and last author were women), and that presenting an article positively was associated with higher numbers of citations.

Many studies also focus on differences in *how male and female researchers spend their time at work*. Although researchers engage in many different types of activities, research is widely recognized as the most prestigious and as the one most important for employment and advancement opportunities. Studies have found shown women researchers are likely to spend a larger amount of time teaching and carrying out 'faculty service' tasks, particularly so-called 'low prestige' service tasks. Also, research indicates that women are more likely to be asked to perform such tasks, though not more likely to say yes than men are. These gender differences in the use of time can influence the amount of time men and women have available for research and may thus help explain gender differences in research performance and career paths. However, it appears that the percentage of time spent on teaching and teaching-related activities may be considered both a cause and a consequence of the gender gap in career progression, which again underlines how intertwined many of the factors explored in the literature are.

Finally, some studies indicate that female researchers have a stronger *inclination to engage with society* than their male counterparts, or that women and men differ in the types of impacts they seek. For instance, data from Australia and the UK indicate that men are more likely to pursue so-called 'hard' impacts (i.e. easily measurable outputs), while women attach greater weight to 'soft' (i.e. difficult-to-measure) impacts. To the extent that such differences are common, they may also contribute to gender differences in career paths.

Even more, studies have *documented differences in how male and female researchers spend their time at home*. Studies have for instance found that women faculty are more likely to experience stress due to heavy workloads and from balancing work ambitions with family duties than their male counterparts are. Women often shoulder the majority of domestic and childcare duties, which may at least partly explain lower productivity levels among female researchers, particularly in the early stages of their careers, where many researchers have small children.

Research indicates, as previously mentioned, that male and female researchers tend to follow rather *different career trajectories*, with men's careers described as more "linear", and women's careers described as "non-linear", i.e. marked by interruptions associated with e.g. parenthood and caregiving duties. Indeed, parenthood – including childbirth and parental leave periods, but also later gender differences in the amount of time spent on caregiving – is often invoked as a factor in understanding gender inequalities in science. According to the literature, family and caregiving duties especially influence the early career stage stretching from the first university degree to the first tenure-track position, during which important career events and demands of e.g. scientific productivity and mobility for many women coincide with childbearing years.

Parenthood has been examined in many studies of research productivity and academic career paths, partly because it is an easily identifiable event. Working in academia is often presented as a 'calling' or 'lifestyle', associated with expectations regarding e.g. faculty members' working hours that are better aligned with the lifestyle of employees who do not have caregiving duties to tend to in their private life. It has been argued that academic institutions, even if they offer a high degree of autonomy and possibilities for flexibility, also come with limitations including high workloads and ambiguous criteria for career advancement. Moreover, although universities often try to provide family-friendly work conditions, they also place increasing importance on e.g. international mobility, high and consistent levels of research productivity, and external funding. These conditions may help explain why studies indicate that women researchers are less likely to marry and to have children than their male peers; why they often tend to delay having children; why studies have found that women researchers with children have lower tenure rates and are more likely to be employed part-time or in non-tenured positions than male researchers or female researchers with no children; and why women with children are more likely to leave academia. However, the evidence on the impact of parenthood on productivity is mixed and inconclusive; also, these effects are not particularly strong in empirical studies, and often disappear when other characteristics are taken into account e.g. personal characteristics, discipline, and work environment.

Can gender bias explain residual gender differences in science? It is pointed out in the literature, that female researchers are, on average, younger than male researchers; they are overrepresented in lower academic positions and positions with a temporary contract – positions often associated with a higher teaching load and lower levels of funding – all factors which may help explain e.g. gender differences in scientific producitivity. However, as mentioned earlier, studies have also found that productivity differences explain only a part of the gender gap, with the residual often attributed at least in part to bias.

The literature mapping did not reveal compelling evidence of gender discrimination. With regards to bias, however, the evidence is highly mixed. However, it is important to bear in mind that the absence of evidence is not evidence of absence; as mentioned in several studies, bias can be difficult to document and may be associated with local contexts rather than present a general issue. As such, while unexplained gender differences in career progression and performance should not be attributed to bias, the presence and impact of bias should not be dismissed. Box 1 presents a summary of the main insights from the literature on gender bias in science.

Gendered perceptions of excellence? Excellence is often invoked in academia, for instance as a criterion for recruitment or funding decisions. Increasingly, concerns have been raised about the implications of the reliance on excellence in such justifications, with researchers arguing e.g. that the concept of 'excellence' is a flexible term that can be used for many purposes (including organizing, funding, assessing, and rewarding science) but which has no intrinsic meaning in academia, i.e. no clear definition or objective and transparent assessment criteria. It has also been argued that the overemphasis on excellence may impede rather than promote good research, by discouraging both intellectual risk-taking and incremental 'steady-state' science and instead of rewarding a steady stream of publications in high-prestige journals. The notion of 'excellent' research is also discussed in a gender perspective, where excellence-based initiatives are argued to favor male scientists and to overlook the uneven distribution of male and female researchers across research topics and traditions, with 'excellence'-based criteria tending to favor fields traditionally dominated by men. 'Excellence' has also been described as a gendered social construct that produces gender inequality by rewarding behavior more prominent among male than female scholars. Research has moreover indicated that men are more likely to be viewed as 'excellent' researchers, even when male and female researchers have comparable achievements.

Box 1. Key insights from the literature on bias in science

Selection of talent in academia is often driven by panels and committees responsible e.g. identifying interesting candidates for recruitment and for reviewing grant and job applications. Such panels and committees may be affected by various forms of bias but also by group dynamics and social interaction within a group of panel or committee members. Many studies have therefore examined the role of gender stereotypes, bias, or discrimination as factors in explaining gender differences in science (noting that both women and men hold implicit gender biases, implying that gender inequalities in science may stem not just from the actions of men but also of women).

Overall, the evidence on the existence of gender bias is highly mixed, with a large number of studies finding evidence of bias or pointing to bias as the possible explanation for residual gender differences, while other studies completely refute these findings and arguments. However, as pointed out in a recent review, the volume of literature that claims that gender bias exists and persists is far greater than the body of work that claims that it is diminishing or disappearing. The authors of the same review cautioned, however, against attributing all non-explained gender differences to discrimination and bias and pointed out that a likely explanation for much of the heterogeneity found in the evidence on the existence of gender bias lies in variations and limitations in the methods and data applied in studies of gender bias. Significant methodological and measurement challenges make it difficult to produce convincing evidence of discrimination and bias; moreover, many of the gender disparities examined in academia are partly influenced by self-selection. In the following, we briefly review various subsets of studies on gender bias in science.

Gender bias in academic search, recruitment, and advancement. Gender bias has been advanced as a possible explanation for gender differences in academic career trajectories and scientific performance. Research has pointed to the limited transparency and accountability that characterizes academic recruitment processes, and the role of informal networks in these processes. Studies have found indications of gender bias in the assessment of candidates' competencies and achievements or in the assessment of their willingness to move to another geographical location. However, there are also a handful of studies finding no evidence of bias, with one study even reporting a preference for hiring female faculty over equally qualified male candidates with matching lifestyles.

Gender bias in research funding. The literature offers mixed findings and no clear answers to the question of whether the grant allocation is affected by gender bias. While some studies find a (typically small) gender bias in the award of research funding in favor of men, others find limited or no evidence of bias. Overall, the mapping of the literature has not pointed to compelling evidence of gender bias in grant allocation processes,

Gender bias and discrimination in research assessment. Peer review and performance assessment play a key role in publication, hiring, and grant award decisions in academia. There is extensive research on the limitations and possible bias in peer review processes, and concerns have been raised that research assessment practices may contribute to gender inequalities in research. For instance, it has been argued that the use of bibliometric methods to assess the scientific performance of individual researchers may sustain or increase gender inequalities in research by applying easily measurable and seemingly impartial and objective indicators that disproportionately reward research practices and achievements more commonly associated with successful male scholars than with female researchers (e.g. high scientific productivity or wider and more international research networks). This may create obstacles for talented researchers who diverge from this norm, with the risk of decreasing diversity in academic goals and approaches pursued. Studies from e.g. Denmark and Italy find indications of a significant gender gap in research evaluation practices, either based on bibliometric methods or peer review. Other studies have examined the relationship between the performance assessment of women researchers and the gender of evaluators. The literature on this issue is relatively limited and inconclusive, with some studies finding benefit from same-gender evaluators, some finding evidence of benefit from having an evaluator of the opposite gender, and some find no significant impact of evaluators' gender.

Working conditions in academia. The academic work environment has been described as a 'chilly' or even hostile climate for women, both for early career researchers and for mid-career or late-career researchers. Some studies have documented experiences with sexual harassment or gender discrimination; others have described how norms prevalent in male-dominated academic environments may cause women researchers to feel marginalized and to report a lower sense of belonging within the workplace.

Some of the literature points to the importance of a *critical mass* of women for retaining women faculty and addressing gender disparities, concluding for instance that female researchers active in fields where women are not a numerical minority experienced higher levels of involvement in decision-making and academic collaborations and less stereotyping and had a more positive view of informal relationships in the workplace. Other studies have pointed to the importance of a critical mass or higher proportions of women for how faculty perceive their academic working environment, for achieving gender equity in salaries, for reducing negative effects of having children on research productivity, and for allowing for a more equitable distribution of resources and allocation of time among male and female faculty.

Women are more likely to 'opt out' of academic research. The higher attrition rate of women researchers is key to understanding gendered performance differences. For instance, as mentioned earlier, gender differences in scientific productivity and impact can at least to some extent be explained by gender differences in publishing career lengths and dropout rates. Studies indicate that a large number of factors influence decisions to leave academia, including e.g. career uncertainties, lack of mentors or role models, conflicts at work but also home, level of job satisfaction, and the existence or lack of supportive, family-friendly work culture. There has been a tendency to explain the leaky pipeline as the result of individual decisions to 'opt out' of academia and gender-related differences in preferences associated with working conditions in academia. The argument presented here is that women are less satisfied with the working and career advancement conditions offered by academia, notably the widespread use of time-limited employment contracts and rigid demands for international mobility. A Danish study also pointed to the existence of self-reinforcing feedback mechanisms whereby for instance female researchers working in environments characterized by masculine norms may feel a lower sense of belonging, which in turn leads to lower visibility (e.g. they are less likely to be considered for or encouraged to pursue positions, awards, collaboration etc.,); this lowers female researchers' chance of retention or advancement and reinforces their researchers' lower sense of belonging. Indeed, it has been argued that what may appear to be a 'supply problem' (i.e. that women choose not to aspire to or take top jobs) may actually be a 'demand problem' (i.e. that jobs or organizations are not appealing to women because of the work conditions and career advancement opportunities that they offer), implying that that attempts to attribute gendered outcomes to the inherent characteristics or choices of women are too simplistic or downright inaccurate.

Can accumulative disadvantages help explain gender disparities in academia? Several scholars argue that many of the factors described above may overlap, and that causal relations between them are complex and difficult to discern. For instance, a researcher's scientific collaborations are likely to influence their citation impact, while citation impact may also influence their opportunities for research collaboration. Also, lower productivity levels or a slower career progression may lead to increased teaching duties, leaving less time for research, which in turn reduces productivity levels and opportunities for progression further – as promotion is associated with additional resources for research and increased prestige and influence – which in turn again is likely to hinder further advancement. The cumulative effect of events and decisions that place women researchers at a disadvantage has been referred to as '(ac)cumulative disadvantage'. There is a need for more studies based on longitudinal data that allow for consideration of unobserved variables (including e.g. scientists' intrinsic abilities, capacity, and effort) and for a better understanding of the bidirectional causal relation between scientific performance, and career advancement.

Summary of the literature on diversity with regards to age, career stage, and nationality

In contrast to the vast amount of research on gender diversity, the literature on diversity with regards to age, career stage and nationality is limited and scattered. Researchers' age, career stage and nationality are rarely addressed in the literature with explicit reference to diversity in science. Yet research indicates that academics' approach and contributions to science differ according to age and career stage; as such, participation of (and adequate opportunities for) researchers of different age groups or at different stages of the academic career is likely to contribute to heterogeneity in research within e.g. a research team, a department, or a discipline. This part of the literature mapping, therefore, focuses on factors that influence the retention and career opportunities of scientific researchers depending on their age, academic rank, or nationality.

The increasingly precarious nature of the academic career

Many contributions to the literature address the increasingly precarious nature of academic careers, particularly given the growing use of temporary contracts and uncertainty about future employment prospects for, especially, early career researchers. Given increasing external funding of research, rising numbers of students, and general constraints on public funding, universities have responded by increasing the proportion of temporary staff (particularly in postdoc positions) and keeping the number of core, permanent staff low to increase their ability to adapt to ongoing changes in their external circumstances. These developments have impacted the organization of research: more research is performed by postdocs employed in time-limited and often externally funded positions, and the likelihood of achieving a career as an independent researcher and, ultimately, full professor, has decreased significantly.

As a result of these developments, an increasing number of academic researchers find themselves in prolonged periods of precariousness, which is associated with increasing levels of stress. The years of uncertain and often time-limited employment often coincide with the stage of life in which researchers start a family – which may both add to the overall level of stress experienced by young researchers and increase their interest in the greater job and wage security.

What determines which researchers progress in their academic careers, and which leave?

Many academics leave academia either during the period following the completion of their doctoral studies or in connection with the transition to a position as an independent researcher or principal investigator (PI). Since more than half of all postdocs worldwide leave academia – either by choice or due to lack of opportunity to obtain an academic position – the question is whether academia can retain (enough) of the most talented young researchers and whether it can retain a sufficiently diverse group of researchers.

The literature does not point to any simple or consistently reliable predictors of who remains and who progresses in an academic career. *Scientific productivity and citation impact* play a role in who stays and advances in an academic career, but they cannot predict it. For instance, a study of associate professors in the Italian university system found that new associate professors within the hard sciences were on average more productive than the incumbents, but also found cases of 'non-winner' candidates that were more productive than the 'winners' over the subsequent three years, as well as cases of 'winners' that were wholly unproductive.

Also, *the institution and group within which early career researchers are trained* matter. For instance, PhDs from strong research groups with above-average publication and funding track records, as well as young researchers who trained and/or co-authored with a top scientist, are more likely to continue in an academic career; such findings underline the role that scientific elites can play in shaping the academic landscape.

Another factor that may influence whether and how young researchers progress in their academic career is *how much of their time is devoted to research vs. teaching and faculty service*. Finally, research has indicated that academic careers of talented researchers can be either stimulated or inhibited by an *accumulation of advantages or disadvantages*, which stresses the importance of even seemingly small differences in early careers (e.g. where PhDs were trained, how their PhDs were funded, their early publication activity etc.).

When competition among talented researchers is high, who remains and who progresses in academia can be partly *the product of chance*. While individual merit certainly matters greatly for advancement in an academic career, researchers have indeed questioned the general portrayal of academic career advancement as being a question of merit alone. For instance, some scholars have drawn attention to the unpredictability of an academic career and emphasized the role of coincidences and luck in shaping pathways in or out of the research. In light of growing competition for publications, research funding, and academic positions, the difference between a 'winner' and a 'runner up' may be marginal or non-existent. For instance, career-defining funding grants are often seen as a signal of the most promising research talents. However, research has found the predictive validity of career grants to be low or even – when comparing grant recipients with the best-performing non-successful applicants – absent. And yet career-defining grants matter for the future careers of non-recipients, including e.g. the speed at which their careers progress.

Research highlights several actions that can strengthen opportunities for early-career researchers, including (a) ensuring fair assessment practices e.g. always supplementing bibliometric indicators (which often favor established researchers) with qualitative assessment, and avoiding direct comparisons between early and late-career researchers, (b) offering professional development and mentoring programs, and (c) taking steps to improve working conditions for young researchers with family obligations, including providing work schedule flexibility and increased institutional support policies.

Finally, for early-career researchers, *demands or expectations of international mobility* have increased, becoming a central feature in the selection and early career progression of academics. Yet international mobility may have several different types of impact on academic careers. For instance, research on tenured faculty members from European business schools showed that while mobility had a positive impact on research-career capital, multiple moves delayed academic promotion. Moreover, research indicates that the longer academics stay abroad, the harder it can be for them to return to their country of origin, possibly because of declining social capital. Finally, rigid expectations of international mobility may pose greater challenges to some early career researchers than others, e.g. those in dual-career couples and those with small children, potentially to the detriment of diversity among researchers.

Challenges for foreign-born academics

A stream of research has focused on the experiences and performance of foreign-born academics. It is been argued in the literature that foreign-born academics make important contributions to the research systems in which they work. For example, several studies point to foreign-born academics having higher scientific productivity than their native-born counterparts. This may however be at last partly explained by foreign-born researchers being employed in research-only positions, spending more time on research to maintain their academic position and visa, and spending less time on teaching and faculty either due to e.g. language barriers or a strong research orientation in their work.

Many foreign-born researchers are employed in time-limited positions and funded by external grants rather than institutional funding. As a result, the conditions of their work are typically conditioned by the characteristics and demands of the specific projects and laboratories to which they are associated and only loosely associated with work and priorities in the departments in which they are embedded.

Research has also indicated that *foreign-born academics experience less job satisfaction, receive less support, and have lower salaries,* though such themes have been addressed in only a handful of studies. Also, a few studies examine differences in native-born and foreign-born researchers' engagement with non-academic actors, generally finding that foreign-born academics are less likely to interact with local stakeholders. Moreover, prior research indicates that foreign-born researchers can experience difficulties and barriers related not just to engagement with external actors but more generally in their career as a result of e.g. limited networks to academics or users of research within their country of employment; a lack of tacit knowledge about recruitment, career advancement or funding; language and cultural barriers; isolation; marginalization or lacking inclusion, etc.

No research was uncovered in connection with this mapping of the literature that examined foreign-born researchers' propensity to apply for research funding or their success rates in accessing external funding in their country of employment.

It is worth noting that *the proportion of foreign-born academics varies substantially across disciplines and sub-disciplines* (e.g. due to differences in the extent of team science, the role of external funding, the extent of international collaboration, all factors which tend to be associated with a higher proportion of foreign-born staff, particularly in early career and/or temporary contracts. Challenges and barriers may thus be experienced to a greater extent by foreign-born researchers in disciplines and sub-disciplines, departments, or groups where there is a low proportion of foreign-born staff.

Perspectives on mid-career and late-career academics

Returning to the subject of diversity with regards to age and academic rank, a small subset of studies document ongoing productivity, and collaboration and innovation activity among late-career researchers. This points to the importance of considering the representation and work conditions of older researchers from a diversity perspective.

While the impact of research grants on academic careers is most often studied in the context of early career researchers, research indicates that career grants can also matter for career progression later in the academic career. For instance, a study of prestigious grants from a private US foundation found that such grants can reinforce the careers and visibility of already established researchers engaged in mainstream research fields, while they have a substantial, beneficial impact on the visibility and career prospects of researchers who are less established or engaged in novel or discipline spanning research. This points to the potential importance of research funding in supporting researchers at different career stages and/or engaged in mainstream vs. potentially novel research – a topic that we will return to in the chapter on the literature on diversity with regards to the research field.

Is peer review biased with regards to researchers' age, career stage, or nationality?

Finally, the base of evidence with regards to whether there is bias in peer review related to age, career stage or nationality is small, and it is therefore not possible to draw any firm conclusions on whether bias exists with regards to these aspects of diversity.

Summary of the literature on diversity with regards to research field

Overall, the literature on diversity with regards to research fields is much less coherent than the literature on diversity with regards to e.g. gender. It focuses mostly on studies of multi-, inter-, or transdisciplinarity, which are referred to in this report collectively as 'interdisciplinarity', referring to some form and level of integration of knowledge, concepts, and methods across specialized bodies of knowledge, which may, in turn, lead to the creation of new knowledge, concepts and methods. The literature includes studies of interdisciplinary collaborations and efforts to measure the interdisciplinarity of research but also studies focusing on individual researchers' degree of specialization or diversification in terms of the fields and topics they research. For the purposes of this report, the term 'research field' is used as a synonym for 'research specialty', 'discipline', or 'knowledge domain'.

What is meant by 'diversity with regards to research field'?

Diversity with regards to research field may be defined in different ways. First, diversity with regards to research field may be pursued by an *individual*, for instance when a researcher moves into a new research field, e.g. one that is adjacent or complementary to the field(s) in which the researcher has formerly been active. Second, it may refer to *a collective of researchers* working collaboratively on interdisciplinary research, either within the same research group or in collaboration among researchers affiliated with different groups, departments, institutions, and/or research fields, potentially also including non-academic stakeholders. Finally, diversity with regards to research field may also refer to *variation within a portfolio of research projects or grants*, i.e. the extent to which the grants awarded from a given research funding organization or research activities within a given discipline or research community are concentrated within certain research fields or dispersed across a wide range of research fields. In this mapping of the literature, however, we focus on the first two, as this was the subject of almost all the literature identified.

Arguments for why diversity with regards to research field matters

Based on the mapping of the literature, arguments for why diversity with regards to research fields matters can be divided into three categories. First, field-spanning research may contribute to *more effective problem-solving in science*. Such arguments are often invoked in studies on interdisciplinarity in research, motivated by an expectation that research which integrates insights and methods from multiple fields is more effective in addressing complex scientific or societally relevant problems than research relying on single-field approaches. This in turn is based on an expectation that knowledge and actions within such a team are more likely to consider the full range of perspectives and approaches relevant to solve the problem that the team is addressing.

Second, field-spanning research plays a crucial role in *the development of scientific disciplines and specializations.* Scientific fields are not static but evolve over time, as the problems that researchers pursue, as well as the means by which they pursue them, are all subject to change. Field-spanning research is crucial in the development of new research fields, and thus also in the academic communities that emerge to address these fields.

Finally, field-spanning research can contribute to *increased levels of variation in questions and methods in science*. A stream of research focuses on the role of interdisciplinarity or cognitive diversity in increasing heterogeneity in research or in increasing the likelihood of achieving novel and important scientific advances or breakthroughs. Yet, science, left to its own, has strong conservative tendencies which imply that each scientist has a strong incentive to opt in favor of promising but 'safe' projects rather than more radical but also riskier research paths. It has been argued that cognitive diversity is particularly beneficial to the advancement of science when the scientific community is faced with sufficiently difficult problems, suggesting that heterogeneity is most beneficial in dealing with complex problems, while homogeneity may be conducive to driving incremental progress along established research paths formed around well-defined problems.

It is also pointed out in the literature, that too much cognitive diversity can be too much of a good thing. Evidence on performance in research teams with disciplinary heterogeneity has been mixed, prompting some recent studies finding a curvilinear relationship between heterogeneity and performance in scientific research groups, i.e. that lower or moderate levels of heterogeneity may be beneficial while high levels of disciplinary heterogeneity entail excessive coordination and collaboration challenges that hamper the performance of the group.

Which factors influence researchers' likelihood of pursuing field-spanning research?

Given that crossing field boundaries is one mechanism that can stimulate heterogeneity and variation in research, it is relevant to ask what makes researchers pursue research paths that diverge from the fields in which they are specialized. The literature points to several factors that influence researchers' incentives to engage in research that crosses field boundaries.

It is argued, for instance, that interdisciplinary and other novel, field-spanning research agendas may offer *a particularly risky path forward for early career researchers*. They have yet to develop a strong disciplinary standing and engaging in field-diverse research is likely to require longer time, involve greater risk (thus delaying scholarly outputs), and make it more difficult for them to publish in prestigious journals and possibly to attract funding and secure academic positions – all situations in which they could be placed at a disadvantage vis-à-vis candidates with a strong disciplinary profile.

Research indicates, however, that *how early career researchers are trained can influence their propensity to later forge independent research careers.* For instance, there are some indications that allowing young researchers higher degrees of autonomy in early-career training encouraging them to deviate from conventional research topics are associated with a higher degree of cognitive independence or original research later in their careers. One study also found that mentorship i.e. working with pioneering top researchers can influence younger scientists' likelihood of pursuing original research paths.

A stream of research focuses on *the influence of gender, thinking styles, and personal preferences on research agendas,* investigating whether scientists' preferences for cognitive specialization vs. diversification in research is either gendered or determined by individual differences in thinking styles and personal preferences. For instance, some studies argue that men generally seek to isolate explanations and gravitate towards abstract and theoretical arguments, while women tend to prefer problem-oriented domains with the potential to impact the community. Women are also argued to prefer assimilating diverse forms of information and for making connections between ideas and the larger context, possibly making women more likely to pursue field-spanning research. Other authors have argued that whether researchers opt for specialization or diversification in their research agendas may have to do not with gendered differences but simply with individual differences in cognitive thinking styles or preferences. For instance, while some researchers have a preference for undertaking incremental research within established domains, others exhibit a preference for holistic thinking and problem-oriented domains, making them more likely to be open to expanding their work into new fields.

The academic career lifecycle may influence scientists' likelihood to engage in field-spanning work: empirical work has indicated that academic researchers tend to focus on singular topics at the beginning and the end of their careers, while often diverging into varied topics and disciplines during the mid-career stage. However, despite studies suggesting that a strong disciplinary background is an advantage in interdisciplinary work, research has shown that the most prominent (i.e. highly cited) researchers tend to pursue a so-called ‘scatter-gather’ strategy, essentially remaining focused on one or two fields over the course of their career, while low-cited researchers work on various areas at a time as well as over the course of their entire career. However, given prior findings that interdisciplinary and novel work may have lower citations take longer to accumulate citations, the relevance of using citations as a proxy for prominence in this study could be questioned.

The literature points to several *disincentives to engage in field-spanning research.* For instance, a recent study found that economics researchers are becoming less likely to diversify into new fields, which the authors attributed to switching costs associated with the need for researchers to be aware of and relate their work to a growing body of literature, and to identify relevant open problems that can be solved with a reasonable effort.

More generally speaking, researchers have pointed out that there is a mismatch between many policymakers’ and research funders’ desire to promote interdisciplinary research on the one hand and the formal organization of universities and incentive structures in science on the other, which generally favor disciplinary work. The transaction costs involved in entering new scientific fields, combined with the risks of pursuing novel, interdisciplinary work, may penalize cognitively diverse researchers or altogether deter researchers from pursuing cognitively diverse research paths. Several studies moreover find support for the hypothesis that field-spanning work is associated with lower productivity, presumably due to the time needed to integrate insights and tools from different fields, and due to the higher risk of failure.

Finally, it has been argued that increasing competition in academia has created incentives for researchers to submit more conservative applications for funding and pursue low-risk research strategies, as research proposals and publications with a high degree of novelty are likely to have less preceding work to build on and to be more difficult to assess within standard disciplinary assessment criteria, which may disadvantage them in the peer-review process. It may also be more difficult to identify suitable reviewers for research proposals and candidates with an interdisciplinary profile.

An extensive review of research on the peer review process examined, among other things, whether there was evidence of *bias against interdisciplinary work*. The careful conclusion of this review was that it is unclear if peer-review treats interdisciplinary research fairly. There is some evidence that interdisciplinary research is associated with lower success rates, but the review called for more research on this topic. Moreover, the review argued that while peer-review appears effective in weeding out research and research proposals of *inferior quality*, it is unclear whether it can effectively identify the *best* research, particularly with this research is interdisciplinary and/or otherwise highly novel. The same review also concluded that the evidence on whether peer-review is affected by a tendency among reviewers to favor their field or way of thinking is unclear, as the evidence also here is mixed.

Finally, a study of grants awarded by a UK funding body found that structurally diverse teams were penalized and biased against. In other words, teams that exhibited greater diversity in knowledge and skills, education, and/or scientific ability were significantly less likely to obtain funding, although they were generally more likely to be successful in their research endeavors (though the effects of these biases were weaker and even negligible for teams led by prestigious researchers).

2

Methods

2 Methods

The aim of this literature mapping was to develop an overview of academic research on diversity in science focusing on the following, selected aspects of diversity: gender, age and career stage, nationality and research field. Identification, screening, and synthesis of the literature as well as the reporting of the results was completed within six months (October 2020-March 2021).

The literature on diversity in science is extensive; it is also distributed across a wide range of themes and publication outlets. Moreover, the literature is characterized by a high degree of heterogeneity with regards to research themes, study designs, methodologies, and the types of data employed in the literature, which – particularly given the sheer volume of relevant research and the time and resource constraints on the project – meant that it was not possible for us to critically assess the data, methods or validity of the studies included.

As such, our focus was on creating an overview of key themes and findings presented in the literature, to provide research funders and other decision-makers with insight into the state of the literature on the selected aspects of diversity covered, that is, gender, age and career stage, and nationality and research field.

The survey of the literature was designed as a mapping of the literature (loosely inspired by Chambers et al. 2017; Miake-Lye et al. 2016; James, Randall, and Haddaway 2016). Systematic mapping or 'evidence maps' refer to attempts to systematically identify and describe existing evidence within a topic of interest. Unlike systematic reviews, which tend to focus on narrowly defined questions and detailed assessment of the evidence base addressing these specific questions, systematic mapping is used to provide an overview of themes and trends within a given area of research (James, Randall and Haddaway 2016). Systematic mapping is appropriate for instance when the body of relevant work is extensive and highly heterogeneous, consisting e.g. of a mixture of quantitative and qualitative studies; emphasis is on mapping key developments in the field, and critical appraisal of included studies is optional (James, Randall and Haddaway 2016).

Finally, it is worth noting that research on diversity in science draws on perspectives and empirical data from a wide variety of countries. We have chosen in this survey to focus on studies from Europe, North America, and Australasia. There are large differences across countries in labor markets and socio-cultural norms that may influence diversity in science e.g. the availability and cost of childcare, public spending on research and development, and the overall level of gender equality in the workforce (Solera and Musumeci 2017). Where relevant, we, therefore, specify which countries studies have focused on and underline that caution should be taken in generalizing insights from one national context to others. Nevertheless, the institutional, organizational, and cultural contexts of science that might influence gender issues are to some extent global – e.g. regarding scientific publication (which are closely tied to norms and practices within disciplines) – meaning that while we can expect some cross-country and regional variation, some findings are likely to be transferable from one national or cultural context to another.

The literature search was undertaken in Scopus. Preliminary searches yielded a high proportion of irrelevant results, as many of the key terms (e.g. 'diversity', 'gender', 'age', 'career stage', 'nationality' and 'research field') are commonly used in a variety of contexts, making it difficult to easily delineate the body of research on diversity in science with regards to gender, age and career stage, nationality and research field.

The following sets of search terms were used in the literature search in an effort to capture as many relevant publications as possible: (("diversity in science") OR ("diversity in academia")), ("gendered science"), ("gender in science”), (("female researchers") OR ("female academics") OR ("female faculty")), ("inequality in science”), (("parenthood") AND ("academic career*")), ((“academic career life cycle”) OR (“academic career stage”)), ((“early career researcher*”) OR (“mid career researcher*”) OR (“early career scientist*”) OR (“mid career scientist*”) OR (“late career researcher*”) OR (“late career scientist*”)), ("disciplinary diversity"), ("research diversification"), (("research funding”) OR ("research funder*”) AND (“diversity”)).

These search terms still resulted in an unmanageable number of search results. The following limitations were introduced to narrow the search: publications had to have been published in 2010 or later; document types were limited to journals, book chapters, and books; source types were limited to peer-reviewed journals and books, and the search was limited to publications in English. The literature search was also limited to publications in the following subject areas: Social sciences; Economics, Econometrics, and Finance; Psychology; Business, Management, and Accounting; Arts & Humanities; Multidisciplinary.

These searches resulted in a total of 5,444 publications, which were screened based on their title and, where necessary, abstract after duplicate publications had been deleted. Articles were omitted if for instance they exclusively dealt with other aspects of diversity than those in focus in this survey (e.g. diversity with regards to race or ethnicity, gender orientation, sexual preference, disability, etc.) or if they drew exclusively on empirical data from geographical areas other than Europe, North America or Australasia. Publications were also omitted if they focused on diversity issues in science teaching, primary and secondary education, tertiary education (unless they explicitly addressed the ‘pipeline’ of students into doctoral studies and academic research careers), and in private firms or in the non-academic workforce in general. In addition, studies that were pure method development papers (e.g. developing new indicators to measure interdisciplinarity in research) and included limited or no conceptual/theoretical development and no empirical application were omitted. Finally, many studies were omitted simply for lack of relevance, i.e. papers on e.g. technological diversity or innovation in farming.

This resulted in a set of 1,230 publications, which were then submitted to a second screening based on their abstract. 729 of these addressed gender diversity; 519 diversity with regards to age or career stage; 71 diversity with regards to nationality; 145 diversity with regards to research field; while 45 dealt with diversity issues in general. Some publications addressed two or more of these themes, e.g. both gender diversity and diversity with regards to age or career stage (which was by far the most common combination of themes).

Upon closer reading of the abstracts, more than some of these publications were omitted for lack of relevance or added value. In total, the 1,230 selected in the second screening were narrowed to approximately 440 publications.

Also, relevant work published before 2010 was identified and included, based on references from articles identified in the literature search. In particular, prior work was included when references were made to seminal papers that e.g. defined key concepts or lead to major trends in the research, and when the literature drew heavily on work published before 2010 (particularly when older references were deemed useful in making sense of mixed evidence on a given theme). In total, 67 articles were included through such ‘snowballing’. In total, approximately 500 publications were included in the mapping.

3

The literature on diversity with regards to gender

3 The literature on diversity with regards to gender

Gender diversity in science is a long-standing issue in academia. The debate regarding gender issues in science is however highly polarized and often draws on normative perspectives that are either critical or favorably inclined towards efforts to address gender inequality.

The literature on gender diversity in science is extensive. It is also fragmented across topics, methods, and publication outlets (Dehdarirad, Villarroya and Barrios 2015), and its results are often inconsistent and thus inconclusive (Ceci et al. 2014). The mixed results found in the literature have been attributed to the complex and changing nature of gender differences that exist in academia (Webber and González Canché 2018) but also to variation in the data and methods applied to studies of gender differences in science (Traag and Waltman 2020).

There are many variations in the literature with regards to which terms are used, and how they are used, which contributes further to a lack of clarity regarding the state of knowledge about gender issues in science. In this report, we draw on the following definitions of 'gender inequality', 'gender difference', 'gender disparity', and 'gender bias' as recently defined by Vincent Traag and Ludo Waltman in a blog post:

> We propose to define a "gender inequality" or a "gender difference" simply as any observed difference between people with a different gender.
> Our proposal is to use the term "gender disparity" to refer to any difference between people with a different gender that is *causally affected by their gender*. This means that if a woman had been a man (or vice-versa), the outcome of interest would have been different.
> The strongest term is "gender bias", which we propose to define as any difference between people with a different gender that is *directly* causally affected by their gender. Similar to a gender disparity, this means that if a woman had been a man, the outcome of interest would have been different. However, whereas a gender disparity may be the result of an indirect causal pathway from someone's gender to a particular outcome, a gender bias is a *direct* causal effect.
> To clarify the distinction between a gender disparity and a gender bias, consider the example of being accepted at a prestigious university. Suppose that the acceptance rates for men and women are equal for each study programme, but that some study programmes have lower acceptance rates than others. If women apply more often for study programmes with lower acceptance rates, this results in a lower overall acceptance rate for women. In this case, there is a gender disparity in the overall acceptance rate. However, because the causal effect is mediated by study choice, this gender disparity should not be called a gender bias (...). In contrast, suppose that a change in someone's gender on an application form affects the acceptance decision. In that case, gender does have a direct effect on acceptance, which means there is a gender bias in acceptance rates.
> (Traag and Waltman 2020)

In this chapter, we begin by outlining key arguments presented in the literature for why gender diversity in science matters (in section 3.1), before turning our attention to observed gender differences in researchers' career trajectories (3.2), in their scientific performance (3.3) and research funding (3.4). We then examine proposed explanations for these gender differences (3.5), before outlining ways in which different actors in and around academia have sought to address gender inequalities in sciences (3.6).

3.1 Arguments for why gender inequality in science matters

Different arguments are presented in the literature for why gender differences in science should be investigated and addressed. We argue that these arguments tend to fall into one of two categories, which are described below.

Ensuring representation, avoiding loss of talent, and providing equal opportunities

The first set of arguments call for equal opportunities for all qualified researchers to pursue and excel in an academic career, regardless of their gender. First, some researchers emphasize the importance of *increasing thr representation of underrepresented groups* in academia, including but not limited to female researchers. The second set of arguments focus on how higher attrition rates for female researchers represent a problematic *loss of talent* for the academic research community (e.g. Goulden, Mason, and Frasch 2011). Meanwhile, the third set of arguments call for the removal of *unreasonable barriers* for female researchers to pursue or advance in a research career, regardless of whether these barriers stem from discrimination, conscious or unconscious bias, or structural barriers, i.e. to ensure equal opportunities for all talented researchers (e.g. Valantine and Collins 2015; Campbell et al. 2013).

Increased creativity, variety, and relevance in scientific research

The second set of arguments focus on possible benefits of research from diversity or heterogeneity among researchers. First, several studies (see box 1) have argued that a moderate level of heterogeneity among members of a research team or similar group is associated with *a higher degree of creativity and strengthened problem-solving ability*. Here, gender diversity has been identified as one of several possible sources of heterogeneity in groups, with gender being associated with e.g. heterogeneity in cognitive thinking styles and in communication styles, which can contribute positively to the overall performance of the group.

Box 1. Moderate gender diversity can strengthen creativity and problem-solving in teams

Nielsen et al. (2017) argued that gender diversity matters for the outcomes of scientific research processes, highlighting that prior work has documented that cognitive diversity in groups matters for their ability to perform well in creative tasks. For example, Woolley et al. (2010) investigated factors that influence groups' ability to perform a wide variety of tasks, which they refer to as the 'collective intelligence' of the group. They found that groups' task solving ability was associated positively with the average social sensitivity (i.e. the ability to identify other people's emotions) of group members), with the degree of equal participation in group discussions, and with the proportion of women in the group. The latter, according to the authors, was likely to be mediated by the fact that women tend to exhibit higher levels of social sensitivity. In a later paper, Woolley, Aggarwal, and Malone (2015) reiterated the conclusion that a group's collective intelligence is a better predictor of group performance than the intelligence of its individual members. Building on prior research showing that groups performing creative or innovative tasks tend to benefit from diversity within the group, while groups tasked with ensuring or increasing efficiency are often hampered by diversity (Williams and O'Reilly 1998), and that cognitive diversity in e.g. thinking styles and perspectives are crucial for the collective intelligence of groups (Kozhevnikov, Evans and Kosslyn 2014), Woolley and colleagues found that evidence of a curvilinear relationship between cognitive-style diversity and collective intelligence. Put differently, groups with moderate levels of diversity in cognitive styles performed better than groups with very similar or very dissimilar cognitive styles, underlining that excessive diversity can be as harmful to creative achievements in groups as lacking diversity.

Valantine and Collins (2015) cited multiple prior studies indicating that gender diversity can contribute positively to complex problem-solving and creative work in teams as well as broaden perspectives and approaches in e.g. corporate and healthcare settings, and called for more evidence on the impact on gender diversity for the quality and outputs of academic research, particularly from beyond the biomedical disciplines, which has been the subject of most existing studies on this topic. On a more general note, Phillips (2014) argued that differences within a group (whether these stem from e.g. ethnic/racial differences, gender differences, or opposing political views) promotes creativity and innovation by removing assumptions that everyone holds the same information and shares the same perspectives, and by increasing the likelihood that divergent and alternative perspectives are put forth and discussed.

On a related note, Campbell et al. (2013) found that gender-heterogeneous teams typically produced journal articles that were more heavily cited by peers than teams comprised of highly-performing individuals of the same gender: peer-reviewed publications by gender-heterogeneous authorship teams received 34 percent more citations than publications produced by gender-uniform authorship teams. This may indicate that research by mixed-gender teams have a greater impact on scientific discussions. In this connection, it is worth noting that Holman and Morandin (2019) found that researchers co-publish with colleagues of the same gender more often than expected by chance, with this pattern being consistent and even becoming slightly more pronounced over the past ten years. Moreover, their study also found that publications in journals with high impact factors tended to have a relatively low proportion of same-gender coauthor teams, again possibly indicating a positive association between mixed-gender author teams and research with high scientific impact.

Nielsen, Bloch, and Schiebinger (2018) however pointed out that team members' beliefs about the possible benefits of gender diversity can matter for team outcomes, citing various prior studies including one that found that openness to diversity was positively associated with performance in gender-diverse teams (Lauring and Villesèche 2019).

Moreover, national and cultural contexts matter: a meta-study of 68 diversity studies concluded that gender-egalitarian societies (e.g. Canada, Finland, and Sweden) are more likely to see positive effects of team diversity on task performance than less egalitarian societies (Schneid et al. 2015, cited in Nielsen, Bloch, and Schiebinger 2018).

Although many studies highlight possible benefits of diversity, meta-studies do not provide a clear picture of whether the main effects of diversity in teams are positive or negative, as benefits from e.g. diversity in thinking styles and approaches may be reduced or outweighed by higher levels of detachment and conflict (Chambers et al. 2017). Nonetheless, the literature does offer insights into the conditions under which increased diversity can lead to positive outcomes and thus into how best to manage diversity (Chambers et al. 2017).

Second, it is argued that diversity can *contribute to greater variety in research questions and approaches* (see box 2), as researchers who differ from each other are more likely to pursue different types of research fields, research questions, methods, types of interaction with non-academic actors, etc. For instance, there are indications in the literature that women and men may differ in their preferences for research fields and methods. Such variation implies that the full body of research covers a broader range of themes and approaches, which ultimately increases the responsiveness of research to the full set of societal needs.

Box 2. Gender diversity may contribute to greater variety in research questions and approaches

Gender diversity in scientific teams can increase the perspectives, research questions, and research areas addressed. For example, Nielsen and Börjeson (2019) examined how the intellectual contents of research disciplines change as they become more gender diverse. In a study of more than 25,000 management papers, they found no effects of team gender diversity on per-paper scientific impact when controlling for factors such as geographical setting, institutional prestige, and authors' collaboration patterns. However, they found a consistent pattern of gender-related variations in research focus: while women researchers were well-represented in social and human-centered areas of management, men were more likely to author papers addressing more technical and operational areas of management. In conclusion, the authors argued that gender diversity may lead to a wider range of perspectives, values, and questions which can increase the responsiveness of research to the full set of societal needs and expectations.

Nielsen, Bloch, and Schiebinger (2018) proposed paying greater attention to the impact of gender diversity on the research questions and priorities addressed in a field, based on the idea that for instance, female entrants into a male-dominated discipline may bring new research questions to light. As the authors pointed out, no studies appear to have systematically examined whether gender diversity is associated with changes in the types of questions asked within a field, though they cite historical examples indicating that women's entrance into traditionally male-dominated research fields coincided with broadening research agendas, e.g. in medical research, primatology, and history.

However, Nielsen, Bloch, and Schiebinger (2018) called for research on whether the relationship between team diversity and diversity in research questions differs across disciplines, characterized by different disciplinary norms and epistemic cultures, and for more insight into how organization factors (e.g. different organizational climates, staff policies, and human resource management practices) influence gender diversity in teams.

Finally, a stream of the literature focuses on the role of diversity in *strengthening the relevance of research* (see box 3). Research has shown that author teams with women authors are more likely to consider and report sex and gender-related factors. Researchers have long pointed to the importance of considering the role that gender and sex analysis may play in informing procedures and practices in healthcare, in light of well-documented differences in e.g. physiology and therapeutic response among men and women. Though the importance of including and reporting gender and sex analysis has been focused on the health sciences, it has been argued that incorporating gender and sex analysis into experimental designs is likely to improve science and engineering across disciplines (e.g. addressing known gender bias in algorithms or differences in sex-based responses to climate change), by promoting more rigorous and responsible research and, ultimately, greater social equity.

Box 3. Gender diversity may contribute to greater relevance in research

Women's participation in science matters for the extent to which research considers the role of sex and gender-related factors in their studies: based on a study of more than 1.5 million medical research papers, Nielsen et al. (2017) found that papers with women authors as first or last authors were more likely to include sex and gender as variables. A similar conclusion was presented by Sugimoto et al. (2019). Indeed, gender and sex are important factors to consider in many studies. Researchers have for example pointed to the importance of considering the role that gender and sex may play in biomedical and health research in order to ensure complete and accurate results that may inform procedures and practices in health care – including e.g. choice of diagnostic tests and treatments – ultimately improving patient outcomes (Day et al. 2017; Legato, Johnson, and Manson 2016; Nielsen et al. 2017).

The physiology of women differs from that of men, and there are well-documented differences between men and women, in how they experience illness and in their responses to therapeutic interventions (Legato, Johnson and Manson 2016); nonetheless, female subjects have only been included in clinical trials in recent decades (Legato, Johnson and Manson 2016). Moreover, there is growing evidence that both sex and gender have a role to play not only in how individuals respond to treatment but also in their choice of treatment (Clayton and Tannenbaum 2016).

Here, it is important to differentiate between sex and gender: 'gender' refers to "social, environmental, cultural, and behavioral factors and choices that influence a person's self-identity and health" and thus includes e.g. gender identity, norms and relations; meanwhile, 'sex' refers to a set of biological attributes that influence individuals' health (Clayton and Tannenbaum 2016).

Debates regarding the inclusion of gender and sex-related factors in academic research remain salient, as seen for example in a recent study of registered clinical trials aimed at developing new treatments and vaccines for COVID-19: Brady et al. (2020) examined the inclusion of sex and/or gender in registered SARS-CoV-2/COVID-19 studies on ClinicalTrials.gov and found that less than 17 percent of 2,484 registered trials explicitly mentioned sex or gender as a criterion considered in the recruitment of participants and that around just 4 percent mentioned sex or gender in the description of their analysis. In addition, the authors found that none of the 11 clinical SARS-CoV-2/COVID-19 trials published in scientific journals in June 2020 reported results disaggregated by sex, which according to the authors indicates that a lack of mention of gender or sex in connection with the registration of trials is not corrected during the execution or reporting of trials. Yet existing knowledge indicates that sex and gender matter for both SARS-CoV-2 infection and COVID-19 mortality, as well as for efficacy and the incidence of side effects associated with medical treatment of infections.

Day et al. (2017) argued that subjects' sex should be integrated into research designs from the outset of the research process, i.e. at the stage during which research proposals are developed, to ensuring meaningful integration of gender-related factors. Moreover, data should be analyzed and reported by sex, gender, or both, to avoid the risk of overlooking differences in e.g. male and female subjects in clinical studies, and to facilitate e.g. replication and meta-studies (Clayton and Tannenbaum 2016).

Guidelines for researchers for considering and reporting sex and gender differences in studies have been put forth (see e.g. Day et al. 2017). Moreover, some funders have underlined the importance of considering sex as a factor in relevant studies. For instance, the US National Institutes of Health requires grant applicants to consider and report relevant biological variables including sex as a variable in biomedical research (Clayton and Tannenbaum 2016; Legato, Johnson and Manson 2016).

While gender and sex analysis are increasingly considered in the life sciences and medical sciences, and to some extent also in e.g. computer science, attention to the potential importance of sex and gender-related factors in other disciplines e.g. engineering remains limited (Nielsen, Bloch, and Schiebinger 2018). However, Tannenbaum et al. (2019) presented a compelling argument that incorporating gender and sex analysis into experimental designs is likely to improve science and engineering across the board, by promoting more rigorous and responsible research and ultimately greater social equity. As examples of gender and sex analysis that can strengthen the interpretation, validation, reproducibility, and generalizability of research findings, they mention (among other examples): research into the genetic and hormone-mediated basis for sex differences in immunity (e.g. relevant for novel cancer immunotherapies); gender bias in algorithms, including e.g. that facial recognition systems, are more likely to misclassify gender for darker-skinned women than for lighter-skinned men; insight into sex-based responses to climate change enabling improved modeling of demographic change among marine organisms and downstream effects for humans; and that seatbelts and airbags have been designed and evaluated with a focus on the typical male occupant, with data indicating that belt-restrained female driver is more likely to sustain severe injuries in a crash than male drivers.

3.2 Gender differences in academic career trajectories

The 'leaky pipeline'

Many policy reports and academic studies document a skewed gender distribution within academia.

The observation that the proportion of women decreases along the academic career path is often described using the metaphor of the 'leaky pipeline', which was first introduced by Berryman (1983). Studies, particularly from the US, have shown that women are particularly likely to 'leak' out of the academic pipeline in connection with personal events such as marriage and childbirth (Goulden, Mason and Frasch 2011; Ahmad 2017; Cruz-Castro and Sanz-Menéndez 2019). For instance, female doctoral students with children are less likely to complete their doctoral studies than students with no children (Wladkowski and Mirick 2020).

Exit from academia may also occur after a major career event such as e.g. completion of the Ph.D. degree (Paksi, Nagy and Király 2016; Titone Tiv and Pexman, 2018; Lörz and Mühleck 2019). For example, Evers and Sieverding (2015) examined academic career intentions among 380 postdocs who had recently completed their Ph.D. at a German university and found that women were less likely to report academic career intentions than men were. A follow-up study eight months later revealed no gender differences in the intention to continue in an academic career among the 129 postdocs who were still working in academia, indicating that early events and decisions are crucial in understanding why women leak out of the academic pipeline after their Ph.D.

Studies have also shown that women are more likely to leave academia in connection with the transition to researcher independence (e.g. Ley and Hamilton 2008) or a tenure-track position (Caprile et al. 2012). Moreover, women are less likely to apply for tenure-track positions than men (Ceci et al. 2014).

Several studies point to the importance of early-career decisions and events for understanding gender differences in career trajectories. For instance, Danell and Hjerm (2013) found that women are significantly less likely than men to become professors in Sweden and that women's prospects of becoming professors have not improved over time. They also found that gender differences in promotion rates could be attributed to early career events. In a related study, Danell and Hjerm (2013b) explored one such event, the prestigious postdoctoral fellowship, and concluded that male and female researchers had the same probability of achieving a fellowship and that men and women who had achieved this had equal opportunities to become professors. However, in the group of young researchers who were not awarded a postdoctoral fellowship, women were substantially worse off than their male counterparts.

Other gender differences in career trajectories in academia

Based on longitudinal studies of researchers' career trajectories, Ramos, Cortés, and Moreno (2015) found that male and female researchers have rather different trajectories, with men's careers described as more 'linear', and women's careers described as "non-linear", i.e. marked by interruptions associated with e.g. parenthood and caregiving duties.

Data also indicate that women researchers are more likely to be employed in part-time, time-limited, and non-tenured positions. For instance, based on a review of prior studies, Misra, Lundquist, and Templer (2012) concluded that women researchers with children have lower tenure rates and are more likely to be employed part-time or in non-tenured positions than male researchers or female researchers with no children, and they are also more likely to leave academia.

Moreover, data indicate persistent a gender pay gap across countries, both in the labor market in general and in scientific and research occupations in particular (Caprile et al. 2012). Research on gender differences in pay in academia is scarce (Caprile et al. 2012), and existing studies on this topic tend to focus on selected countries (Renzulli et al. 2013; Javdani and McGee 2019) or even particular research disciplines within a selected country (Kelly and Grant 2012; Mumford and Sechel 2020), providing limited generalizable insights. Nonetheless, Caprile et al. (2012) argued that observed gender differences in pay are partly explained by the underrepresentation of women in leadership positions but also e.g. by differences in working time for men and women, pointing to the complexities involved in understanding the causes of gender differences in pay.

Several studies have found that women advance more slowly in their academic careers (e.g. Cruz-Castro and Sanz-Menéndez 2019; Ryazanova and McNamara 2019; Waaijer et al. 2016; Heijstra, Bjarnason, and Rafnsdóttir 2015; Pyke 2013; Kelly and Fetridge 2012; Barrett and Barrett 2011). Also, Carter and Tully (2019) found that women researchers' careers tend to plateau at the mid-rank level (e.g. associate professor) while men's careers tend to accrue towards the highest rank (i.e. professor).

According to a review of the literature by Caprile et al. (2012), family and caregiving duties play an important role in explaining gender differences in academic career trajectories. They stress that family especially influences the early career stages stretching from the first university degree to the first tenure-track position, during which important career events and demands of e.g. scientific productivity and mobility for many women coincide with childbearing years.

A report on career paths among scientists in Denmark echoed many of the findings in the international literature within the context of Danish academia (DFiR, 2019). First, career progression has slowed for both genders, as it generally takes researchers two years longer to be promoted to associate professor (compared to ten years ago). Men (particularly if they have no children) are more likely to be hired as a full professor than women (particularly women with children, who are the least likely to become full professors). Women were also more likely than men to be hired in time-limited professor appointments (the so-called 'professor MSO'-position). The same report showed that researchers with children – and women with children in particular – have become more likely to leave science: today, 54 percent of women with children have left academia six years after completion of their Ph.D. degree, compared to 38 percent twenty years ago; also, 44 percent of men with children haft left academia six years after their Ph.D., compared to 31 percent twenty years ago. The proportion of childless researchers leaving academia today has remained relatively stable over the past two decades, for both women and men.

Some recent studies have suggested that gaps in career advancement between men and women in academia may be narrowing or disappearing among younger generations of researchers (Webber and González Canché 2018; Ceci et al. 2014; van Arensbergen, van der Weijden, and van den Besselaar 2012) or emerge in later career stages (van den Besselaar and Sandström 2016). For instance, Webber and González Canché (2018) did not find evidence of gender differences in the path toward tenure in the US higher education labor market in the first decade after degree completion. However, they did find that women academics had significantly lower salaries than men and that the gender gap in salaries grew from approx. 12.000 to 21.000 USD over the decade.

Finally, women are also less likely to work in university management (e.g. Shepherd 2017). Moreover, in a study of deans in US medical schools, Schor (2018) found that women were most prevalent in decanal positions focusing on education and mentoring or institutional public image and least prevalent in those focusing on corporate strategy and policy, finance, or government relations. The same study also found that schools with female deans or interim deans had a higher percentage of women in decanal positions than those with a male dean or interim dean.

Differences across research fields

Women's participation in science varies across disciplines (e.g. Silander, Haake and Lindberg 2013). The underrepresentation of women is most apparent in mathematically intensive fields, such as geoscience, engineering, economics, mathematics/computer science, and the physical sciences, while the proportion of women is much higher in other scientific fields such as psychology, the life sciences, and the social sciences (Burnett et al. 2012; Duch et al. 2012; Ceci et al. 2014; Su, Johnson and Bozeman 2015; Thelwall 2018).

Women also appear to specialize in different sub-fields than their male colleagues do. For instance, while the proportion of women is higher in the humanities overall, it is lower in philosophy; similarly, while women are more common in the social sciences, they are less common in economics and political science (Fine et al. 2014). Based on a study of more than 5.4 million research papers indexed in the Web of Sciences databases, Larivière et al. (2013) found gender differences in the fields that researchers specialize in; female-dominated disciplines included nursing, midwifery, speech, language and hearing, education, social work, and librarianship. Male-dominated disciplines included military sciences, engineering, robotics, aeronautics, and astronautics, high-energy physics, mathematics, computer science, philosophy, and economics. Like Eve et al. (2014), the authors also noted that while publications from social science disciplines revealed a larger proportion of women authors, publications in the humanities were predominantly authored by men.

On a related note, Dolado, Felgueroso, and Almunia (2012) analyzed gender distributions across research fields in economics based on a dataset of almost 1,900 researchers affiliated with top-50 economics departments. They documented an uneven distribution of women across research fields and found that the likelihood that women work in a given research field was positively related to the proportion of women already working in that field (though younger female researchers were more likely to spread out evenly across research fields). Light (2013) demonstrated that women in sociology are represented in some subfield specializations that are associated with a lower likelihood of achieving publication in prestigious journals, and Zeng et al. (2016) found evidence for gender segregation in some sub-disciplines in molecular biology, in particular in genomics, where female faculty was clearly underrepresented.

Thelwall et al. (2019) also drew attention to gender differences in the choice of research fields and subfields, which they argued, with reference to prior research, may be explained by differences in male and female interests or by gendered norms in some fields, which may be off-putting to researchers of the opposite gender. In a study of US male and female researchers between and within 285 narrow Scopus fields inside 26 broad fields, Thelwall and colleagues concluded that differences in field specialization cannot be explained fully by gendered differences in interests, although they noted the following exceptions: greater female interest in veterinary science and cell biology, and greater male interest in abstraction, patients, and power/control fields, such as politics and law. The authors noted that these differences might be explained not just by gendered differences in interests, but also e.g. the availability of alternative career options. They also found that women were more likely to use exploratory and qualitative methods, and males were more likely to use quantitative methods.

Finally, Nielsen, Bloch, and Schiebinger (2018) emphasized the importance of ensuring adequate career and funding opportunities and recognizing the value of non-mainstream perspectives for reducing the risk of gendered "ghettoization" in both male and female-dominated sub-disciplines.

3.3 Gender differences in research patterns and performance

Several studies have described gender differences in how men and women undertake research and in their scientific performance; some key findings from this literature are outlined in the following.

Women tend, overall, to have fewer academic publications than men

Several studies have found that female researchers are less productive than their male counterparts, meaning that they produce fewer publications. Though gender differences in productivity vary to some extent across disciplines – and are reduced when studies control for factors such as career length, academic rank, and time devoted to research – findings regarding the lower productivity of women researchers remain largely consistent across a wide range of disciplines, geographical areas and measures of researchers' productivity (Lerchenmueller and Sorenson 2018; van den Besselaar and Sandström 2017; Beaudry and Larivière 2016; Mairesse and Pezzoni 2015; Larivière et al. 2013; Snell et al. 2009; Jagsi et al. 2006; Stack 2004; Xie and Shauman 1998; Long 1992; Cole and Zuckerman 1984).

Results are mixed, however, with some studies finding few or no productivity differences among women and men – both in older studies from the 1990s (see references cited in Kretschmer and Kretschmer 2013) and in more recent studies. For instance, Sotudeh and Khoshian (2014) found no gender differences in productivity in nanotechnological research. Similarly, in a longitudinal bibliometric study of health science researchers, Frandsen, Jacobsen, and Ousager (2020) examined researchers' productivity and impact over a 16-year period, finding no or little difference in productivity or impact among the group of health sciences researchers from the time of enrollment in the Ph.D. program and 10 years beyond. In some cases, examined in their study, women even outperformed men. In another study, Abramo, D'Angelo, and Caprasecca (2009b) examined research productivity among the entire population of researchers in the scientific-technological disciplines of the Italian university system and confirmed the presence of significant differences in productivity between men and women. These differences were however smaller than often reported in the literature, which the authors explained by a tendency towards declining gender differences in productivity. The authors also found significant variation in gender differences in productivity across research fields, including sectors where women did not exhibit lower performance. Duch et al. (2012) examined publications by more than 4,000 faculty members at top US research universities and likewise found that gender differences in productivity are discipline-specific.

In a study of researchers in the social sciences in the Netherlands, van Arensbergen, van der Weijden, and van den Besselaar (2012) concluded that gendered performance differences were disappearing in the younger generations of researchers, echoing earlier findings by Xie and Shauman (2003). Similarly, Bentley (2012) found that gender differences in productivity among Australian scientists had been reduced over time, with female publishing increasing from 57 percent of the male average in 1991-3 to 76 percent in 2005-7. On a related note, several studies described by e.g. van den Besselaar and Sandström (2016) have found that women researchers catch up with male peers later in their careers, though their lower productivity early in the career can have a lasting negative effect on their academic career. Moreover, Mairesse and Pezzoni (2015) found that scientific productivity declined with age more rapidly for male than for female scientists, suggesting that the reason for women's lower productivity in the early stages of an academic career may be associated with factors that vary with age, including parenthood and family responsibilities, or differences in the types and amount of work responsibilities (related to e.g. teaching or administrative duties) that male and female research have. We return to these and other possible explanations for gender differences in scientific productivity in section 3.5.

On a related note, studies have found that women are less likely to be 'star scientists'. In a study of Italian scientists, for example, Abramo, D'Angelo, and Caprasecca (2009) found that men were twice as likely to be star scientists[1] than women, and that male star scientists exhibited higher performance than female star scientists. The authors also found that while gender differences in productivity were found to diminish with career progression, male star scientists' higher productivity was found to increase with career progression. More recently, Chan and Torgler (2020) examined publications by more than 94,000 scientists in 21 fields across 43 countries. They found that that female representation among top (i.e. most frequently cited) scientists varied strongly across countries. Compared with the total share of women in science, they found that women were underrepresented among the top scientists by 28.52 percentage points, but with variation across research fields, with the lowest proportion of female top scientists found in mathematics and statistics, engineering, and physics and astronomy. Despite the low proportion of top women researchers in these fields, the female top scientists (on average) published more impactful research than their male colleagues, which was not the case in most other research fields. The authors also found that female scientific success was positively correlated with a nation's higher score on gender equity indicators, lower discriminatory values, and less negative attitudes and preferences towards women.

The higher attrition rate of women researchers is key to understanding gendered performance differences; for instance, Huang et al. (2020) found that gender differences in scientific productivity and impact were largely explained by differences in publishing career lengths and dropout rates for men and women. In a study of the complete publication history of over 1.5 million gender-identified authors whose publishing career ended between 1955 and 2010, covering 83 countries and 13 disciplines, the authors found that the increase of participation of women in science has been accompanied by an increase in gender differences in both productivity and impact. However, these differences were, as stated, largely explained by differences in publishing career lengths and dropout rates for men and women. Overall, the authors found that men and women publish at a comparable annual rate and have an equivalent career-wise impact for comparably sized bodies of work.

In summary, it is important to keep in mind that the results of studies on gender differences in productivity are highly sensitive to the methodologies applied (Kretschmer and Kretschmer 2013). Nonetheless, the overall takeaways are that there appears to be an overall gender gap in productivity (see e.g. Ceci et al. 2014; Davies and Healey 2019), part of which cannot be explained by the factors controlled for in the studies on this topic. However, this gender gap varies in magnitude across research fields, being nonexistent or even in favor of women researchers in some fields. Moreover, there are indications that gender differences in productivity decline over the course of the academic career; possibly both because less productive women leave academia at earlier career stages, or because women researchers have more time and/or resources at later career stages than early in their career.

Moreover, early productivity differences may have lasting effects on women's academic careers. Indeed, performance at the start of an academic career can have long-term effects, as shown in a study by Lindahl, Colliander, and Danell (2020). They examined how performance during doctoral education affects the probability of attaining research excellence in the early career, using data on Swedish doctoral students employed at the faculty of science and technology and the faculty of medicine at a Swedish university. They found that research performance during a doctoral education has a positive effect on attaining excellence in the early career. Their results also suggested that publication volume and quality in doctoral students' performance could be indicative of future excellence, and that performance differences in the

[1] 'Star scientists' were here defined as individuals with a performance level within the top 10 percent within their research field, as indicated by several measures for performance, including both total and fractional productivity, and the total and fractional weighted sum of publications (with the weight for a publication being equal to the normalized Impact factor of the journal In which It was published).

early career (primarily during the doctoral education) indicated that male researchers had a higher probability of attaining excellence than females. On a related note, Xing et al. (2019) examined 'dropouts' from academic careers among physicists in American Physical Society journals using publication data and found that in the early career phase, the dropout rate was high and negatively correlated with researchers' research performance (measured by both productivity and impact). In more mature stages of the career, the dropout rate became stable and independent of the early performance of the scientists, only to increase in the late-career stage (here mainly determined by retirement and external factors).

Women are less likely to be listed in prestigious first or last author positions

Several studies have investigated the extent to which male and female researchers are listed as first or last author on publications, i.e. in positions that often indicate the main or most senior author. Being listed as first or last author has long been known to strengthen researchers' visibility, regardless of whether or not the position in the author list reflects their actual contribution to the study reported (Zuckerman 1968).

In a study based on more than eight million papers from the natural sciences, social sciences, and humanities, West et al. (2013) found that women are significantly underrepresented as authors of single-authored papers. Several studies have also found that women are less likely to be listed on publications as the first or the last author (Jagsi et al. 2006; Larivière et al. 2013; Filardo et al. 2016; Lerchenmueller, Lerchenmueller and Sorenson 2018; González-Álvarez and Cervera-Crespo 2019; Odic and Wojcik 2019), even in fields where men and women have similar productivity levels (West et al. 2013). For instance, Lerchenmüller, Lerchenmueller, and Sorenson (2018) found that women researchers in cardiovascular research and across the life sciences had over time become more likely to be listed as first author on publications, but not as last author.

Being listed in 'in between' author positions may lead to slower career advancement for female researchers (van den Besselaar and Sandström 2017). A study of Dutch researchers by van den Besselaar and Sandström (2016) found that women researchers advance more slowly in their academic career than men and that this could be only partly explained by gender differences in research productivity; even when controlling for academic age, performance, mobility, and researchers' discipline, gender differences in career advancement remained, and the authors argued that the residual differences could be explained by gender bias in e.g. career hiring and advancement decisions.

Women are less likely to publish in the most prestigious journals

Some studies have found that women researchers are more likely to publish or be listed as the first author in lower-impact or lower-prestige journals within their field (Jagsi *et al.*, 2006; Brooks, Fenton and Walker, 2014; Lerchenmueller and Sorenson, 2018; Lerchenmueller, Lerchenmueller and Sorenson, 2018; Andersen *et al.*, 2019; Odic and Wojcik, 2019).

As argued by e.g. Andersen et al. (2019), this may reflect a generation effect – as there are more men in senior academic positions than women, and senior academics are more likely to be able to publish in high-prestige journals. It may also reflect, they argued, that women researchers are less likely to submit publications to high-impact journals, or that they may have lower success in achieving publication in high-impact journals due to gender bias or topic bias in peer review processes.

Nielsen, Bloch, and Schiebinger (2018) also drew attention to the fact that a disproportionate share of female researchers undertake research in topics with a lower likelihood of being published in what have deemed the most prestigious journals (citing prior work by Nielsen 2017; Ryan 2013; Dolado, Felgueroso, and Almunia 2012) and argued that realizing the potential benefits of gender diversity for the diversity of research questions and approaches requires adapting the use of performance metrics to recognize novel, non-mainstream research areas, and approaches.

Are women's publications cited less?

A number of studies have concluded that women researchers' publications receive fewer citations than those of their male counterparts (e.g. Lerchenmueller and Sorenson 2018; Beaudry and Larivière 2016; Larivière et al. 2013). For instance, using data on more than 5.4 million research papers indexed in the Web of Sciences databases, Larivière et al. (2013) found all articles that were sole-authored, first-authored, or last-authored by women received fewer citations than those with men in the same positions. This finding was consistent for both national and international collaborations. Using a database on funding, scientific papers, and citations for academics in Quebec, Beaudry and Larivière (2016) found that publications by women researchers are cited less even when they have similar numbers of co-authors or target journals with similar impact factors; they also found that researchers in the health, natural and engineering sciences who co-authored publications with a larger proportion of female co-authors consistently received fewer citations than those who published with a predominantly male group of co-authors.

Meanwhile, other studies have found no evidence of gender differences in citations to publications, and some have even found evidence of higher citation scores for women than for men, casting doubt on the argument that differences in citation rates are a salient factor in the production of gender inequalities in research. For instance, in a cross-sectional bibliometric study, Nielsen (2016) examined the relationship between Danish researchers' gender and their research performance, by comparing citation and self-citation rates and collaborative patterns of more than 3.000 male and female researchers at a Danish university. According to the author, the results of the study challenge the assumption that there is a persistent gender performance gap as far as citations are concerned. For a review of other contributions on this topic, see e.g. van den Besselaar and Sandström (2017) and Andersen et al. (2019), the latter of which also discusses several methodological issues in prior studies of gender differences in citations.

More recently, Nielsen (2017a) found a marginal difference in citation impact in favor of women management scholars, concluding that differences in citation rates appear to be a negligible factor in the reproduction of gender inequalities in management research. Also, based on a matched case-control study of more than 1.2 million papers in selected areas of medicine published between 2008 and 2014, Andersen et al. (2019) found that papers with female authors were, on average, cited less than papers with male authors. The authors stressed, however, that the standardized mean differences were very small, and there was an extensive percentage overlap between distributions for male and female authors. Adjusting for some relevant factors (including self-citations, the number of authors on publication, international collaborations, and journal prestige), the authors found almost identical citation impact per paper for male and female researchers in first and last author positions. Most of the small average differences, the authors explained, were accounted for by self-citations[2] and journal prestige. Overall, their results draw attention

[2] Men are more likely to cite their own prior work, thus increasing the total amount of citations to their work. King et al. (2017) explored data on 1.5 million research papers in the JSTOR database published between 1779 and 2011 and found that male researchers were significantly more likely to cite their own work, particularly in the last two decades of publications covered in their study. The authors pointed out that these citation patterns could be explained by differences in the number of papers that male and female researchers publish rather than gender-specific patterns of self-citation behavior. Similarly, Andersen et al. (2019) underlined that there may be generation effect at play here, in that senior male researchers have more of their own publications to cite. Indeed, Mishra et al. (2018), In a replication of the study by King et al. (2017) found that gender differences in self-citations rates were reduced when controlling for authors' publication records. Mishra and colleagues argued that self-citation is the 'hallmark of productive authors' regardless of gender, who cite their own novel publications early, thus giving their publications a

to the importance of careful methodological approaches in comparing citation impact of male and female researchers; they also indicate that marginal if any gender differences in citation impact exist, suggesting that gender differences in citations are not a key factor in understanding differences in male and female researchers' academic careers.

On a related note, Thelwall (2018) found little practical gender difference in citation impact to male and female-authored publications in countries with mature science systems. Thelwall (2020) examined the evolution of gender differences in citation impact 1996–2018 for six million articles from seven large English-speaking nations: Australia, Canada, Ireland, Jamaica, New Zealand, UK, and the US – and found a small female citation advantage for all these countries except the US, where no practical difference was found. Again, these findings indicated that any academic bias against citing female-authored research cannot explain gender gaps in career advancement in academia.

Nielsen (2018) concluded that most existing research appears to find that women are as cited or in some cases even more cited than men, despite the inconclusive and ambiguous nature of the evidence on gender differences in citations. The author moreover argued that some of this ambiguity may be explained by variations in citation patterns across disciplines, geographic areas, and gender composition across research fields.

Women collaborate less with domestic and international researchers

Collaboration among scientists, along with increasing specialization and the growth of team science, are common in science – but gender differences in collaboration patterns may help to explain gender differences in scientific productivity (Mairesse and Pezzoni 2015) because collaboration has been linked to enhanced productivity (Fox and Mohapatra 2007; Collins and Steffen-Fluhr 2019), also for women researchers (Kyvik and Teigen 1996). Increased collaboration may also enhance a researchers' chances of new collaborations and career advancement by signaling the value of his or her work (Collins and Steffen-Fluhr 2019).

Studies have shown that women researchers' collaboration patterns differ from those of their male peers. For instance, Uhly, Visser, and Zippel (2017) found that women engage less in international research collaborations than men, in a study based on the 2007 Changing Academic Profession (CAP) International Data Set, an international survey of faculty and academic researchers from 19 countries, from all continents. Similarly, according to a study by Larivière et al. (2013), women are less likely to publish papers with international collaborators and thus miss out on the additional citations generally associated with international co-publication. However, as pointed out by Mairesse and Pezzoni (2015), the reason why women researchers' collaboration patterns differ from those of men is not well understood.

Zeng et al. (2016) investigated publication and collaboration patterns among almost 4,000 faculty members in STEM fields in the US and found that lower numbers of co-authors for female researchers could be explained by women's lower publication rate and shorter academic career length; women were also less likely to engage in repeat coauthorship than men.

Using data on 5,600 Norwegian researchers' publications during a three-year period, Aksnes, Piro, and Rørstad (2019) found the main factor in explaining scientists' propensity to engage in international collaboration to be the discipline in which they were active. Overall, they found that men were more likely to co-

boost in citations. The authors furthermore argued that the main driver of lower self-citations among women is attrition, as women are more likely to abandon their academic career than men.

author papers with international collaborators but pointed out that there were lower proportions of women in fields with higher international collaboration rates, arguing that choice of discipline or field is a key factor in understanding differences in women's lower propensity to collaborate with international co-authors. Moreover, when controlling for the scientific field, academic position, and publication productivity, they found no significant gender differences in international collaboration, suggesting that this is not a salient factor in understanding gender inequalities in the Norwegian research context. Instead, they identified the lower productivity level of female researchers as the likely main impediment to their academic career development.

In a study of publications from 1948 to 2013 by industrial–organizational psychologists, Fell and König (2016) found no evidence that a lack of collaboration could be linked to lower scientific success among women researchers; instead, they found that female researchers were more likely to engage in scientific collaborations.

On a related note, Abramo, D'Angelo, and Di Costa (2019) examined differences in collaboration behavior among male and female Italian top researchers. They found no overall evidence of significant gender differences in the overall propensity to collaborate among top researchers, though their analysis revealed some differences at the level of individual disciplines, with women researchers being less likely to engage in international collaboration in mathematics and chemistry, and more likely to engage in extramural domestic collaborations in physics.

In conclusion, the findings on gender differences regarding collaboration are mixed. Several results point to women engaging less in international collaboration. However, in many cases, differences may be explained by the lower publication rate and shorter academic career lengths of women.

Women are less likely to patent and/or start a company – and to collaborate with industry

Again, there is variation to be found across fields. For instance, the gender gap in academic entrepreneurship found to be smaller in nanotechnology than in the overall tech area (Meng 2016).

While gender is often included as a control variable in studies of academic entrepreneurship, it is rarely in focus in such studies (Link and Strong 2016). The studies that have examined the role of gender in academic entrepreneurship, however, find rather consistently that women researchers are less likely to take out patents (Meng 2016) or to start a company based on their research findings (Di Paola 2020; Iffländer, Sinell, and Schraudner 2018; Best et al. 2016), which is in line with research on women and entrepreneurship in general, as reviewed by e.g. Iffländer, Sinell, and Schraudner (2018).

Abreu and Grinevich (2017) examined academic entrepreneurship in a wide range of disciplines using survey data collected in 2008-2009 from more than 22,0000 UK-based academics and found that women researchers were more likely to be involved in applied research, to have less prior experience of running a business, and to feel more ambivalent about research commercialization. They were also more likely to be employed in junior positions and the health sciences, social sciences, or humanities. All these factors were moreover correlated to lower rates of spinout activity. The authors concluded that certain combinations of characteristics of male academics, that were rare or nonexistent among women researchers, explained a large proportion of the gender gap in academic entrepreneurship.

Colyvas et al. (2012) questioned the assertion that female scientists are less involved in formal technology transfer. Based on a study of US medical school data, Colyvas and colleagues found no significant gender differences in the likelihood of reporting inventions or successfully commercializing them, though women in their study tended to disclose fewer inventions than male scientists. They argued that these findings may indicate that female scientists are an untapped source of entrepreneurial talent.

Nonetheless, drawing on survey data from a large public research organization, Goel, Göktepe-Hultén, and Ram (2015) found significant gender differences affecting male and female researcher's propensities to start a business. For instance, prior patenting and institutional leadership was associated with entrepreneurial tendencies among male researchers, but not among female researchers.

Fernández-Pérez et al. (2014) examined the effect of social networks on academics' entrepreneurial intentions among a sample population of 500 Spanish academics engaged in commercially oriented fields of research. Business (i.e. industrial and financial) networks played a key role in promoting entrepreneurship both directly and indirectly (by affecting both entrepreneurial attitudes and self-efficacy on opportunity recognition), but male and female academics differed in their perceptions of support from business and financial networks and in their use of these resources to start a business. In another study based on Spanish data – a survey of 1,178 academics at Spanish universities – Miranda et al. (2017), found female academics have less of an entrepreneurial intention. The further analysis explained this not by the absence of any of the factors typically considered as determinants of entrepreneurial intention, but rather attributed it to the existence of implicit barriers for women that influenced their entrepreneurial intention.

Iffländer, Sinell, and Schraudner (2018) examined the motivations and strategies of academic entrepreneurs, including gender differences therein, and found that female academic entrepreneurs were often driven by their ideals of finding broader application for research results and thereby making a social difference, while male academic entrepreneurs often pursued more personal, practical goals such as financial success and recognition, and placed a strong focus on product value and technological advantages. This indicates, the authors suggested, that increased female participation in academic entrepreneurship may lead to both greater diversification of academic spin-offs, but also more spin-offs focusing on people's benefits and needs.

On a related note, based on a sample of 6,000 life scientists, Ding, Murray and Stuart (2013) found that male scientists were almost twice as likely as females to serve on the scientific advisory boards of biotechnology companies (after controlling for constant professional achievement, network ties, employer characteristics, and research foci). They moreover found no evidence supporting a choice-based explanation for this gender gap, pointing instead to another possible explanation, i.e. gender-stereotyped perceptions and unequal opportunities embedded in social networks.

Finally, several studies indicate that male researchers are more likely than their female counterparts to engage in commercialization activities and collaboration with industry, even when controlling for seniority and scientific discipline (Calvo, Fernández-López and Rodeiro-Pazos 2019; Abreu and Grinevich 2017; Tartari and Salter 2015; Link, Siegel and Bozeman 2007; Thursby and Thursby 2005).

However, based on a large-scale study of UK physical and engineering scientists, Tartari and Salter (2015) argued that gender differences in collaboration activity can be tempered by the social context in which female scientists work, notably by factors such as the presence of women in the local work setting and/or the scientific discipline and institutional support for women scientists' careers.

How gender differences in scientific performance may affect career trajectories

In summary, the evidence is mixed, but as a whole indicates some overall gender gap in productivity, a slower start to the publication career for women, a greater likelihood that women will publish in low-prestige journals than men, and some gender differences in collaboration practices.

It should be noted that scientific productivity is neither an indicator of the quality of a researcher nor of the researcher's contribution to science or society. For instance, studies have shown that researchers are likely to have fewer publications when they engage in interdisciplinary and/or highly novel (and thus typically more time-consuming and risky) research (as described in DEA and Independent Research Fund Denmark, 2019). Nonetheless, scientific productivity often has implications for scientists or for the institutions that employ them. For example, several countries (including Denmark) allocate funding to e.g. universities using performance-based models that rely in various ways and to different degrees on publication counts. Thus, individual productivity may ultimately impact institutional funding. Moreover, scientific productivity is one of several bibliometric indicators often used in the assessment of researchers' performance, e.g. in connection with hiring, advancement, and funding decisions.

Webber and González Canché (2018) found that scientific publications were by far the most important contributor to career advancement for both male and female academics in the decade following degree completion. As such, scientific productivity matters. For example, Lerchenmueller and Sorenson (2018) investigated early career transitions in the life sciences by following more than 6,000 scientists who received a postdoc grant from the National Institutes of Health in the US. They followed the scientists from the postdoc stage to becoming a principal investigator, which, as the authors argued, marks a critical transition in an academic career. They found that a large part of the gender gap in the life sciences could be traced to this period of transition: women transitioned to principal investigators at a 20 percent lower rate than their male counterparts. The authors moreover found that differences in scientific productivity explained about 60 percent of this difference, and argued that the residual difference could likely be explained by gender differences in the returns to publications, i.e. how many citations researchers receive to their publications.

Similarly, gender differences in citations to publication, where these exist, hold implications for researchers' career opportunities. Citation indicators are commonly used to support decisions regarding recruitment, promotion, and funding of researchers; if there are gender differences in citation impact, such differences may exacerbate gender inequalities in research (Andersen et al. 2019). Thus, even though gender differences regarding citations in many studies are found to be explained by other factors (e.g. productivity, male self-citation, etc.), the 'raw', remaining differences can still contribute to gender differences through e.g. hiring and funding decisions.

3.4 Gender differences in funding

While section 3.3 examined indications of gender differences in scientists' *performance*, this section focuses on gender differences in research *funding*. Research funding is sometimes viewed as a performance parameter for researchers, and sometimes as a resource in enabling performance.

Gender disparities in funding

There are clear gender imbalances in the number of grants awarded to female and male researchers. These differences however are to a large extent explained by differences in the number of women in a given research field (Cruz-Castro and Sanz-Menéndez 2019).

Several studies have investigated imbalances in research funding. Some studies find that women have both lower success rates and received smaller amounts of grant money (Urquhart-Cronish and Otto 2019). Yet most of the literature reviewed in connection with this mapping finds no clear evidence of differences in success rates for men and women (e.g. Leberman, Eames and Barnett 2016; Pohlhaus et al. 2011; Waisbren et al. 2008). For instance, in an analysis of sex differences in National Institutes of Health (NIH) award programs, Pohlhaus et al. (2011) found that in programs where participation was lower for women than men, the disparity was primarily related to a lower percentage of women applicants compared with men, rather than decreased success rates or funding rates. However, the longitudinal analysis showed that men with previous experience as NIH grantees had higher application and funding rates than women at similar career points.

Women (overall) receive less funding – and are less likely to (re)apply

Studies have indicated that women apply for fewer grants (see e.g. Leberman, Eames, and Barnett 2016; Cruz-Castro and Sanz-Menéndez 2019), even in fields with near-equal gender distribution e.g. medical sciences in the US (Ley and Hamilton 2008). Some studies also indicate that women, overall, tend to receive less funding.

Hosek et al. (2005) looked at grants from three major public US research funding federal agencies: the National Institutes of Health (NIH), the National Science Foundation (NSF), and the US Department of Agriculture. The authors found few gender differences in federal grant funding over the three-year-period period examined when controlling e.g. applicants' disciplines, institutional affiliation, and past research output. The authors did however find that women applying as principal investigators to NIH received less funding than men did (but this was largely explained by women being less likely to lead top 1 percent grants) and that women were generally somewhat less likely to apply again to the same agency.

Waisbren et al. (2008) examined research grant support between male and female faculty at eight Harvard Medical School-affiliated institutions and found that women were awarded less money than men at the ranks of instructor and associate professor. They however found no significant differences in grant success rates for women and men after controlling for academic rank.

Oliveira et al. (2019) examined grant amounts to first-time female and male grant awardees from the US National Institutes of Health (NIH) from 2006 to 2017. 43.6 percent of the first-time principal investigators were female (similar to the proportion of women enrolled in US MD-PhD programs at the time, i.e. 38 percent). The authors found no statistically significant differences by gender for baseline performance measures (i.e. median number of articles published, median number of citations per article, median number of research areas). The study also found gender differences in the size of NIH grants awarded to a comparable first-time female and male PIs, even at top research institutions. For most grant types, men were favored; however, women received larger R01 grants, the most frequent award for first-time awardees.

Biernat et al. (2020) examined responses to imagined negative grant reviews among National Institutes of Health (NIH) K-Awardees—Principal Investigators of Mentored Career Development Awards; they found that women were less motivated to reapply for funding after receiving a review highlighting inadequacy rather than promise.

Larivière et al. (2011) examined the relationship between sex, age, research funding, publication rates, and scientific impact for all professors at universities in Quebec, Canada, and found among other things that women after the age of 38 on average received less funding. Put differently success rates for men and women were comparable until women reached their late 30s, at which point men's success rates remained unchanged while women's success rates either plateaued or increased more slowly. After the age of 38, women were also less productive (a finding which is in contrast to findings of other studies described in section 3.3, which found that gender differences in productivity lessened in later career stages). They argued that possible explanations included women's more limited (as in smaller and more local/domestic) collaboration networks, parenthood and caregiving duties, women's lower rank in academic communities (as men are, on average, older and employed in more senior positions), and possibly also differences in genders' choice of research topics. They also argued that lower levels of funding for female researchers may play a key role in explaining their lower productivity, which in turn affects their chances of obtaining funding; but the direction of causality here is not well understood. Moreover, the authors pointed out that men remained more productive than female researchers given equivalent levels of funding, indicating that funding is not necessarily associated with higher levels of productivity.

Finally, looking at internal university funding, Sege, Nykiel-Bub, and Selk (2015) found that female junior researchers in the basic biomedical sciences received less start-up support from their universities than men.

Women take longer to receive key grants and advance more slowly in their careers

In the aforementioned study by Lerchenmueller and Sorenson (2018), which tracked 6,000 scientists in the life sciences from the postdoc stage to becoming a principal investigator (i.e. receiving a R01 grant), the authors found that a large part of the gender gap in the life sciences could be traced to this period of transition: women transitioned to principal investigators at a 20 percent lower rate than their male counterparts, spending on average a year longer than men with a similar number of citations in transitioning to the R01 grant. The authors moreover found that differences in scientific productivity explained about 60 percent of this difference, and argued that the residual difference could likely be explained by gender differences in the returns to publications, i.e. how many citations researchers receive to their publications.

In a Danish context, in a report on gender aspects of grants from the Danish Independent Research Council, Bloch and Henriksen (2013) found that female postdocs recruited to work on larger grants from the council had almost twice the Ph.D. age compared to the male postdocs recruited. They also found that the proportion of men recruited by their Ph.D. advisor was almost twice as high as for women. In addition, while women in their data were more likely to leave academia, the likelihood of opting out of academic research was significantly lower for both male and female researchers who had received an independent research grant, compared to rejected applicants. Finally, the report showed that male grant recipients were more likely to advance in their career within the first four years after receiving a grant, during which time female grant recipients showed the same level of career advancement as rejected male applicants.

On a somewhat related note, Sheltzer and Smith (2014) examined recruitment practices at leading laboratories in the US biomedical research community and found that male faculty members tended to employ fewer female graduate students and postdocs than female faculty members did, and that elite male faculty trained significantly fewer women than other male faculty members. Meanwhile, elite female faculty did not exhibit gender inequality in employment patterns. The authors also found that new assistant professor hires were largely comprised of postdocs from within these prominent laboratories. Finally, the authors pointed out that the disproportionately low number of women employed in leading biomedical research labs could be the result of either some exclusion of women or their self-selected absence.

3.5 What explains gender differences in career trajectories, research performance, and funding?

In the previous three sections, we have painted an overview of key findings with regards to the existence of gender differences in academic employment, scientific performance, and research funding. In this section, we present possible explanations for gender differences in academic career trajectories, research performance, and acquisition of research funding, as they are presented in the literature.

Some of the explanations presented focus on specific types of gender differences, while others have broader relevance for understanding gender issues in science. However, they are presented here in the same section because many of the factors explored in the literature are closely interrelated.

Two recurring themes in the literature are, first, whether the oft observed performance differences are a result of or an antecedent to gender inequality in academia (Besselaar and Sandström 2017) and, second, whether women researchers' higher attrition rates are the results of structural and cultural barriers in academia or individual factors, including e.g. personal priorities and preferences and performance (Nielsen 2016).

Gender differences in ability

Several studies have since the 1980s explored whether evidence could be found for significant differences in men and women's biological or psychological abilities, but the emerging consensus in the literature appears to be that no convincing evidence has been found of differences that could explain gender differences in researchers' performance or career trajectories (van den Besselaar and Sandström 2016; Abramo, D'Angelo, and Caprasecca 2009a; Hyde and Linn 2006).

In a review of prior work, Cruz-Castro and Sanz-Menéndez (2019) concluded that capacity-based explanations for gender differences in e.g. STEM participation have lost power, as gender gaps have narrowed. Instead, they drew attention to the role of social-psychological and socio-cultural perspectives, referring to the importance of stereotypes, preferences, and expectations among e.g. teachers, family, and peers in shaping actions directly or indirectly via bias. Such bias, the authors pointed out, may play a small role in any given single decision, but can have cumulative effects over the course of individuals' lives, contributing to substantially different outcomes for women and men.

For instance, Cruz-Castro and Sanz-Menéndez (2019) refer to work by Correll (2004; 2001), who argued that cultural beliefs about gender can have different effects on the early career decisions of men and women, by biasing individuals' perceptions of their competencies, e.g. in mathematics. When such beliefs influence career decisions, they may for instance deter women from pursuing a career in STEM fields. On a related note, Leslie et al. (2015) and Meyer, Cimpian and Leslie (2015) argued that women are underrepresented in academic fields where 'raw, innate talent' or 'brilliance'[3] is seen as key to success, as such qualities are stereotypically associated with men rather than women. Similarly, van den Besselaar and Sandström (2016) hypothesized that men and women of similar academic ability may end up on divergent career paths – due to e.g. bias and gender stereotyping – with men more likely to pursue research-oriented trajectories and women more likely to pursue lower-prestige e.g. teaching-oriented trajectories, leading to higher gender differences in performance.

In another study, Epstein and Fischer (2017) investigated academic career intentions within a sample of approximately 1,100 recent doctoral graduates from medicine and basic life sciences in the US. They found a strong and significant association between research self-efficacy and academic career intentions, with lower research self-efficacy among women explaining gender differences in career intentions among women in medicine. However, they found no gender differences within the basic life sciences concerning academic career intentions or research self-efficacy.

[3] Storage et al. (2020) found that people associate brilliance with men more than women; this finding was consistent for both men and women, children and adults, and across both different US regions and different countries, and argued that this may help explain why women are underrepresented in careers where success is perceived to depend on high levels of intellectual ability (e.g. brilliance or genius), e.g. in STEM disciplines.

Differences in degrees of research specialization

Research specialization here is understood as the extent to which researchers focus their research on one or a few subfields or engage in research across multiple subfields. Leahey (2006) argued that women researchers tend to specialize less than their male counterparts. The author further argued that women, as a result, miss out on an important means of increasing their scientific productivity – as specialization carries benefits such as e.g. making it easier to master debates and methods within a subfield and build relationships with other researchers in the field, which in turn may strengthen opportunities for publication, career advancement and the like.

On a related note, Rhoten and Pfirman (2007)) found that women researchers were more likely than male researchers to engage in interdisciplinary research, i.e. apply tools, concepts, data, methods, and results from other fields and disciplines; engage in research at the intersections between disciplines; work in teams or networks across fields and disciplines, and to work on problem-oriented questions that involve not just multiple disciplines but also stakeholders inside or outside of academia. However, as the authors pointed out, they could not ascertain to which extent these patterns were the result of individual attributes, group characteristics, socio-structural conditions, or some combination thereof – or of other possible intervening factors e.g. cohort, institutional context, disciplinary field, etc. As such, they cautioned against claiming with certainty that gender is a key factor in understanding scientists' propensity to work across disciplinary boundaries.

However, Abramo and D'Angelo (2017, cited in Abramo, D'Angelo, and Di Costa 2018) documented gender differences in the extent of research diversification, both overall and in most disciplines – with male researchers being more likely to diversify their research – but this finding was primarily explained by males' higher publication productivity. Once controlling for productivity, gender differences disappeared in all but two disciplines: mathematics, where women had a higher degree of research diversification, and biology, where men had more diversified research.

A large-scale study by Mishra et al. (2018) found that male and female researchers, on average, showed similar levels of age-normalized expertise, thus casting further doubt on the role of research specialization in understanding gender differences in scientific productivity. On a related note, Abramo, D'Angelo, and Di Costa (2018) examined the role of gender, age, and academic rank on research diversification based on all publications from 2004 to 2008 by all Italian professors in the sciences[4] and concluded that were no gender differences in scientists' propensity to focus or diversify in their research. Moreover, they found that women researchers' propensity to diversify their research varied based on the type of diversification examined as well as the researcher's discipline. The authors, therefore, cautioned against viewing the degree of research diversification as a factor in the gender gap in scientific productivity.

Differences in numbers and career paths – and in researchers' visibility

Larivière et al. (2013) pointed out that differences in how often male vs. female researchers are listed as first or last author may at least be partially explained simply by the fact that there are more male than female researchers in academia, particularly in the senior positions that often assume lead author positions on publications. Female researchers are, on average, younger than male researchers; they are overrepresented in lower academic positions and positions with a temporary contract – positions often associated with a higher teaching load and lower levels of funding (Besselaar and Sandström 2017). All of these

[4] Here defined as: Mathematics and computer sciences, Physics, Chemistry, Earth sciences, Biology, Medicine, Agricultural and veterinary sciences, Civil engineering, Industrial and information engineering.

factors may help explain productivity differences. However, as mentioned earlier, studies (e.g. Lerchenmueller and Sorenson 2018; van den Besselaar and Sandström 2016) have found that productivity differences explain only a part of the gender gap, with the residual presumably explained at least in part by bias.

Some have argued that gender differences in science will disappear over time. However, Cruz-Castro and Sanz-Menéndez (2019) challenged the "time will solve gender disparities"-argument, arguing that it cannot be considered valid, if gender differences remain when researchers' seniority and other salient factors are held constant – for instance as gender gaps of researchers in senior positions remain substantial, despite narrowing gender gaps in earlier phases of the 'pipeline' e.g. doctorate production. Similarly, Gaiaschi and Musumeci (2020) concluded that the path to gender equality is "extremely slow and non-linear".

Studies have also found that women are less likely than men to apply for promotions (Bosquet, Combes and García-Peñalosa, 2019). Some studies have also investigated factors that may affect women's visibility and thereby their possibilities for career advancement. For instance, Nittrouer et al. (2018) examined gender differences in speakers at an academic colloquium at 50 prestigious US colleges and universities, arguing that colloquium talks may enhance researchers' reputation, networks, and collaborations (and thus, ultimately, their employment options). They found that women were underrepresented relative to men as colloquium speakers across six disciplines, as men were more likely than women to be colloquium speakers even after controlling for the gender and rank of the available speakers. They found no indication that women were more likely to decline an invitation to give a talk or to question the importance of giving such talks. However, having female colloquium chairs (and potentially committee members) increased the likelihood of having female colloquium speakers, pointing to the role of such 'gatekeepers' in addressing gender inequalities in colloquium speakers. Sardelis and Drew (2016) also examined the representation of women as symposia speakers in two professional societies in biological research and found that for each additional female conference organizer, there was a marked increase in the number of female speakers.

Another aspect of the visibility or presentation of female researchers' work concerns how they present their research. Lerchenmueller, Sorenson, and Jena (2019) men and women differ in how they frame their research findings. Based on titles and abstracts from more than 6 million articles in clinical research and life sciences published between 2002 and 2017, the authors found that articles with a male first or last author were more likely to describe their findings using 25 positive words including e.g. "novel" or "excellent" (compared to articles in which both first and last author were women), particularly in the highest impact journals. The authors also found that presenting an article positively was associated with higher numbers of citations.

Differences in how male and female researchers spend their time at work

Although researchers engage in many different types of activities, research is widely recognized as the most prestigious and as the one most important for employment and advancement opportunities (e.g. Kretschmer and Kretschmer 2013). Studies have found that women researchers are likely to spend a larger amount of time teaching, which influences the amount of time they have available for research (see e.g. Marchant and Wallace 2016).

For example, based on a survey among US faculty, Winslow (2010) found that women faculty preferred to spend a larger proportion of their work time on teaching, while men preferred to spend more time on research. The same study showed, not surprisingly given of these stated preferences, that women faculty spent a larger part of their workweek teaching and a smaller part doing research than men. However, actual time allocation diverged more from preferences for women than for men.

Such differences may help explain productivity differences. For instance, Taylor, Fender, and Burke (2006) found that both teaching and service commitments (including e.g. serving as a department chair or on committees) significantly reduced economics researchers' productivity.

Such differences may also help explain gender differences in career paths. For instance, based on a survey among academics employed at the 24 Russell Group universities in the UK, Santos and Van Phu (2019) found that the percentage of time spent on teaching and teaching-related activities had a negative and statistically significant association with academic rank, which was more pronounced for women, who spent a higher percentage of their working time on teaching and teaching-related activities than men did, as did those in lower academic ranks. The authors pointed out that the percentage of time spent on teaching and teaching-related activities may be considered both a cause and a consequence of the gender gap in career progression.

Even in Sweden, which is generally considered to be characterized by a high degree of gender equity, interviews echo patterns described in other studies, with women faculty likely to take on more teaching and service duties, even to the detriment of their research performance, drawing comparisons to 'worker bees' of academia (Angervall and Beach 2020). Interviewees also revealed that research and teaching activities are increasingly associated with separate career paths (Angervall and Beach 2018; 2020). The development of increasingly distinct research and teaching career paths may be associated with the different degrees of prestige attached to research and teaching (ibid.), but also to increasing competition for positions and the growing dependence on external research funding (Angervall, Beach and Gustafsson 2015).

Several studies have also drawn attention to the amount of time women researchers spend on so-called 'faculty service', 'academic service', or the more derogatory 'academic housekeeping' (e.g. Pyke 2011; Miller and Roksa 2020; Rauhaus and Carr 2020). For instance, Guarino and Borden (2017) found that, among American faculty, women spent significantly more time on academic service than their male counterparts, after controlling for academic rank, race/ethnicity, and research field or department. They moreover found that this academic service was primarily in the form of internal service, e.g. to the department or university. On a related note, in a study of political science faculty in the US, Mitchell and Hesli (2013) found that female faculty were not only asked to provide faculty service more often than men but also that they more frequently said 'yes' to such requests. However, women in their study were most likely to be asked to provide low-prestige or 'token' service, and less likely to be asked to e.g. serve as department chair, chair committees, or lead academic programs.

While some faculty service, e.g. editing a journal, may heighten a researcher's prestige, other forms of professional service often do not, including contributing to teaching and service in the researcher's home institution (O'Meara et al. 2017). In addition to being low-prestige, faculty service work may be time-consuming, as in the case of mentoring faculty members (Bird, Litt and Wang, 2004; O'Meara et al. 2017).

The question is why women engage in more teaching and faculty service. O'Meara et al. (2017) presented three possible explanations. First, women may choose to spend more time on these activities than men, as several studies indicate that many women faculty express a desire to improve academic programs at their institution, support colleagues, and contributing to their department. Second, women may get asked to do these types of activities more often than men, for instance, to add diversity to search committees and the like (especially if the proportion of women in a given department is low), because they have expressed an interest in similar activities at some point in time because they are expected to be more likely to say yes, or because they are ‘typecast’ into caretaking and academic housekeeping tasks. Third, women may be more likely to say yes when asked than men, particularly if criteria for career advancement are ambiguous, and/or rewards or penalties associated with a yes or no answer are unclear. Based on a survey among 111 associate and full professors from US research universities, O’Meara et al. (2017) found that women faculty spent more time on faculty service, student advising, and teaching-related activities, while male faculty spent more time on research-related activities and in an editor and associate editor roles. They also found that male faculty spent almost twice as much time as women in professional conversations with colleagues in their field. The survey also indicated that women were more likely to receive work activity requests, particularly for service work, while men were more likely to receive research-related requests. The authors found no significant differences between women and men’s likelihood to say yes to tasks, or to delay their answer.

Finally, some studies indicate that female researchers have a stronger inclination to engage with society than their male counterparts (Bührer and Wroblewski 2019), or that women and men differ in the types of impacts they seek. Chubb and Derrick (2020) found, based on data from Australian and UK academics, that men were more likely to pursue ‘hard’ impacts, while women attached greater weight to ‘soft’, difficult-to-measure impacts. To the extent that such differences are common, they may also contribute to gender differences in career paths.

It is worth noting that in a study of former recipients of National Institutes of Health career development awards, which can be considered an elite group of researchers, Jones et al. (2016) found limited differences in initial aspirations (related to e.g. research, teaching, other work tasks, salary, etc.) among men and women researches.

Differences in how male and female researchers spend their time at home

Several studies have found that women faculty are more likely to experience stress due to heavy workloads and from balancing work ambitions with family duties than their male counterparts are (Angervall and Beach 2020).

Women researchers may also be more affected in their research productivity than men are by starting a family, as women often shoulder the majority of domestic and childcare duties (Sallee, Ward, and Wolf-Wendel 2016; Baker 2010b; Long 1992; McCutcheon and Morrison 2016), which is associated with higher levels of stress and conflict for women (McCutcheon and Morrison 2018; Sallee and Pascale 2012), and which may at least partly explain lower productivity levels among female researchers, particularly in the early stages of their careers (Mirick and Wladkowski 2020).

For instance, in a study of more than 11,000 PhDs covered by the US National Research Council's 1995 Survey of Doctoral Recipients, Stack (2004) found that productivity was relatively low for women researchers who had young children. This finding also held for the social sciences, the field with the highest proportion of female PhDs, and where gender was otherwise unrelated to productivity.

Hunter and Leahey (2010) found – in a study of researchers in linguistics and sociology – that productivity growth declined for all researchers after the birth of a child, but more so for women than men. On a related note, in a survey by Mirick and Wladkowski (2020), 70 percent of woman doctoral students and graduates reported that motherhood decreased their productivity.

Misra, Lundquist, and Templer (2012) investigated how faculty members at a US research university spend their time on work-related activities such as research, teaching, mentoring and faculty service, and activities in their private lives including housework, childcare, and care for elderly family members. Their study indicated that faculty (despite many working more than 60 hours a week) found it as difficult to strike a balance between different activities at work as to strike a balance between work and their private lives. The authors also found that male and female researchers spend different amounts of time on housework and caregiving, and those female researchers with young children spent less time on research, which in turn affects their opportunities for academic career advancement.

Even though the Nordic countries are generally recognized for a high level of gender equality and their family-oriented work policies, parenthood may still influence men and women differently. For instance, Rafnsdóttir and Heijstra (2013) examined how academics structured their time in Iceland. They found clear gender differences in time use, and that despite flexible working hours, female researchers still appeared to shoulder more domestic and caregiving responsibility. Among other things, the authors found that the flexibility offered was associated with greater difficulties in leaving work early or not being 'on call' outside of regular working hours for women than it was for men. On a related note, Nikunen (2014) investigated the effects of parenthood on work and careers as perceived by Finnish academics employed on short fixed-term contracts; despite recognition of considerable freedom and flexibility in achieving work/life balance, having children or taking long parental leave was still associated with anxiety and risk of a negative impact on career prospects.

Based on in-depth interviews with 47 doctoral students, Hill (2020) found that women were more likely than men to perceive starting a family and pursuing an academic career as incompatible, and they were more likely to report opting for singlehood and intentionally delay romantic relationships, marriage, and parenthood while pursuing career goals.

However, as briefly reviewed by van den Besselaar and Sandström (2016), the evidence on the question on how parenthood affects researchers' performance is mixed, as several studies (mostly dating back to the 1970s-1990s) have found no evidence that female researchers' academic careers are negatively impacted by parenthood.

For instance, Krapf, Ursprung, and Zimmermann (2017) – in a study of the effect of parenthood on the research productivity of academic economists – found no significant, overall relationship between motherhood or the birth of a first child and low research productivity, although becoming a mother before the age of 30 appeared to have a detrimental effect on research productivity. They also found indications that the effect of parenthood on research productivity was negative for unmarried women and positive for untenured men.

Joecks, Pull, and Backes-Gellner (2014) found that female researchers with children in business and economics were *more* productive than female researchers without children. They proposed two possible explanations: that female researchers with children either manage to overcompensate the negative resource effect associated with childbearing by working harder or that only the most productive female researchers decide to pursue both an academic career and parenthood. A descriptive analysis of female researchers in business and economics in Austria, Germany, and the German-speaking part of Switzerland provides indications that the latter may be the case, as only the most productive female researchers with children self-select or are selected into an academic career.

Finally, it is unclear how parenthood affects the total number of working hours for academics. For instance, academic mothers in the US did not appear to work fewer hours compared to male researchers with children or compared to female researchers without children; meanwhile, their German counterparts worked around 8 hours less per week compared to male researchers with children and compared to female researchers without children (Sieverding et al. 2018).

Women are less geographically mobile and may be more likely to work in less prestigious institutions

Several studies have found woman researchers to be less geographically mobile than male counterparts, as reviewed e.g. by Kulis and Sicotte (2002), who argued that lower degrees of geographical mobility may have negative effects on women researchers' recruitment, career advancement, and salary. Using data from the National Survey of Doctoral Recipients in the US, the authors found that women researchers are disproportionately drawn to large cities, areas that have many local colleges, and regional centers of doctoral production. The authors presented several possible explanations for this, including that women researchers settle in the geographical area where they earned their doctoral degree or in large cities that offer a broad range of employment opportunities for dual-career couples. The authors moreover suggested that women researchers' mobility patterns are affected by family and gender role dynamics; they found that women's geographical mobility was affected more by having children than by marriage. Finally, they found that women employed in doctoral production centers were less likely to hold a tenured position and more likely to be employed part-time, and women in larger cities were less likely to be on the tenure track.

Other studies have shown e.g. that women researchers are less likely to be internationally mobile than their male counterparts Jöns (2011). Caregiving responsibilities may affect researchers' international mobility and research collaboration (Lubitow and Zippel, 2014), both with regards to longer research stays and the like, and with regards to short-term travel e.g. participating in academic conferences (Henderson and Moreau, 2020) but also other research-related travel e.g. traveling to give an invited talk (Tower and Latimer, 2016). Reconciling mobility with family/caregiving duties was found to be an issue even for highly successful Austrian female researchers even highly successful female researchers' decisions about mobility (Fritsch, 2015).

Studies from North America in particular moreover indicate that women researchers are more likely to work in less prestigious institutions (Cruz-Castro and Sanz-Menéndez 2019). There are also studies suggesting that women prefer or thrive more in certain institutions. For instance, based on a study of life scientists in the US, Smith-Doerr (2004) found that women perform better in flat hierarchies in private firms than in academia. Corley and Gaughan (2005) found that women researchers performed better in research centers than in traditional university departments; although women in centers were younger, employed at lower academic ranks and less likely to be tenured than their male colleagues, they did spend as much time as men undertaking research, writing grant proposals and administering grants.

Gender bias and discrimination

Selection of talent in academia is often driven by panels and committees that are e.g. responsible for identifying interesting candidates for recruitment and for reviewing grant and job applications; such panels and committees may be affected by various forms of bias but also by group dynamics and social interaction within a group of panel or committee members (van Arensbergen, van der Weijden, and van den Besselaar 2014). Many studies have examined possible bias or discrimination as factors in explaining gender differences in science.

Where discrimination refers to the different (typically less favorable) treatment of individuals or groups with similar characteristics or circumstances, bias (which can be conscious or unconscious) refers to characteristics of evaluators' cognitive or attitudinal mindset (e.g. preferences, prejudices, or incomplete information) that can impact the objectivity of their evaluation (Cruz-Castro and Sanz-Menéndez 2019). It is widely recognized that reviewers are often positively inclined towards work similar to their own, possibly because of bias, possibly because it is more difficult for them with confidence to assess work more dissimilar to their own (Bloch and Henriksen 2013).

Gender bias can be shaped by stereotypes (e.g. Teelken, Taminiau, and Rosenmöller 2019) and may take different forms. For instance, Heilman (2001) distinguished between descriptive gender stereotypes (associated with expectations about what women or men are like, for instance as women are attributed with social and service oriented, or 'communal' traits and men with e.g. 'agency' and decisiveness), and prescriptive gender stereotypes (associated with expectations of how people of a certain sex should behave). The author moreover argued that both of these types of stereotypes can lead to biased evaluations, including e.g. devaluation of women's performance (with reference to prior work indicating that women can be viewed as less skilled than a man even when equally successful at a male sex-typed task), a denial of credit to women (e.g. drawing on research showing that women but not men are judged to be less competent when group feedback is given instead of individual feedback), or even penalization of competence (if for instance, women exhibit behavior normally ascribed to men).

Bias has also been argued to affect researchers' salaries. In a study of Canadian faculty in accounting, Wiedman (2019) found that women received a significantly lower salary for coauthored articles they published with men than those they published with other women; no similar variations in reward was evident for men. According to the author, this was indicative of a bias in the attribution of credit for coauthored research in the determination of salary and may help explain why salaries for female academics vary systematically from those of men even after considering productivity.

Drawing on prior work in economics, Cruz-Castro and Sanz-Menéndez (2019) distinguish between two forms of bias. The first is discrimination based on preferences, in which an evaluator has a personal preference for certain characteristics associated with certain groups of individuals, and these preferences affect his/her assessment of effort, achievement, and/or future potential positively or negatively. The second is statistical discrimination, where evaluators – e.g. because of incomplete information about candidates under assessment – rely on e.g. information on the average performance of certain groups of candidates (e.g. candidates of the same gender, or who received their Ph.D. from the same institution, or the same research subfield, etc.) to provide additional information for use in their assessment; such information may moreover be accurate or inaccurate.

As pointed out by e.g. O'Meara et al. (2017), it is worth noting that prior research has shown that women, as well as men, hold implicit biases towards women, including e.g. perceptions that women are likely to be helpful and communally-oriented and to contribute to academic service.

In the following, we examine studies that investigate the role of gender bias and discrimination. Because the literature on this topic is rather extensive, we will first consider studies examining bias and discrimination in academic search, recruitment and advancement processes, second, in the allocation of research funding, and third, in research assessment generally speaking. However, as pointed out by (Cruz-Castro and Sanz-Menéndez, 2019), the evidence on these topics is highly mixed. Several studies find evidence of bias or point to bias as the possible explanation for residual gender differences. Meanwhile, other studies refute these arguments. For instance, Ceci and Williams (2011) argued that evidence does not support arguments of discrimination against women in journals, grant assessments and hiring, and that differences in outcomes for men and women can be explained by different choices (free or constrained) i.e. by men/women's individual choices and constraints imposed not by academia but by society at large (Williams and Ceci 2015).

Cruz-Castro and Sanz-Menéndez (2019) pointed out that these contributions have been highly controversial, particularly for attributing gender inequalities in science to factors beyond the reach of the academic system itself. They also pointed out that "the higher we go in the academic hierarchy, the more difficult [sic] is to disentangle performance and career differences from other factors that impede women's entry into the most elitist ranks" (Cruz-Castro and Sanz-Menéndez, 2019), and that the volume of literature that claims that gender bias exists and persists is far greater than the body of work that claims that it is diminishing or disappearing. At the same time, Cruz-Castro and Sanz-Menéndez cautioned against attributing all non-explained gender gaps/variation to discrimination and bias. Finally, they pointed out that a likely explanation for much of the heterogeneity found in the evidence on the existence of gender bias are variations and limitations in the methods and data applied in studies of gender bias.

Gender bias and discrimination – in academic search, recruitment, and advancement

Gender bias in decisions about e.g. recruitment, advancement, and funding in academia has been advanced as a possible explanation for gender differences in academic career trajectories and scientific performance (Zuckerman 2001), fueled in part by an oft-cited study by Moss-Racusin et al. (2012). Moss-Racusin and colleagues investigated whether science faculty showed bias against female students. In a randomized double-blind study, science faculty from research-intensive universities were asked to rate the application materials of a student – who was randomly assigned either a male or female name – for a laboratory manager position. Male applicants were rated as significantly more competent and ‘hireable’ than (identical) female applicants; they were also offered a higher starting salary and more career mentoring. Moreover, female and male faculty were equally likely to exhibit bias against the female students, who were generally viewed as less competent.

Scouting and recruitment processes in academia are characterized by limited transparency and accountability (van den Brink, Benschop and Jansen 2010); indeed, it has been pointed out that much of the selection process takes place even before a position is announced, underlining the importance of researchers’ informal networks and visibility for their chances of obtaining a position (Nielsen, 2017c). IGiven the importance of ‘scouting’ for suitable candidates in academic recruitment practices (Van den Brink 2011; Munar and Villesèche 2016), understanding how such candidates are identified and encouraged is relevant to consider. For example, in a study of appointment practices for medical professors in the Netherlands, Van den Brink (2011) found that the pool of potential candidates was restricted when candidates were identified through homogenous male networks and that gendered preconceptions of what constituted a suitable candidate could influence the recruitment processes. On a related note, Neale and White (2014) found based on interviews with women researchers in an Australian and a New Zealand University that female researchers perceived that informal processes around promotion discriminated against senior academic women.

Clauset, Arbesman and Larremore (2015) examined placement data on nearly 19,000 regular faculty in three disciplines in the US Across disciplines. They found that faculty hiring followed a hierarchical structure that reflected social inequality; among other things, doctoral prestige was a key factor in explaining placements, women generally placed worse than men, and increased institutional prestige was associated with increased faculty production, better faculty placement, and a more influential position within the discipline. On a related note, Sheltzer and Smith (2014) found that high-achieving male faculty members in the biological sciences trained 10-40 percent fewer women in their laboratories relative to the number of women trained by other investigators. They pointed out that these findings might be the result of self-selection among female scientists or conscious or unconscious bias on the part of some faculty members.

Reuben, Sapienza and Zingales (2014) found in an experiment that without the provision of information about candidates other than their appearance, men were twice more likely to be hired for a mathematical task than women. If the ability was self-reported, women still were discriminated against, because employers did not fully account for men’s tendency to boast about performance. Providing full information about candidates’ past performance reduced discrimination but did not eliminate it.

Abramo, D'Angelo, and Rosati (2016) examined academic recruitment processes in Italy and found that certain factors appeared to give male applicants an advantage, e.g. having worked for several years in the same university as a committee member, or if the chairman of the committee was also male. For female applicants, having the same family name as a full professor in the same university was associated with a higher likelihood of employment. However, they found that female candidates were less likely to be affected by negative bias than male candidates, which the authors argued could be explained by a concentration of male top scientists might lead to discrimination against male candidates.

Rivera (2017) examined junior faculty search procedures at a large US research university, focusing on the role of search committees, and found indications of discrimination related to candidates' relationship status. The qualitative study showed that search committees considered the relationship status of female candidates in heterosexual relationships, but not of male candidates, based on an assumption that female partners were 'movable', while male partners with academic or high-status jobs were not. The author concluded that this type of practice could disadvantage women in academic hiring procedures.

However, it is worth noting that a study of faculty members at 7 US universities by Zhang, Kmec and Byington (2019) found that women who perceived their career as primary compared to that of their partner were more likely than men to have considered refusing their job offer had their partner not found suitable employment. Women were also more likely than men to have considered leaving their current job had their partner not found suitable employment (regardless of the importance of their career relative to that of their partner's).

Treviño et al. (2015) examined the professorial appointments of 511 management professors at top American research universities. After controlling for research performance and other factors, they found that women were less likely to be awarded named professorships, particularly when the endowed chair was awarded to an internal candidate. They also concluded that women derive lower returns from their scholarly achievements when it comes to appointments to endowed chairs.

In contrast, Williams and Ceci (2015) reported a 2:1 preference for hiring female faculty over equally qualified male candidates with matching lifestyles (e.g. single, married, divorced) through hiring experiments where 873 faculty members from 371 colleges and universities evaluated hypothetical female and male applicants for assistant professorships in biology, engineering, economics, and psychology. The only exception to their findings was found among male economists, who exhibited no gender preference in the experiments.

Moratti (2020) pointed to several issues in academic recruitment shown in prior work to put women at a systematic disadvantage including positions awarded by direct invitation (rather than via open job postings), the use of nominally open job calls which routinely get only one applicant, and procedural rules that allow the filtering out of qualified applicants without sharing the grounds of the decision with the candidates. The author examined associate professor recruitment procedures at the Norwegian University of Science and Technology (NTNU) over a ten-year period and concluded that the gender-equal characteristic of the university (with the share of female associate professors stable at 40 percent for over a decade) acted as an antidote to the potential biasing effect of low-openness and low-transparency hiring procedures. The author also found no indication that low-openness and low-transparency procedures systematically advantage women.

Looking beyond hiring decisions, some studies have examined how parenthood and different national-level policies may affect academic job search. For instance, Ollilainen (2019) interviewed 67 women academics in Finland and the US and found that – despite substantial differences in work-family policies in the two countries – women in both countries felt a need to maintain a visible presence at work, even while they were on parental leave. Despite generous work-family policies in Finland, the prevalence of fixed-term contracts shaped decisions about when to start a family and how to manage periods of parental leave.

Parenthood – or the possibility of parenthood – may also influence decisions regarding recruitment. Gloor et al. (2018) found that childless women in the early stages of an academic career were likely to be associated with greater uncertainty and inconvenience – and experience more incivility – than childless early-stage male academics.

Finally, Martell, Emrich, and Robison-Cox (2012) argued that institutional or field level gender differences in e.g. performance or career advancement can be seen as consequences of the collective behavior of individuals who express only slight bias in favor of e.g. mean and that the unintentional processes by which this occurs are difficult to observe. This suggests that even small biases may contribute to wider, aggregate effects.

Gender bias and discrimination – in research funding and peer review

Is grant allocation affected by gender bias or discrimination? Evidence on this topic is highly mixed. For instance, taking a recent example, Steinþórsdóttir et al. 2020) argued that the Icelandic research funding system is biased not only in favor of men but also more generally towards male-dominated and culturally masculine positions and fields., indicating that bias may be found not just in grant allocation decisions but also in the wider norms and decisions that shape the funding system and overall allocation of funding. In contrast, Urquhart-Cronish and Otto (2019) found no evidence that funding outcomes were affected by gendered differences in language used in applications, based on a study of approximately 2,000 public research summaries from the 2016 Natural Sciences and Engineering Research Council individual Discovery Grant (DG) program.

Cruz-Castro and Sanz-Menéndez (2019) reviewed the literature on gender disparities with regards to funding and concluded that arguments that gender differences can be explained by bias or discrimination are often supported using normative principles rather than robust empirical evidence. However, as pointed out by Cruz-Castro and Sanz-Menéndez (2019), there are significant methodological and measurement challenges that make it difficult to produce convincing evidence of discrimination, particularly because many of the gender disparities examined in academia are partly influenced by self-selection, increasing methodological challenges. The authors go on to discuss major methodological issues in the literature, including attempts to estimate discrimination based on multivariate or regression analysis based on data, on grant allocation outcomes, or career advancement as the dependent variable and a series of independent variables that include individual factors (including gender) and, in some studies, contextual factors also. The authors point to the limitations of such studies, notably that it is extremely difficult to include all factors likely to affect such an outcome, particularly as some of these factors are unobservable or at least difficult to measure. E.g. a researchers' potential, degree of originality etc. The authors also argued that the gender differences that studies have tried to explain may be the result of previous gender differences (e.g. in productivity, scientific reputation, etc.), which may themselves be the result of discrimination; in that case, such studies are at best likely to underestimate the extent of discrimination. The authors argue in favor of more experimental approaches, which they argued have higher levels of internal validity, but which pose challenges for researchers to meet sampling and generalizability requirements. Cruz-Castro and Sanz-Menéndez (2019) also pointed out that many studies seek to examine possible bias or discrimination in static, single-event settings, e.g. a single grant allocation decision, and including no information on e.g. prior assessments of the candidate which might affect the event under study, or interventions/learnings in policies and approaches, effects of interactions between groups, etc. .

Many contributions to the literature discuss whether *peer review* disadvantages women researchers, but again we see conflicting evidence, as apparent from various reviews of this literature (see e.g. Guthrie, Ghiga, and Wooding 2018; Marsh et al. 2009).

An oft-cited study by Wennerås and Wold (1997) of the grant peer-review system of the Swedish Medical Research Council suggested that reviewers were gender-biased in their assessment of scientific merit. It should be noted that replication of this study by Sandström and Hällsten (2007) found that ten years later, the gender bias was actually in favor of women, with female principal investigators receiving a 10 percent bonus on their scores when compared to male applicants.

Arguments that a gender bias in grant peer-review exists were however echoed by a meta-analysis of 21 studies undertaken by Bornmann, Mutz, and Daniel (2007), which concluded that grant applications by men were 7 percent more likely to be approved than those submitted by women. Similarly, a review by Kaatz, Gutierrez, and Carnes (2014) concluded that women generally have lower rates of publication and success rates for high-status research awards than men.

Meanwhile, Brouns (2000) examined outcomes of peer review processes in two research funding bodies in the Netherlands, the Dutch Organization for Scientific Research (NWO) and the Royal Dutch Academy for the Sciences. The study concluded that women applicants were evaluated differently from male applicants – but the impact of this different treatment differed across disciplines: in some disciplines, women appeared to have been discriminated against, while in others, they appeared to have been favored.

Kaatz et al. (2016) examined peer review assessments of both funded and unfunded R01 applications to the National Institutes of Health (NIH) from a midwestern university and found indications of subtle gender bias. Meanwhile, van der Lee and Ellemers (2015a) examined grant funding rates for a national full population of early-career scientists in the Netherlands. Their data was based on application and review materials for 2,823 proposals under three calls from the Netherlands Organization for Scientific Research (NWO). They found a gender bias in favor of male applicants in how the 'quality of the researcher' was assessed (but not in how the 'quality of the proposal' or 'knowledge utilization' was assessed, where no gender differences were observed). More precisely, they found that male applications received significantly more positive assessments on the criterion 'quality of the researcher' and also had significantly higher application success rates – with these patterns being most prevalent in disciplines with the highest number of applications and equal gender distribution among the applicants (i.e. life sciences and social sciences). They also used content analyses of the instructional and evaluation materials from the NWO and concluded that there was a use of gendered language favoring male applicants. Overall, the authors reported a 4 percent 'loss' of women during the grant review process for awards to early-career scientists.

The study received criticism, however, from Albers (2015) and Volker and Steenbeek (2015) who criticized the statistical procedure applied in the study and questioned whether the gender effect was statistically significant. The critics argued for instance that if a higher proportion of women applied for grants in competitive disciplines with low success rates for both genders (e.g. life sciences and social sciences), then an analysis of success rates across all disciplines might incorrectly indicate gender inequality in the allocation of grants. Among other things, they also criticized the lack of inclusion of control variables that could have explained the gender differences found. van der Lee and Ellemers (2015b; 2015c) replied to these criticisms, reiterating that lower success rates for women were primarily observed in the disciplines with a high proportion of female applicants (51 percent) and low success rates; they also emphasized that their data indicated that women were less likely than men to be prioritized in every step of the review procedure. They argued that prior research has shown that in disciplines with low success rates, assessors are more likely to rely on stereotypes in their evaluation of applicants. They also argued that their conclusions were based on several findings from their study and not just the contested statistical finding highlighted in criticisms. Finally, van der Lee and Ellemers stressed the finding that gender differences in application success rates could only be traced to gender differences in 'quality of researcher' ratings, as there were no observable gender differences ratings of proposal quality or expected knowledge utilization, warranting greater focus on the existence of possible gender bias in grant assessment procedures and the wording of instructional and evaluation materials.

Witteman et al. (2018) examined a natural experiment from the Canadian Institutes of Health Research (CIHR) which in 2014 divided all investigator-initiated funding into two new grant programs: one with and one without an explicit review focus on the caliber of the principal investigator. Based on an analysis of almost 24,000 grant applications from more than 7,000 unique principal investigators over a five-yearperiod from 2011 to 2016, the authors found that the predicted probability of funding success in traditional programs was 0.9 percentage points higher for males than for female principal investigators. Meanwhile, in the new programs established in 2014, the gap was 0.9 percentage points in favor of male principal investigators in the program focused on the proposed science, but 4.0 percentage points in the program with an explicit focus on the caliber of the principal investigator. According to the authors, this indicated that gender differences in grant application success are explained not by differences in assessments of the quality of science led by women as much as by less favorable assessments of women as principal investigators.

Hechtman et al. (2018) examined funding trajectories for more than 34,000 biomedical research grant holders from the US National Institutes of Health (NIH). They found that women had comparable funding longevity to men (meaning that they are funded at the same rate as men after receiving their first major research grant). There were indications of a slight gender difference in funding longevity in favor of men. But the authors also found that women held fewer grants, submitted fewer applications, and were less successful in renewing grants; all factors which according to the authors could help explain any gender differences in funding longevity. Overall, the authors argued that their study showed that women were comparable to men in their ability to sustain research funding, and that focus should therefore be on (i) increasing women's representation among initial NIH grantees (where they accounted for just 31 percent) and (ii) increasing women's rates of new and renewal application submissions to address funding imbalances.

In contrast, Ceci and Williams (2011) argued based on a review of two decades of studies that claims of gender discrimination in grant and manuscript reviewing and academic recruitment are no longer valid, and that studies indicate that peer review, overall, is fair regardless of applicants' gender. The authors concluded that gendered differences in outcomes must be explained by other factors, notable differences in resources, which they argued are attributable to individuals' choices (which in turn may be free or constrained). They reiterated this conclusion in Ceci et al. (2014), where they argued that male and female researchers were equally likely to have their publications accepted and their grants funded.

Reinhart (2009) examined peer review procedures at the Swiss National Science Foundation, based on applications covering research in biology and medicine from the year 1998. The study concluded that only scientific performance indicators were significant predictors of the funding decision, finding no evidence of gender bias, age bias, nationality bias, or bias related to the academic rank of the applicant, the requested amount of funding, or institutional affiliation.

Mutz, Bornmann, and Daniel (2012) investigated the grant peer-review process at the Austrian Science Fund based on more than 8,400 research proposals across all disciplines from 1999 to 2009. They found no evidence that the final grant decision was affected by the applicant's gender or by any correspondence between the applicant's and reviewer's gender. However, they found that women were 10 percent more likely to obtain a grant when there was parity or majority of women in the group of reviewers.

Additional arguments against the existence of gender bias in peer review have been put forth by several studies, as reviewed e.g. by Ismail, Farrands, and Wooding (2009). Marsh et al. (2009) evaluated gender differences in peer reviews of grant applications, extending prior work including the aforementioned study by Bornmann, Mutz, and Daniel (2007) that reported small gender differences in favor of men, but found no evidence of gender bias in the assessment of grant proposal, with non-effects consistent across country, discipline, and publication year. They argued that results reporting evidence of gender bias in prior work could be explained by the fact that many of these studies pursue a null hypothesis-testing approach, and that if the sample size is sufficiently large, statistically significant gender differences will almost always be present, even if the effect of such differences is so small as to have no substantive importance or implications. The authors stressed that reported gender differences in prior work tend to be small and warned against overinflating small gender differences.

Moreover, a large-scale study across disciplines by Marsh, Jayasinghe, and Bond (2011) found no evidence of gender bias in peer-review of grant proposals. The non-effects of gender identified in their study were consistent across disciplines, whether assessors were chosen by the researchers themselves or by the funding agency, and by the country of the assessor.

Gender bias and discrimination in research assessment and bibliometric approaches

Whether with the aim of assessing grant applications or recruiting talent, peer-review and performance assessment play a key role in talent selection in academia. There is extensive research on the limitations and possible bias in peer-review processes, as reviewed e.g. by Guthrie, Ghiga, and Wooding (2018), and concerns have been raised that research assessment practices may contribute to gender inequalities in research (e.g. Brooks, Fenton, and Walker 2014). In the following, we briefly review some of the work that has focused on possible gender bias and discrimination in research assessment.

Nielsen (2018) has argued that the use of bibliometric methods to assess scientific performance, when used to assess the performance of individual researchers, may sustain or increase gender inequalities in research by applying easily measurable and seemingly impartial and objective indicators that disproportionately reward research practices and achievements more commonly associated with successful male scholars than with female researchers, e.g. high scientific productivity or wider and more international research networks. In other words, the use of bibliometric indicators is shaped, he argued, by implicit cultural assumptions about how scientists should be and perform, and thus may create obstacles for talented researchers who diverge from this norm, with the risk of decreasing diversity in academic goals and approaches pursued in a given department. More specifically, Nielsen (2018) raised concerns about specific bibliometric indicators, including e.g. the popular *h*-index, which favors researchers who publish in subfields with high citation frequencies and with many co-authors, and which is highly correlated with scientific productivity and thus scientific age.

Nielsen (2017b) examined the extent to which national performance funding allocation mechanisms reflect the research performance of female and male researchers differently, focusing on one such mechanism: the Danish ‘Bibliometric Research Indicator’ (BRI). The BRI is based on a counting of publications in peer-reviewed outlets, assigning a higher number of points to publications in outlets that have been deemed well-regarded and selective, and a lower number of points to publications in more standard outlets. The author found that male researchers on average received more BRI points for their publications than women. Two likely explanations for this finding are presented by the author. First, that women account for approximately a quarter of the members of the committees that determine, which publication outlets are categorized as well-regarded, and which are listed as standard outlets, and that this may result in biases in the process of assigning BRI points to outlets. Second, the author argues that the BRI model rewards collaborative research, which disadvantages women due to the aforementioned gender differences observed in male and female researchers' collaborative patterns.

Offering a perspective from Italy, Jappelli, Nappi, and Torrini (2017) examined data on the assessment of 180,000 research papers evaluated during the Italian national research assessment 2004–2010. The authors found a significant gender gap in research evaluation, with women being less likely to receive a high evaluation. This gap was reduced when controlling for researchers' academic rank but could not be explained by differences in co-authorships or international collaborations nor by periods of maternity leave. Moreover, they found no evidence that women received more favorable evaluations than men if the reviewer was a woman.

Jappelli, Nappi, and Torrini (2017) also found that bibliometric evaluations were more favorable to women than assessment through peer review, as women were significantly less likely to receive high evaluations, relative to men when their work was assessed through peer review; meanwhile, assessment via bibliometric methods had no significant effect on the likelihood of women receiving high evaluations. However, the authors noted that this finding was based on a specific subset of papers, namely the three best papers in the period 2004-2010 selected by authors themselves and that the findings might therefore not apply to an assessment of researchers' full scientific production.

Overall, Jappelli, Nappi, and Torrini (2017) did not find that the national research assessment was 'unfair' to women researchers, but could not explain the small but persistent gender gap in research assessment. They proposed that the residual gap might be the result not of an 'evaluation effect' but a 'selection effect', i.e. the result of gender differences that emerge in other stages of the academic career.

Picking up on one of the factors addressed by Jappelli, Nappi, and Torrini (2017), other studies have also examined the relationship between the performance assessment of women researchers and the gender of evaluators. As briefly reviewed by Jappelli, Nappi, and Torrini (2017), the literature on this issue is relatively limited and inconclusive, with some studies find benefit from same-gender evaluators (van den Brink, Brouns, and Waslander 2006; Zinovyeva and Bagues 2011; De Paola and Scoppa 2015), some finding evidence of benefit from having an evaluator of the opposite gender (e.g. Bagues, Sylos-Labini and Zinovyeva 2014), and some finding no significant impact of evaluators' gender (e.g. Zinovyeva and Bagues 2011).

Leahey (2006) argued that while several of the gender differences observed in academia – e.g. in salaries, in career advancement, and funding success – can be explained to a large extent by differences in scientific productivity, the cause of these productivity differences have been harder to explain. Indeed, questions regarding the existence of gender bias in academia have been driven in part by efforts to explain gender differences in academic careers which could not fully be explained by gender differences in scientific productivity. For example, Filandri and Pasqua (2019) examined the effect of gender in professors' career advancement using data on the entire population of professors in the Italian university system. In Italy, qualifying for an associate or full professorship requires researchers to obtain the National Scientific Qualification (NSQ) accreditation, which establishes a minimum level of research productivity, which differs across disciplines and sub-disciplines. The authors set out to investigate whether gender differences in research productivity could explain the gender gap in career advancement; this was not the case. Using four different indicators of research performance, the authors consistently found a gender gap in the probability of career advancement. More specifically, the authors found that female assistant professors' probability of advancing to associate professorship was 8 percentage points lower than their male colleagues; their probability of advancing from associate to full professor was 17 percentage points lower. The authors interpreted these findings as evidence of structural gender bias. Looking at the proportion of female full professors across academic sectors, they moreover found that the gender gap was not statistically significant in sectors with more female full professors, indicating that higher proportions of women among the professorial staff may be associated with less pronounced structural gender bias.

On a similar note, based on a panel data econometric analysis of individual publication productivity differences for two large samples of French physicists, Mairesse and Pezzoni (2015) found that women were less likely than men to advance to higher academic positions, even when controlling for past publication productivity. They also found that women researchers more frequently had periods of no or very low-quality publications, which according to the authors might be explained by periods spent to a higher degree on duties related to motherhood or childcare, and other family and household duties. When considering the probability of promotion and the probability of having periods with no or very low-quality publications, the authors found that female physicists were as productive as their male colleagues at the French National Centre for Research (CNRS), and more productive in French universities, despite the authors controlling for coauthorship and initial conditions that proxy for unobserved factors of productivity.

Finally, student evaluations of teachers are often used in the assessment of researchers in connection with e.g. tenure, promotion, and compensation decisions. However, it has been argued that this may be discriminatory against women, with one study suggesting this is because male professors are overvalued as teachers by students, rather than that female professors are undervalued (Hoorens, Dekkers and Deschrijver 2020). For instance, Mitchell and Martin (2018) showed that a male instructor administering an identical online course as a female instructor received higher ordinal scores in teaching evaluations, even when questions were not instructor-specific.

Gendered perceptions of 'excellence'?

Excellence is often invoked in academia, for instance as a criterion for recruitment or funding decisions. Concerns have however been raised about the implications of the reliance on excellence in such justifications. For instance, Moore et al. (2017) argued that the concept of 'excellence' is a flexible term that can be used for many purposes (including organizing, funding, assessing, and rewarding science) but which has no intrinsic meaning in academia, i.e. no clear definition or objective and transparent assessment criteria. Although the rhetoric of 'excellence' is presented as a suitable method for identifying quality in research and allocating resources, the authors stressed that it is neither as efficient nor accurate as it is presented to be. They moreover argued that the overemphasis on excellence may impede rather than promote good research, by discouraging both intellectual risk-taking and incremental 'steady-state' science. Instead, the authors argued, it rewards a steady stream of publications in high-prestige journals, increases existing competition for scarce resources and positions in science, and may encourage if at least not dissuade researchers from engaging in questionable research practices.

The notion of 'excellent' research is also discussed from a gender perspective (e.g. by Thornton 2013; Harford 2018; Lipton 2020). Nordic reports on gender issues in science have concluded that excellence based initiatives tend to favor male scientists and tend to overlook the uneven distribution of male and female researchers across research topics and traditions, with 'excellence'-based criteria tending to favor fields traditionally dominated by men (Faber, Nielsen, and Gemzøe 2019), and similar criticisms have been put forth of the Professorships Programme at the Swiss National Research Foundation (Fassa and Kradolfer 2013).

On a related note, van den Brink and Benschop (2011) argued that excellence in academia, while cloaked in a "myth of meritocratic impartiality" is, in fact, an evasive and gendered social construct that produces gender inequality by rewarding behavior more prominent among male than female scholars. Citing prior work casting doubt on the neutrality and objectivity of merit-based systems in academia, the authors examined processes surrounding the evaluation of Dutch professorial candidates and identified three problematic practices. First, a focus on lengthy publication track records, which can disadvantage candidates with non-standard career trajectories, parental leaves, and larger amounts of other academic work (e.g. teaching or management). Second, evaluations were influenced by perceived personality and leadership potential, where for example search committees were likely to view men as likable, which could yield additional 'excellence points', while women being viewed as modest could result in a loss of such points. Finally, network connections were observed to be associated with the assessment of higher status and influence, thus favoring candidates with strong male networks that could encourage them to apply, recommend them for positions and recommend them to committee members. These three qualities, the authors argued, are not gender-neutral.

Research has indicated that men are more likely to be seen as excellent even when male and female researchers have comparable achievements (Coate and Howson 2016). Healey and Davies (2019) argued that a narrow conception of 'research' may prevent some individuals from identifying as 'research-active' and therefore engaging with research, underlining the potential implications of different conceptions of research. On a related note, Reynolds et al., (2018) – in a study of what constitutes academic success for nine successful female early career researchers at an Australian university – found that women pointed to multiple themes in defining academic success, including objectives measures related to e.g. publications, grants, and citations, but also more subjective views of success including making a contribution to society through their research, undertaking research they are passionate about, having autonomy in their role and achieving work-life balance. These findings may indicate that women define success in broader terms, which in turn may affect their career progress and decisions about their career.

Working conditions in academia

The academic work environment has been described as a 'chilly' or even hostile climate for women (Carr et al. 2000, 2003; Misra, Lundquist and Templer 2012; Fotaki 2013; Pololi et al. 2013; Settles et al. 2013; Jenner et al. 2019; Miner et al. 2019). The perception of a chilly or even hostile climate has been associated not only with early career and non-tenured researchers but also with mid to late-career researchers (Carter and Tully 2019). Some of these studies documented experiences with sexual harassment or gender discrimination (see also e.g. Taylor et al. 2018; Fernando and Prasad 2019). Others described how norms prevalent in male-dominated academic environments may cause women researchers to feel marginalized and to report a lower sense of belonging within the workplace (Chapman et al. 2011). However, while some women faculty feel marginalized, many may be thriving, as was e.g. the case in a study of academic chemists in the US (Chapman et al. 2011).

Other work focuses on how women perceive specific aspects of the academic work environment e.g. in connection with fieldwork (e.g. Benz 2014; Soyer 2014; Chiswell and Wheeler 2016; Kloß 2017; Lynn, Howells and Stein 2018; O'Brien 2019; Vogels 2019; Jenkins 2020) or academic conferences. For instance, a survey among female presenters at US conferences indicated that women were more likely to perceive a conference as having a 'chilly climate' when there was a lower representation of women relative to men at the conference (Biggs, Hawley and Biernat 2018). Also, Settles and O'Connor (2014) found in a survey among US male and female researchers that women reported more incivility and perceived the climate to be more sexist at academic conferences they had attended than men did.

Mairesse and Pezzoni (2015) cited earlier work giving examples of difficulties encountered by women researchers who enter into traditionally men-centered disciplines. They argued that such experiences may lead women researchers to alter their behavior and select into other disciplines. Moreover, Casad, Petzel, and Ingalls (2019) drew attention to the role perceptions of the working environment among women in

STEM fields in the US in influencing e.g. their sense of perceived control and risk of disengagement from STEM fields.

There may also be differences in the degree of support offered by different institutions and departments. In a study of grants applications to the UK Research Councils and the Wellcome Trust, Blake and LaValle (2000, cited in Cruz-Castro and Sanz-Menéndez 2019) found that women were equally successful as compared with men in obtaining the grants they applied for, but were less likely to apply for grants due to their lower status in their home institutions and because they received less support in doing so.

Some of the literature also points to the importance of a critical mass of women for addressing gender imbalances. Cain and Leahey (2014) systematically reviewed hundreds of autobiographical accounts of scientific success in fields with a large proportion of women researchers (psychology and the life sciences) and fields with a low proportion (engineering and physics) and concluded that female researchers active in fields where women are not a numerical minority experienced higher levels of involvement in decision-making and academic collaborations. They also experienced less stereotyping and had a more positive view of informal relationships in the workplace. According to Nielsen et al. (2017), these findings point to the importance of a certain 'critical mass' of women (or other underrepresented minorities, for that matter) in the academic workplace, which they estimated to be at 15 to 30 percent of team members. In this regard, it is worth noting that Joshi (2014) found, in a survey-based study of scientific collaborations at a US university, that gender-integrated teams with a higher proportion of highly educated women were more productive in disciplines, where there was a larger proportion of female faculty.

Studies have also indicated that a certain critical mass of women is crucial for retaining women faculty (Verbos and Dykstra 2014) and for how women faculty perceive their academic working environment. For instance, Maranto and Griffin (2011) found that faculty women were more likely to perceive exclusion from academic departments that had a low representation of women. Similarly, Hillard et al. (2014) found that a higher proportion of women in a department was related to increased perceptions that the department advances women.

Lee and Won (2014) found that that the proportion of female full professors was positively associated with improved gender equity in assistant professors' salaries, while the proportion of female associate and assistant professors was not found to be significantly associated with improved gender equity.

Carrigan, Quinn and Riskin (2011) found that a critical mass of women faculty in a discipline mitigated gendered divisions of labor and thus lead to more equitable distribution of resources and allocation of time for male and female faculty.

On a related note, Stack (2004) found, based on a review of prior literature, that the measured negative effect of having children on scientific productivity is weaker in disciplines with a higher proportion of women (e.g. social science) than in the so-called 'hard' disciplines. This, according to Stack (2004) and Mairesse and Pezzoni (2015), suggests that disciplines with a higher proportion of women have qualities that lead to lower 'penalties' on productivity from parenthood, e.g. more developed women-researcher networks or more flexible academic career paths.

As previously mentioned, Leahey (2006) found, looking at the proportion of female full professors across academic sectors, that the gender gap was not statistically significant in sectors with more female full professors, indicating that higher proportions of women among the professorial staff may be associated with less pronounced structural gender bias.

Moreover, Angervall, Gustafsson, and Silfver (2018) argued that there are significant differences between academic work environments, using a study within two areas of education sciences in Sweden to illustrate departments characterized by collaboration and joint production among faculty and close integration of teaching and research activities. Their work indicates that there may be a variety of ways in which to organize academic departments and that some of these ways may be more attractive to e.g. female researchers than others.

Women are more likely to 'opt out' of academic research

The higher attrition rate of women researchers is key to understanding gendered performance differences; for instance, Huang et al. (2020) found that gender differences in scientific productivity and impact were largely explained by differences in publishing career lengths and dropout rates for men and women. In a study of the complete publication history of over 1.5 million gender-identified authors whose publishing career ended between 1955 and 2010, covering 83 countries and 13 disciplines, the authors found that the increase of participation of women in science has been accompanied by an increase in gender differences in both productivity and impact. However, these differences were, as stated above, largely explained by differences in publishing career lengths and dropout rates for men and women. Overall, the authors found that men and women publish at a comparable annual rate and have an equivalent career-wise impact for comparably sized bodies of work.

According to Preston (2004, cited in Cruz-Castro and Sanz-Menéndez 2019), both men and women are likely to cite the following as reasons for leaving academia: inadequate salary and career opportunities, difficulties in balancing work and private life, lack of mentoring, and inadequate match between individual interests and perceived opportunities in an academic career, but women were more likely to be influenced in their choice by structural factors.

It is worth noting that a study of faculty members in two universities found that women faculty were more likely to report 'role overload' than men were; they also reported higher levels of 'career development stress' (Russell and Weigold 2020).

Dorenkamp and Süß (2017) surveyed German academics and found that career uncertainties and a lack of mentor support were associated with higher degrees of conflict both at work and at home. Excessive working hours were associated with increased conflict at work while having children was associated with increased conflict at home. Moreover, young women researchers experienced strong conflict-intensifying effects from excessive working hours and from the lack of mentor support than men did. Watanabe and Falci (2016) used data on tenure-track faculty at a US research university to investigate which factors can predict faculty job turnover intentions with to achieve a better work-family balance. They found that work-related demands and resources were much stronger predictors of turnover intentions than family-related demands or resources, particularly work-to-family negative spillover. Job satisfaction and a supportive work-family culture was negatively associated with turnover intentions.

Based on US data, Webber and Rogers (2018) found that perceptions of department fit, recognition, work role balance, and mentoring were more important to women faculty's satisfaction than male peers. On a related note, Ahmad (2017) noted that the lack of family-friendly work conditions is one of the main reasons why women opt out of tenure-track careers. Crabb and Ekberg (2014) found, in a study among Australian postgraduate research students, that women were significantly less likely than men to wish to pursue an academic career, particularly if they did not have dependent children.

Moreover, men and women may differentiate in the expectations of their academic career; Baker (2010) interviewed academics in New Zealand and found that most women did not expect to make professors before retiring, while the majority of male respondents planned for and expected this. The author argued that perceptions as well as actual experiences of career support, collegiality, and family circumstances can be gendered, influencing ambition and career paths differently for male and female researchers.

There has been a tendency to explain the leaky pipeline as the result of individual decisions to "opt-out" of academia and gender-related differences in preferences associated with working conditions in academia (van den Besselaar and Sandström 2016); put differently, the argument presented here is that women are less satisfied with the working and career advancement conditions offered by academia (Faber, Nielsen and Gemzøe 2019), notably the widespread use of time-limited employment contracts and ensuing uncertainty (Stringer et al. 2018; Faber, Nielsen and Gemzøe 2019; O'Keefe and Courtois 2019)

Nielsen (2017a) examined the decision to opt-out of academia among early-career female researchers in Denmark and emphasized the importance of the postdoc phase for success in academic careers, while it is simultaneously a critical time in the personal life of academics, particularly those starting a family. The study drew attention to the role of work-life tensions affecting women researchers, including the effects of job insecurity and precarious employment conditions, increasing demands for international mobility which can clash with family obligations and priorities in dual-career couples, a lack of female role models, and mentors, a poor work-life balance, and blurry performance thresholds and criteria for advancement. Moreover, the study pointed to the existence of self-reinforcing feedback mechanisms whereby e.g. female researchers working in environments characterized by masculine norms may feel a lower sense of belonging, which in turn leads to lower visibility (e.g. for positions, awards, collaboration, etc.); this lowers female researchers' chance of retention or advancement and reinforces their researchers' lower sense of belonging.

Fernandez-Mateo and Kaplan (2018) argued that what may appear to be a 'supply problem' (i.e. that women choose not to aspire to or take top jobs) may be a 'demand problem' (i.e. that jobs or organizations are not appealing to women because of the work conditions and career advancement opportunities that they offer), and stressed that attempts to explain gendered outcomes to the inherent characteristics or choices of women are likely to be too simplistic or inaccurate. As such, they call for further research that examines the interactions between supply and demand side mechanisms.

It has been argued that there has been a shift in the literature in recent years, from a "fix the women"-approach, which focuses on the individual women, to a 'fix the organizations'-approach, which focuses instead on institutional structures and cultures (see references in Faber, Nielsen, and Gemzøe 2019).

How family matters for (women) researchers (they matter but in complex ways)

Parenthood and family care duties may affect researchers in several ways, including their research productivity. Parenthood has been examined in many studies of research productivity and academic career paths, partly because it appears to play a significant role (see e.g. Ramos, Cortés and Moreno 2015), and partly because it (unlike some of the other potentially relevant) is an easily identifiable event (Mairesse and Pezzoni 2015).

Andersen et al. (2020) examined the gender distribution of authors on 1.893 medical papers related to the COVID-19 pandemic and on papers published in the same journals in 2019 and found that the proportion of COVID-19 papers with a woman first author was 19 percent lower than that for papers published in the same journals in 2019 (which is in line with findings by Minello, Martucci and Manzo (2020) that mothers during the spread of the COVID-19 pandemic in early 2020, female researchers devoted more time to teaching, leaving less time for research. Female first authors of COVID-19-related papers were especially low for papers published in March and April 2020. Results regarding the frequency of women as last authors and the overall proportion of women authors per paper were inconclusive. Nonetheless, these findings suggest that the research productivity of women was affected more than that of male researchers by the changes to academic work-life (including e.g. the need to tend to families at home, with the closure of the schools and daycare institutions, and possibly changes to teaching duties given the sudden shift to online teaching).

On a related note, Yildirim and Eslen-Ziya (2020) found in a survey that having children disproportionately affected women in terms of the amount of housework during the lockdown. However, as pointed out by Utoft (2020), many female researchers do not have children, and researchers – regardless of gender – have been affected in their work by circumstances associated with the COVID-19-pandemic.

Many studies have examined how parenthood and other care duties may affect women's academic research careers, and vice versa, under normal (i.e. non-pandemic) circumstances. As previously mentioned, Misra, Lundquist, and Templer (2012) investigated how faculty members at a US research university spent their time on work-related activities such as research, teaching, mentoring and faculty service, and activities in their private lives including housework, childcare, and care for elderly family members and found that faculty (despite many working more than 60 hours a week) found it as difficult to strike a balance between different activities at work as to strike a balance between work and their private lives. The authors also found that male and female researchers spent different amounts of time on housework and caregiving, and those female researchers with young children spent less time on research, which in turn affects their opportunities for academic career advancement.

Working in academia is often presented as a 'calling' or 'lifestyle', associated with expectations regarding e.g. faculty members' working hours that are better aligned with the lifestyle of employees who do not have caregiving duties to tend to in their private life (Ward and Wolf-Wendel 2004; Misra, Lundquist and Templer 2012; Cervia and Biancheri 2017; Faber, Nielsen and Gemzøe 2019; Lynch et al. 2020). Academic institutions – like many other workplaces – rely on voluntary commitments from their staff and can play a core role in their social identity, but also compete with employees' personal life and family for time and attention (Brandth and Kvande 2001). Even if they offer a high degree of autonomy and possibilities for flexibility (e.g. the ability to plan one's working hours or to work part-time), academic positions especially for younger researchers also come with limitations including high workloads and ambiguous criteria for career advancement (Ward and Wolf-Wendel 2004). Moreover, although universities often try to provide family-friendly work conditions, they also place increasing importance on e.g. international mobility, high and consistent levels of research productivity, and external funding (Faber, Nielsen, and Gemzøe 2019).

These conditions may help explain why women researchers are less likely to marry and to have children than their male peers; why they often tend to delay having children; why studies have found that women researchers with (especially young) children have lower tenure rates and are more likely to be employed part-time or in non-tenured positions than male researchers or female researchers with no children; and why women researchers with children are more likely to leave academia (for references to studies on these issues, see Misra, Lundquist, and Templer 2012).

However, Ward and Wolf-Wendel (2004) amongst others have also pointed out that motherhood may have beneficial impacts on scientists' productivity, including e.g. increased motivation and self-esteem or more efficient use of time at work.

Indeed, several studies find no impact on productivity from parenthood, or even that women with small children can be more productive than women with no children or with school-age children (see review by Mairesse and Pezzoni 2015 for more information on these studies). On the other hand, a study of French physicists, (Mairesse, Pezzoni and Visentin, 2019) found that female scientists suffered an average productivity loss of about one article when they had a young child, while male scientists suffered an insignificant loss. However, they also found that female scientists benefit from having large families, with a productivity gain of 0.63 articles per year per child. Thus, overall, the evidence of the effects of parenthood on scientists' productivity are mixed; also, these effects are not particularly strong in empirical studies, and often disappear when other characteristics are considered e.g. personal characteristics, discipline, and work environment (Mairesse and Pezzoni 2015).

In a qualitative study of the impact of parenting on academic careers in Australia, Hardy et al. (2018) found that parenthood can have a significant impact on senior academics, who are less able to 'park' their careers and whose increased visibility on e.g. boards and committees can make absences problematic; they also found that caregiving duties associated with parenthood are not limited to parenting small children in that older children also have e.g. emotional needs that require parental support (which may not be compatible with e.g. extended periods of international travel). Hardy et al. (2018) also drew attention to differences across disciplines. For instance, they found that in disciplines such as the arts and humanities and social sciences, where the degree of collaboration is lower, parental leaves were likely to lead to periods of no or low productivity. Meanwhile, in the sciences, the authors found that researchers could maintain a certain level of publication productivity during leaves, although their field and lab work was unsurprisingly influenced. Moreover, the authors found that researchers keen to maintain their productivity were driven less by career advancement goals and more by a wish to maintain or gain employment, particularly for early career researchers and researchers in the sciences, where short-term contracts were more common. Other studies have focused on the importance of researchers' marital status for their performance or career advancement, rather than whether or not they have children. Some studies found no effect on scientists' productivity of being married, while others found a positive effect, and more studies yet indicate that the type of marriage and spouses' occupation is associated with different types of impacts from marriage (for a review of older studies on this topic, see Mairesse and Pezzoni 2015). For instance, in a study based on the 2007 Changing Academic Profession (CAP) International Data Set, an international survey of faculty and academic researchers from 19 countries, from all continents, Uhly, Visser, and Zippel (2017) found that researchers' family status – indicated here by their partner's employment status and whether or not they have children – affects researchers' likelihood of engaging in international research collaboration, but it affects men and women in different ways. For instance, the authors find that both men and women benefit from having a partner, who is employed in academia (compared to having a partner with other or no employment), though men were found to benefit more. Uhly, Visser, and Zippel (2017) also found that male and female researchers' collaboration patterns were most similar when they were single or had an academic partner, while they were most dissimilar when researchers partnered with someone employed full-time outside of academia. Moreover, the authors found indications that the presence of children had a lesser impact on international research collaboration activity for some researchers than the status of their partner (for instance having an academic or part-time employed partner). Their study draws attention to the complexity of the ways in which family status may affect researchers – positively or negatively.

Accumulative (dis)advantages

Among others, Ward and Wolf-Wendel (2004) argued that academic career advancement is most furthered by a steady stream of publications and can therefore be hampered by periods of no or low productivity, e.g. as a result of childbirth and parental leave. When such periods occur in the early stages of an academic (where childbirth is most common), this can have long-term effects on researchers' career opportunities, thus e.g. potentially explaining differences in performance and career paths for male and female researchers (Mairesse and Pezzoni 2015).

Indeed, researchers have pointed out that many of the factors described above may overlap and directions of causality between them are complex and difficult to discern (e.g. van Arensbergen, van der Weijden, and van den Besselaar 2012). For instance, a researcher's scientific collaborations are likely to influence their citation impact, while citation impact may also influence their opportunities to enter into research collaborations. And lower productivity levels or a slow career progression may lead to increased teaching duties, leaving less time for research, which in turn reduces productivity levels and opportunities for progression further.

The cumulative effect of events and decisions that place women researchers at a disadvantage has been referred to as "cumulative disadvantage" (Zuckerman 2001). Mairesse and Pezzoni (2015) cited several prior studies indicating that women researchers have lower wages and take longer to advance in their careers than men with comparable levels of scientific productivity. They further argued that slower career advancement is likely to impact women researchers' productivity negatively – as promotion is associated with additional resources for research and increased prestige and influence – which in turn again is likely to hinder further advancement. The authors argued that this raises an endogeneity issue and that there is a need for more studies based on longitudinal data that allow for consideration of unobserved variables (including e.g. scientists' intrinsic abilities, capacity, and effort) and a better understanding of the bidirectional causal relation between scientific productivity and academic career advancement.

On a related note, with reference to the well-known "Matthew Effect" in Science, Rossiter (1993) introduced the notion of a "Matilda Effect"[5] to describe the situation in which women's research may be viewed as less important than that of their male counterparts and/or their ideas attributed to male peers. Other researchers have argued that this may help explain cases where female researchers' publications are less central in scholarly networks (Dion, Sumner and Mitchell 2018).

3.6 How is gender diversity supported?

Research institutions

Many of the proposed explanations for gender skewness described in section 3.5 are rooted in the institutions that employ researchers. For instance, in their working environments and their search, recruitment, and hiring practices, in the degree of support offered to faculty in connection with e.g. grant applications, in decisions about who gets asked to provide low-prestige faculty service, in the degree of support provided to researchers with families or other caregiving duties. Some of these factors are rooted in the institution, some of them at the faculty, department, or even group level. In the following, we briefly examine some of the measures research institutions can take to support gender diversity.

Increase support for gender diversity within the organization

Research institutions can take several steps to make their organizations more supportive of gender diversity, including practicing dual-career hiring and ensuring family-friendly policies (Mirick and Wladkowski 2020; Nielsen, Bloch, and Schiebinger 2018; Wladkowski and Mirick 2020; Ahmad 2017).

For instance, in a study of the impact of parenthood on academic careers, Hardy et al. (2018) drew attention to the importance of supportive manners and peers, who could for example provide flexible work arrangements. They also recommended focusing not just on needs in connection with the return to work after childbirth, but rather on ensuring attention to needs that arise before a period of parental leave,

[5] The effect is named for the American suffragist Matilda J. Gage (Rossiter 1993).

during parental leave (if for instance researchers are committed to field or lab work that is impacted by their absence), and in the years following the return from leave.

Juraqulova, McCluskey and Mittelhammer (2019) examined work-life policies at 125 doctoral-granting economics departments in the US and found that dual-career policies had a positive effect on female representation at the assistant and associate professor levels but no statistically significant impact at the full professor level.

Su and Gaughan (2014) drew attention to the importance of stable, effective formal institutional structures that focus on the particular needs of women academics – arguing that these were more important than "the presence of policy entrepreneurs or programme support such as the NSF ADVANCE initiative." On a similar note, Eversole and Crowder (2020), the notion of the 'ideal worker' in academia leaves little time for family, which in turn leads to work–life conflict (which, according to the authors, however, may be mitigated by human resource development interventions e.g., training development, performance management, and career development initiatives aimed at reducing work-life conflict, improving well-being, and creating a more family-friendly environment.

Su, Johnson, and Bozeman (2015) found that US academic departments' commitment to gender diversity strategies was related to the degree of administrative power held by their chairs' as well as by their assessment of current gender diversity status. They also found that women chairs were less likely to pursue a gender diversity strategy and that higher numbers of female faculty members did not substantially increase the likelihood of adopting such a strategy. However, as the authors pointed out, it is likely that female-chaired departments and departments with a higher number of women faculty were less likely to have gender diversity strategies because the perceived need for such a strategy may be lower in such departments.

Finally, it is worth noting that departments, universities, and even countries differ in their approach to addressing gender inequality in science, which may influence the types of instruments they chose in their efforts to do so. For instance, Nielsen (2014) found Danish universities to be more reluctant to apply rights-based arguments for addressing gender equality, preferring instead to justify gender equality-related activities based on aims to increase competitiveness, utility, and innovation.

Do mentors matter?

Several contributions have argued in support of providing mentors for women academics (e.g. Thomas, Bystydzienski and Desai 2015; Misra et al. 2017; Conway et al. 2018; Cross et al. 2019) – when mentor-mentee relationships are successful, which is not a given (Straus et al. 2013). Mentor programs may be either formal (e.g. organized within a mentoring programme) or informal (Dunham et al. 2012).

Blau et al. (2010) examined the effects of a randomized trial based on three cohorts of a mentoring program for female assistant professors in economics in the US and concluded that the program increased the total number of publications, the number of top-tier publications, and the total number of successful federal grant applications compared to a control group. Mentoring was provided by a senior female economist.

Schmidt and Faber (2016) identified several benefits of a pilot mentoring program for early-career female researchers including e.g. guidance with regards to career planning, greater competence awareness, the establishment of networks, support in navigating in the research environment, and moral support. Moreover, the authors found that the mentor-mentee relationship was also beneficial to mentors, who benefited in terms of professional development, institutional recognition, and personal satisfaction.

Transparency and clarity with regards to criteria for performance assessment and career advancement

When processes for assessment of candidates and decisions are unstructured, there is a greater risk than cognitive distortion will occur (Heilman 2001). Similarly, when there is a lack of clarity regarding the criteria by which quality of performance is assessed, there is a greater risk that information can be distorted to confirm gendered stereotypes or be dismissed e.g. if it does not fit preconceived notions of what an 'ideal' candidate looks like (Heilman 2001). It also leaves more room for interpretation for assessment committees etc. – this is problematic in view of the aforementioned risk of hiring with homogenous networks and gendering of excellence.

Also, several studies pointed to vague assessment criteria as a factor that may contribute to women taking on e.g. low prestige service tasks or opting out of academia (O'Meara, Templeton and Nyunt 2018; Kulp, Wolf-Wendel and Smith 2019).

Increase the proportion of qualified female applicants in connection with recruitment and advancement decisions

Given the aforementioned role that informal personal networks play in academic recruitment and promotion processes, it can be relevant for research institutions to ensure a higher number of qualified female applicants before the assessment process is initiated (Faber, Nielsen, and Gemzøe 2019).

Palmén and Kalpazidou Schmidt (2019) found that the implementation of gender equality interventions can be aided (or hindered) by severalfactors, including e.g. the level of commitment from senior management, bottom-up involvement of staff members, transparency, and whether there are strategies for tackling resistance. Van Miegroet et al. (2019) found that increasing transparency in expectations and criteria for career advancement and standardizing and codifying the promotion process can help mitigate subjectivity and inconsistencies in promotion outcomes across departments.

Gender composition of assessment and search committees: does having women on board matter?

Checchi, Cicognani, and Kulic (2019) examined the role of the gender composition of selection committees and the role of connections in academic recruitment for entry-level research positions in an Italian research center operating mainly in the hard sciences. They found evidence of bias against women, but that such bias was reduced by the presence of a woman on the selection committee (though prior connections with the center were found to be the most important factor in predicting which candidates were hired – a factor which, generally speaking, worked to the disadvantage of women, who tended to have fewer network links with the institute).

In contrast, Bagues, Sylos-Labini, and Zinovyeva (2017) looked at how the presence of female evaluators affected committees' decisions based on information from 100,000 applications for associate and full professorships in Italy and Spain and the assessments thereof of by 8,000 randomly selected evaluators. More women on evaluation committees, they found, did not increase either the quantity, or the quality of female candidates who were deemed qualified for a position. Moreover, female evaluators were not significantly more favorable toward female candidates; however, male evaluators became less favorable toward female candidates when a female evaluator joined the committee.

Ehrenberg et al. (2012) found that gender composition at the leadership level in American colleges and universities – i.e. among trustees, presidents, and provosts – can also influence hiring practices. More precisely, they found that institutions with female presidents and provosts, as well as those with a greater share of female trustees, increased their share of female faculty at a more rapid rate (with effects being larger at smaller institutions).

The role of e.g. department chairs and their personal beliefs about the role of gender and gender inequality in their departments has also been stressed in the literature (e.g. Wharton and Estevez 2014). In a study of recruitment to tenure-track STEM faculty positions at a large public university, Glass and Minnotte (2010) found that placing greater emphasis on increasing the number of women applicants and placing advertisements in venues that specifically target women could increase women's representation in tenure-track positions.

On the usefulness of bias training and diversity workshops

Some studies find that bias training through e.g. workshops (Eve et al. 2014) or online training can be effective in changing attitudes and behavior towards women in the workplace. However, in a field experiment at a global organization, Chang *et al.* (2019) found that one-off online diversity training produced behavioral change only among groups whose average untreated attitudes were already strongly supportive of women before training; among groups whose average untreated attitudes were relatively less supportive of women, the diversity training resulted in attitude change but not behavior change. This indicated, according to the authors, that diversity training cannot be a stand-alone solution for promoting gender equality,because of such indications of its limited efficacy among those groups whose behaviors decision-makers are most eager to influence.

Other studies indicate that interventions may improve diversity outcomes (e.g. Munar and Villesèche 2016) e.g. raising awareness of bias and gender stereotypes and developed codes of practice to ensure equal opportunities for all applicants, regardless of gender (Faber, Nielsen, and Gemzøe 2019). For instance, Carnes et al. (2015) examined the effects of a gender bias habit-breaking intervention (in the form of a 2.5-hour workshop) in STEMM focused schools and colleges at a US university and found that it leads to increases in gender bias awareness and self-efficacy to promote gender equity in academic science departments, as well as perceptions of a more positive departmental climate.

In a similar study, Devine et al. (2017) compared hiring rates of new female faculty pre- and post-manipulation. The proportion of women hired by control departments remained stable over time, but the proportion of women hired by intervention departments increased by an estimated 18 percentage points, though the effect was not statistically significant.

Régner *et al.* (2019) found that scientific evaluation committees with strong implicit gender biases promoted fewer women if they did not explicitly believe that external barriers hold women back. When committees believed that women face external barriers, implicit biases did not predict selecting more men over women.

Journals and research funders

In the following section, we describe diversity-oriented measures pursued by peer-reviewed academic journals and by research funders. While recognizing that journals and funders are very different types of organizations, they both rely heavily on peer review and other forms of assessment of candidates; some of the same possible measures, therefore, apply to both journals and funders.

Considering the wording of calls

Alvarez et al. (2019) described how the wording of calls for the Doris Duke Clinical Scientist Development Award (CSDA) for biomedical research was changed in response to data indicating that male applicants had higher success rates than female applicants did. More specifically, the use of words thought to be implicitly associated with traditionally masculine traits was minimized, describing ideal candidates in nongendered terms, e.g. replacing “leadership potential” with “promise to make significant contributions”, “importance” with “influence”, “innovation” with “originality”, and “creativity” with “inventiveness.” Attempts were also made to encourage institutions to consider gender equity in applicant’s salaries, as department chairs were asked to provide applicants' salary quartile range relative to those at the same faculty rank in the department. Finally, guidelines were changed to encourage recommenders to focus on objective research achievements and to avoid references to personal circumstances e.g. gender, age, work-life balance, or the like.

Increasing the number of female grant applicants

Some funders have taken steps to increase the volume of female applicants to their grants. For instance, the Science Foundation Ireland (SFI) has a stated goal to ensure that research teams and PIs are comprised of at least 40 percent of each gender; in a grant program, research institutions can nominate a maximum of 6 (out of 12) male candidates; over a two-year period from 2013 to 2015, the percentage of female awardees increased from 27 to 54 percent, according to reports from SFI, as cited in Faber, Nielsen, and Gemzøe (2019).

In other examples mentioned by Faber, Nielsen, and Gemzøe (2019), the Swedish Research Council has a stated aim that women and men should have comparable success rates and receive the same average grant amount, taking into account the nature of the research and the type of grant, while The Research Council of Norway has applied “moderate gender quotas” to increase the share of female grant recipients.

On the subject of quotas, Vernos (2013) pointed out that they offer no “magic wand” for addressing gender inequality. Though the European Commission committed itself to reach 40 percent female representation in Horizon 2020 advisory structures, data from the European Research Council showed no correlation between the proportion of women on its evaluation panels and the success rates of female applicants (Vernos 2013). Vernos (2013) further argued that introducing quotas may place greater demand on the often relatively small pool of women researchers who can serve on such panels, possibly even to the point of hindering their career progress. Instead of pursuing quotas, she recommended looking to expand “pockets of good practice” including e.g. in the form of mentorship programs, family-friendly policies, and transparency in recruitment.

Addressing possible bias in review and grant decisions

Many funders have taken steps to address possible bias in peer-review, including e.g. the US National Institutes of Health that have among other things anonymized grant applications before review, used text-mining software to examine applications and reviewer critiques for evidence of potential bias, and pursued the Early-Career Reviewer program to support early-stage researchers (a third of which were individuals from underrepresented groups in biomedical research) in their career development by allowing them the opportunity to serve on a review panel (Valantine and Collins 2015).

Research funders are increasingly gathering and often publishing data on e.g. gender distributions among grant recipients and applicants to assess the degree of bias in assessment. This also promotes transparency and accountability (Faber, Nielsen, and Gemzøe 2019).

Another mechanism sometimes used is observation. For instance, observers in committee meetings in the Swedish Research Council have noted that informal and non-verifiable information about for e.g. an applicant’s marital status or family relationships was more likely to come up for female than male applicants; moreover, the issue of independence, or perceived lack of independence, was more often problematized in evaluations of women's applications (Swedish Research Council reports cited in Faber, Nielsen, and Gemzøe 2019).

Blinded reviews

With regards to the 'blinding' or anonymization of grant applications before review, this can reduce 'obvious abuses' e.g. when proposals are rejected due to the authors' gender or other personal characteristics (Guthrie, Ghiga and Wooding 2018). However, it has been questioned to which extent anonymization is truly possible, as it is often possible to identify authors to some extent e.g. due to the topic of their research (Bhattacharjee 2012), particularly in research communities where researchers are familiar with each other's work.

Moreover, as pointed out by Jefferson et al. (2002) and Cruz-Castro and Sanz-Menéndez (2019), the evidence of the outcomes of blinded peer review is mixed. Some studies have found that blinding reduces bias with regards to personal characteristics of the author, e.g. geographical location and the prestige of their home institution (Ross et al. 2006), while others have found that it makes little or no difference to the outcomes of grant review processes (Tricco et al. 2017).

In addition, blinded reviews may still be affected by differences in how men and women communicate. Kolev, Fuentes-Medel, and Murray (2019) examined a review of innovative grant research proposals submitted to the Gates Foundation from 2008 to 2016. They found that even with a blinded review, women still received lower scores, which could not be explained by characteristics of the reviewer, proposal topics, or ex-ante measures of applicant quality. However, when the authors controlled for text-based measures of proposals' titles and descriptions, the gender gap in scores was no longer significant. This indicated that male and female researchers use different types of language, which in turn affected reviewers' ratings of their proposal. More specifically, Kolev et al. found that women were more likely to use 'narrow' words, while men used 'broad' words. It is worth noting that the text-based measures that predict higher reviewer scores did not predict higher ex-post innovative performance. However, female applicants exhibited a greater response in follow-on scientific output after an accepted proposal, relative to male applicants.

Does the gender of reviewers or assessors matter?

The evidence on the effects of having women on peer review panels is mixed. For instance, Bowman and Ulm (2009) found a correlation between the gender of grant recipients from Australian academic archaeology and the ratio of women to men on a review panel from the Australian Research Council.

However, Broder (1993) found (in a study of reviews of grant applications to the National Science Foundation) that female reviewers gave female applicants lower ratings than male reviewers did, while no gender differences were found in reviewers' rating of male applicants. Moreover, a report from the European Commission 2009 did not find that more women on panels lead to higher success rates for female applicants.

In a more recent study, Murray et al. (2019) found that mixed-gender reviewer teams lead to more equitable review outcomes in the review of bioscience publications. The study by Murray and colleagues was based on an analysis of peer review outcomes of 23,876 initial submissions and 7,192 full submissions to the biosciences journal eLife between 2012 and 2017. Murray and colleagues found that acceptance rates were generally higher for men and authors from Europe and North America – these groups were also overrepresented both in ‘gatekeeper’ roles i.e. as editors and peer reviewers.[6] They generally found a higher rate of acceptance when there was gender and country homophily – i.e. reviewers were more likely to accept submissions from (last) authors of their own gender and (corresponding) authors from their own country – and gender inequity was at its highest with all-male reviewer teams.

Encouraging or requiring applicants and funding recipients to consider sex and gender variables, where relevant

Funders can have policies in place to encourage gender and sex analysis; indeed, such policies are not uncommon among funding agencies in Europe and North America – e.g. in the form of online training and interactive workshops in gender and sex analysis – and a growing number of peer-reviewed journals have included requirements regarding gender and sex analysis in their guidelines for authors, though the actual effects of such training and requirements have not been much studied (Nielsen, Bloch, and Schiebinger 2018). For instance, Johnson et al. (2014) examined the effects of a requirement introduced in 2010 by the Canadian Institutes of Health Research that applicants had to indicate whether their research designs accounted for sex or gender. They found that the proportion of applicants responding affirmatively to this question increased significantly after this requirement was introduced.

As pointed out by Nielsen, Bloch, and Schiebinger (2018), peer-reviewed publications can also be analyzed for gender and sex analysis, and new methods to estimate the value of gender and sex analysis to society (including e.g. savings from earlier and more accurate diagnoses of illnesses in women and more effective treatments). These are examples of projects that funders (or, for that matter, policymakers) could fund to increase the inclusion of sex and gender variables in scientific research.

Tannenbaum et al. (2019) called on researchers, funding agencies, peer-reviewed journals, and universities to coordinate to support the incorporation of sex and gender analysis across disciplines, where relevant – following the example of e.g. the Canadian Institutes of Health Research, European Commission, US National Institutes of Health, and the German Research Foundation, or efforts by journals to implement editorial guidelines to evaluate the rigor of sex and gender analysis as one criterion among many when selecting manuscripts for publication.

Supporting grant recipients with families

Family matters not just for women. For instance, increasing the window of grant eligibility for applicants with children to ERC grants was associated with an increase in applications from both men and women, with the gender gap in applicants remaining essentially unchanged (Cruz-Castro and Sanz-Menéndez 2019).

Science Europe published a report that recommended funders to pay more attention to family obligations of researchers in the conditions for grants. For example, they recommended supplementary funding during maternity/paternity leave, change from full-time to part-time and other measures to secure a better work-life balance (Faber, Nielsen, and Gemzøe 2019).

[6] In a study of another field, Pan and Zhang (2014) found that women's participation in editorial boards of general marketing of journals generally corresponded to their presence in the profession.

Earmarked funds

Earmarking funding for certain academic ranks can affect women and men in different ways. For instance, a US survey by Blake and LaValle (2000, cited in Cruz-Castro and Sanz-Menéndez 2019) found that women were less likely to be eligible for grants because they were more likely to be employed in fixed-term contracts, in part-time positions, or at a lower academic rank. They also found that men were more likely to be listed as principal investigators on applications (presumably because there are more men in senior positions), and women more likely to apply for funding to cover their position (presumably because they are more likely to be employed in fixed-term positions)

An argument in favor of earmarked programs for women is that they can quickly increase the number of female researchers (Faber, Nielsen, and Gemzøe 2019).

Bührer and Frietsch (2020) and Bührer et al. (2020) examined two German flagship programs to increase the participation of female researchers in the science system, the 'Women Professorship Program' and the 'Pact for Research and Innovation'. They concluded that these programs have increased the number of women researchers. They also found an increase in the number of women who are (co)authors of scientific publications, and that women's publications were cited at an increased and high level.

In Denmark, examples of earmarked funding include the FREJA program (1998), YDUN (2014), and the more recent Inge Lehmann program (2019). A consultancy report evaluating the YDUN program found that success rates were low (3 percent) and that the program motivated an increased number of women, relative to other calls for grants, to seek research funding as independent research leaders. Applicants to the YDUN program were more likely to be first-time applicants and were on average 4.6 years younger compared to female applicants to five comparable instruments in the 5-year period up to the program (DAMVAD 2015, cited in Faber, Nielsen, and Gemzøe 2019). However, as described by Faber, Nielsen, and Gemzøe (2019), both the FREJA and YDUN programs were controversial and met with considerable criticism, for being perceived as discriminatory towards male scientists.

Affirmative action may actually place women at a disadvantage.

Criticisms of earmarked funding for women in Denmark was linked to a backlash for grant recipients, who risked being regarded as less competent or less accomplished academics, as confirmed by various evaluation and policy reports (Faber, Nielsen, and Gemzøe 2019).

On a related note, Heilman (2001) argued, citing prior work, that affirmative action is associated with preferential treatment and that persons who have been the beneficiaries of affirmative action can be "tainted with a stigma of incompetence" and not viewed as being deserving of the positions or rewards they have received. Citing prior work that showed that association with diversity initiatives had a negative effect on reactions to female peers, Heilman (2001) argued that affirmative action initiatives may therefore actually backfire, by providing a plausible explanation for the success of women who have been beneficiaries of some form of affirmative action e.g. in the form of mentoring.

On a more general note, Dover, Kaiser and Major (2020) argued that organizational diversity initiatives (i.e. programs and policies intended to e.g. promote the inclusion, hiring, retention, and promotion of underrepresented groups) can have unintended effects, including, first, that they lead to a "presumption of fairness" for underrepresented groups, making discrimination harder to identify and deal with. Second, they may lead to a "presumption of unfairness" for members of overrepresented groups, making it more likely that other groups will perceive themselves as excluded or as victims of discrimination, particularly if they have traditionally held an advantage over other groups. Third, in line with the abovementioned arguments, diversity initiatives may be taken as a signal that underrepresented groups are not sufficiently competent or capable to succeed without help and thus less qualified.

On a somewhat related note, Teelken and Deem (2013) argued based on qualitative interviews in the Netherlands, Sweden, and the UK that formal management approaches to stimulate equality of opportunities may create a 'veneer of equality' yet not address various, often subtle, forms of discrimination that continue to affect e.g. selection and promotion practices.

There is no 'magic bullet' – and there are no 'quick fixes'

Several researchers have argued that gender inequality challenges in academia should be seen as the result of a complex combination of factors – including e.g. structural, cultural, and institutional factors – requiring holistic, integrated approaches (e.g. Schmidt and Cacace 2017; Westring et al. 2012; Timmers, Willemsen, and Tijdens 2010).

For instance, Westring et al. (2012) examined factors influencing women researchers' careers in academic medicine, based on among other things inputs from 133 female assistant professors at a US university, and identified four important and interrelated but distinct factors: equal access, work-life balance, freedom from gender biases, and supportive leadership. This suggests that many factors need to be in place to maintain or increase gender diversity in academia.

4

The literature on diversity with regards to age, career stage and nationality

4 The literature on diversity with regards to age, career stage, and nationality

This chapter describes key insights from the recent literature on diversity with regards to age, career stage, and nationality. In contrast to the vast amount of research on gender diversity, the literature on these aspects of diversity is limited and scattered.

With regards to the literature on the role of age and career stage, most of the identified contributions center on issues related to early career researchers. With regards to nationality, the literature mostly addresses issues related to working conditions for foreign-born academics as well as the advantages and disadvantages of being internationally mobile.

Researchers' age, career stage, and nationality are rarely addressed explicitly in the literature as aspects of diversity in science. Yet research indicates that academics' approach and contributions to science differ according to age and career stage; as such, participation of (and adequate opportunities for) researchers of different age groups or at different stages of the academic career is likely to contribute to heterogeneity within e.g. a research team, a department, or a discipline. Similarly, researchers of different national origins are likely to bring different cultural backgrounds and perspectives to bear on a research project or discipline.

Because the literature on this topic is scarce, the conclusions that can be drawn on the research on diversity with regards to age, career stage, and nationality should be viewed as tentative and as a starting point for further discussion and research.

The chapter examines several issues which may influence who progress in an academic career, and who doesn't, and thus ultimately the level and nature of diversity in science. We first review the literature on the changing nature of the academic career (section 3.1) and on what distinguishes those early career researchers to stay in academic from those who don't (3.2). We then turn to increased demands for international mobility in an academic career (3.3) before focusing on the conditions and experiences of academics working outside their country of origin (3.4). Finally, we examine the literature on mid-career and late-career researchers (3.5) and on the possible existence of bias in peer review processes, which can be related to researchers' age, career stage, or nationality (3.6).

4.1 The precariousness nature of academic careers

Numerous scholars have drawn attention to the increasingly precarious nature of an academic career, as indicated by the increased number of researchers employed on a series of temporary contracts, often characterized by poor working conditions and uncertainty about the likelihood of continued employment (e.g. Waaijer et al. 2017; Huisman, de Weert, and Bartelse 2002).

In particular, an increasing number of (especially early-career) researchers have employed in externally funded positions, which may offer an opportunity to enter an academic career and be easier to obtain, but which are also less attractive due to their fixed-term nature and the uncertain future academic career prospects offered by such positions (Brechelmacher et al. 2015). Indeed, Franssen and de Rijcke (2019) argued that the rise of project funding has contributed to the increase in temporary academic positions and to extending the phase of temporary employment in academic careers. Fixed-term contracts, they further argued, have fueled increased job and grant market participation of early career researchers, which, in turn, has led to competition as the process by which 'winners' are selected, contributing to anxiety and career uncertainty among academics. Franssen and de Rijcke moreover argued that these developments impact the social fabric of research groups and departments.

Using data from a large-scale representative survey of researchers in all European countries, Castellacci and Viñas-Bardolet (2020) found that academics with a permanent contract were on average more satisfied with their job than those that were employed temporarily. In a study of academics in non-tenure-track appointments in the US, Reevy and Deason (2014) found that these academics perceived significant stressors at work related to their contingent positions. Several studies have documented work overload, poor work-life balance, high levels of stress, and low levels of well-being among academic researchers (as reviewed e.g. by Urbina-Garcia 2020; see also Azevedo et al. 2020 and Johnson, Willis, and Evans 2019), and career uncertainties have been associated with higher degrees of conflict both at work and at home (Dorenkamp and Süß 2017).

Indeed, attaining full-time, permanent academic positions has become increasingly difficult in many countries (Ates and Brechelmacher 2013). Similar tendencies have been documented in studies from both North America and Europe (Huisman, de Weert and Bartelse 2002), describing how universities have responded to growing constraints on public funding, rising numbers of students, and a growing reliance on external research funding by increasing the proportion of temporary staff and keeping the number of core, permanent staff low to increase their ability to adapt to ongoing changes in their external circumstances (Huisman, de Weert, and Bartelse 2002; Åkerlind 2005; Stage 2020). These developments affect how attractive an academic career is, increasing the risk of talented young researchers opting out of academia.

These changes are also reflected in the career trajectories of individual academics. Academia is generally seen as having become more competitive, and the chances of making the journey from Ph.D. to full professor have decreased (see e.g. Moore et al. 2017). Moreover, Milojevic, Radicchi, and Walsh (2018) found that not only do more researchers leave academia today, but there has also been a dramatic rise in the proportion of scientists who spend their entire career only as supporting authors without having been listed as lead author on a publication (according to their data, from three scientific disciplines, from 25 to 60 percent since the 1960s till today). This should be seen in the light of the importance of early-career researchers' ability to become intellectually independent for their academic career prospects (Laudel and Bielick 2018).

The worldwide growth in the number of postdoctoral researchers represents a substantial shift in how academic research is produced (Cantwell 2011). Concerns have been raised regarding the growth in the numbers of postdoctoral researchers, e.g. due to the lack of any systematic definition of postdoctoral research positions, the lack of policies on postdoctoral researchers, and growing dissatisfaction among postdocs with both the conditions of their current position and their future employment prospects (Åkerlind 2005). And yet, despite a general perception among both postdoctoral researchers and their supervisors that academic employment opportunities are limited, both parties have a tendency to view and treat the postdoc period as a period of preparation for an academic position (Åkerlind 2005), and many Ph.D. students maintain an intention to pursue an academic career (Wood et al. 2020), even though – internationally – more than half of all postdocs leave academia (McAlpine and Emmioğlu 2015).

4.2 What distinguishes those who stay in academia from those who leave?

Crucial phases in the advancement (or abandon) of an academic career

In light of the increasing number of Ph.D. students and postdoctoral researchers, and increased competition for academic positions (Stage 2020), it is unsurprising that many researchers leave academia, either by choice or due to lack of opportunity to obtain an academic position. The literature points to several career stages at which researchers are most likely to leave academia (see e.g. Brechelmacher et al. 2015), the first of which is the period just after completion of the doctorate, or in the first years after the Ph.D. (Browning, Thompson and Dawson 2017). This early phase of an academic career is a challenging period, where early-career researchers must find a balance between the three aspects of their academic role – teaching, research, and service – while trying to build and demonstrate their academic worth in terms of both explicit and tacit (and often ambiguous) expectations (McKay and Monk 2017).

Other research highlights the transition from postdoc to principal investigator (PI), typically defined by the attainment of the first PI grant (e.g. Hallonsten and Hugander 2014) as another stage at which many young researchers leave academia. The transition to PI can be preceded by a lengthy period of postdoctoral work, often involving international mobility, and making a successful transition has been described as being partly the result of luck (McAlpine 2016). In other words, with increasing pressure on research grants and academic positions, obtaining these requires more than merit - a certain level of randomness in who takes the prize is introduced.

Career-defining funding grants are often addressed as key factors in determining young researchers' career trajectories, as grant allocation mechanisms are seen as a way in which to identify the best and most promising young researchers and reward them with resources.

In a Danish study of grant recipients from the Danish Council for Independent Research (today the Independent Research Fund Denmark), Bloch, Graversen, and Pedersen (2014) found that research grants had a positive impact on the research performed under the grant itself but also important secondary effects on research performance through positive effects on academic career advancement. For instance, they found that the probability of obtaining a full professorship for grant recipients was almost double that for rejected applicants, and that grant recipients had a significantly higher probability for career advancement.

On a related note, van den Besselaar and Sandström (2015) examined whether career grant competition results in the selection of the best young talents, using a sample of 260 early career grant applications in three social science fields. They examined the output and impact of the applicants about ten years after the application to find out whether the selected researchers performed ex-post better than the unsuccessful ones. They found that the predictive validity of career grants was low and even – when comparing grantees with the best-performing unsuccessful applicants – absent. These findings hold important implications, as the authors also found that recipients of career grants did have better careers than the unsuccessful applicants.

Research grants can also influence the career prospects of mid-career researchers. Azoulay, Stuart, and Wang (2013) examined the impact of receiving a major status-conferring prize – i.e. becoming a Howard Hughes Medical Institute (HHMI) Investigator – on citations to articles the scientist published before the prize was awarded. The authors found evidence of a post-appointment citation boost, but the effect was small and limited to a short window of time. However, the effect of the prize was significantly larger when there was uncertainty about article quality (e.g. because articles were published in low-impact journals, written in a novel area of science, or combined ideas from multiple scientific fields), and when prize winners were of (relatively) low status at the time of election to the HHMI Investigator Program. As such, conferring a prize on already recognized researchers working in established fields of research and publishing in high-impact journals may reflect rather than cause changes in their performance, whereas the same type of prize can have a significant impact on researchers that are not well-recognized or publishing in novel fields or low-impact journals at the time where they received the prize. The authors moreover propose two possible explanations for the positive effect of receiving the prize on recipients' citation impact: first, it may cause researchers already aware of the prize recipients' work to reassess the quality of this work; second, the publicity associated with becoming an HHMI Investigator can attract new readers to a researchers' work. This research indicates that prestigious grants can reinforce the careers and visibility of already established researchers engaged in mainstream research fields, but have a substantial, beneficial impact on the visibility and career prospects of researchers who are less established or engaged in highly novel or discipline spanning research.

What makes the difference in pursuing and building an academic career?

Understanding what causes Ph.D. graduates to leave academia is not a simple matter. For instance, Roach and Sauermann (2017) examined whether and when science & engineering Ph.D. students lose interest in an academic career. Using a longitudinal survey that followed a cohort of Ph.D. students from 39 US research universities over the course of their graduate training, they found that the declining interest in an academic career was not a general phenomenon across all Ph.D. students; instead, 55 pct. of all students remained interested in pursuing an academic career, while 25 pct. lost interest. 15 pct. never had an interest in an academic career. The observed decline in interest among some Ph.D. students, moreover, was driven not by expectations of academic job availability, postdoctoral requirements, or the availability of research funding, but rather by a misalignment between students' changing preferences for specific job attributes on the one hand, and the nature of the academic research career itself on the other; changes in students' perceptions of their research ability also played a role.

Other contributions in the literature have focused on the role of changing conditions and demands in the academic sector on researchers' decisions to leave academia, including e.g. demands to produce a constant stream of publications, to publish in highly-ranked journals, to attract external funding, etc. – arguing for instance that these tendencies contribute to unproductive 'hyper competition' for resources and positions and that these tendencies exert excessive pressure on researchers (Alberts et al. 2014; Tijdink, Verbeke, and Smulders 2014; Tijdink, Vergouwen, and Smulders 2013; Fang and Casadevall 2012; van Dalen and Henkens 2012; Miller, Taylor, and Bedeian 2011).

However, Waaijer et al. (2018) argued, based on a survey among recent Ph.D.'s and postdocs at selected Dutch universities, that the effects of publication and grant-seeking pressures as externally imposed pressures, by themselves, are limited; instead, their importance is inflated by early-career researchers' concerns about their chances in the competition for academic employment and resources.

Nonetheless, researchers' scientific productivity is often a focal point in the assessment of candidates for academic positions or funding. Publication records have been linked to researchers' chances of obtaining academic positions and advancing in their academic careers (e.g. Dobele and Rundle-Theile 2015), creating pressure on early career researchers to produce a steady stream of publications in well-respected journals as soon as possible. Productivity has also been associated with faster career advancement (Sanz-Menéndez, Cruz-Castro and Alva 2013). Indeed, Lee (2019) found that early career-related factors can predict the future research performance of computer and information scientists with the most important predictor of future research productivity and citation impact being the number of publications produced in the early career years. On a similar note, Kaiser and Pratt (2016) found that publication productivity in graduate school was a good predictor of future career publishing success, based on a study of publication records from 407 US-based faculty in criminology and criminal justice.

Moreover, Horta and Santos (2016b) found, based on a study of a representative sample of Ph.D.'s from all fields of science working in Portugal, that researchers who published during their Ph.D. had greater research productivity, were more cited (both on a yearly basis and throughout their career), and more likely to engage in international collaboration, when compared to those who did not publish during their Ph.D.

Li et al. (2019) found that junior researchers who coauthored work with top scientists enjoyed a persistent competitive advantage throughout the rest of their careers, compared to peers with similar early career profiles but without top coauthors. They argued that these findings underline the role that a small scientific elite can play in shaping the academic landscape (see e.g. Kwiek 2016).

Yet productivity alone cannot predict academics' career trajectories. Abramo, D'Angelo, and Rosati (2014) examined recruitment procedures for associate professors in the Italian university system and found that new associate professors within the hard sciences were on average more productive than the incumbents. However, they also found cases of 'non-winner' candidates that were more productive than the 'winners' over the subsequent three years, as well as cases of 'winners' that were wholly unproductive. Also, Milojevic, Radicchi, and Walsh (2018) found that neither researchers' early productivity, the citation impact of their early work, or their level of scientific collaboration were reliable predictors of whether or not the scientists would ultimately remain in academia.

While individual merit certainly matters greatly for advancement in an academic career, researchers have indeed questioned the general portrayal of chances for academic career advancement as being a question of merit alone, with some scholars drawing attention to the unpredictability of an academic career and emphasizing the role of coincidences and luck in shaping pathways in or out of research (Brechelmacher et al. 2015). For instance, Kindsiko and Baruch (2019) examined career trajectories for three cohorts of Estonian PhDs and concluded based on insights from surveys and interviews that chance played a substantial role in the pathways ultimately taken by the young researchers. Van Balen et al. (2012) compared the careers of pairs of similar researchers that were considered very talented in their early careers, all from the Dutch research system. Of every pair, one had continued in academia, and one had not. Though based on a relatively small number of observations, the study yielded interesting insights into the complex set of factors that influence the outcomes of embarking on an academic career. Indeed, the study did not reveal any key factors in determining who stays in academia, and who leaves. However, their results suggested that academic careers of talented researchers were either stimulated (for those that stayed) or inhibited (for those that left) by an accumulation of advantages or disadvantages, some of which were attributed by the interviewees to sheer coincidence.

The environment in which academic researchers are trained may also influence their subsequent career paths. For instance, Broström (2019) investigated how characteristics of a research group are related to the early career success of Ph.D. candidates trained in the group. Based on a study of a cohort of Swedish doctoral graduates in science, engineering, mathematics, and medicine, the author found that students trained in groups with a lower number of Ph.D. students performed better in terms of academic productivity. The author also found that Ph.D. students trained in groups with funding for Ph.D. research that was conditioned by funder influence over the topic of thesis research were more likely to stay in academia, although PhDs from such groups had lower than average scientific productivity and citation impact. In contrast, Waaijer, Heyer, and Kuli (2016) found that Dutch Ph.D. candidates that were externally funded as opposed to employed and funded by a university were disadvantaged in that they had less funding for research, significantly lower personal income, less access to office facilities, and more frequently experienced stress.

On a related note, Hottenrott and Lawson (2017) examined a sample of research groups in the fields of science and engineering at universities in Germany and found that groups that attracted more public funding and were led by professors with high research performance were more likely to produce researchers who take jobs in public research, while industry links predicted researchers finding employment in the private sector.

In a study of life scientists in Japanese universities, Yoshioka-Kobayashi and Shibayama (2020) found that supervisors apply different approaches to early-career research training and that these approaches can exert different influences on the degree of trainees' independence in their later careers. More specifically, they found that scientists that were allowed higher autonomy in upstream research functions in early-career training tended to attain greater organizational independence with higher organizational ranks later in their careers. They also found that scientists encouraged to deviate from conventional research topics during early-career training tended to later achieve greater cognitive independence by producing original research output. Finally, differences in the training approaches applied by supervisors were influenced by the training that they had received in their early-career training, pointing to the importance of socialization in local training contests, where training approaches are passed down from one generation of researchers to the next.

How academics spend time at work, especially how much time is devoted to teaching, can also influence chances of staying in academia. Tagliaventi, Carli, and Cutolo (2020) argued that the growing focus on assessment of researchers based on scientific publications can jeopardize benefits derived from other forms of activities, including teaching but also 'academic citizenship' or 'faculty service', i.e. various forms of academic services (as also discussed in section 3.4), which they describe as 'cornerstones of universities functioning'. Based on a study of the effects of an evaluation system focused on research performance and records of the publications and service activities of 353 Italian scholars in the accounting discipline, they found that academics exhibit different orientations towards research and academic citizenship – ranging from those who focus on a single type of academic citizenship or research orientation to a significant proportion of researchers who appear unable to achieving a satisfying performance in any domain. Based on a qualitative study of research careers in education, Angervall and Gustafsson (2014) argued that researchers with a background in teaching appeared to find it harder to develop research careers, as they seemed to be bound to forms of career capital that are seen as more needed in teaching.

Finally, in chapter 3, we examined the literature on how motherhood can influence women researchers' academic careers. However, as pointed out by e.g. Reddick et al. (2012) and Ecklund and Lincoln (2011), parenthood is also an important factor in the career experiences and decisions of male academics. Having children and other caregiving duties can challenge the 'ideal academic worker norm' (Ollilainen and Solomon 2014) (which was also addressed in e.g. section 3.5). For example, Cech and Blair-Loy (2014) describe a phenomenon that they refer to as 'flexibility stigma', that is, the tendency to devalue workers who seek or are presumed to need flexible work arrangements, and found that staff working at a top research university who reported this stigma had lower intentions to persist in academia and reported worse work-life balance and lower job satisfaction. Hunter and Leahey (2010) found – in a study of researchers in linguistics and sociology – that productivity growth declined for all researchers after the birth of a child, though more so for women than men.

Ensuring fair assessments for early career researchers

The literature on science evaluation in general stresses that metric-based evaluation cannot stand alone and has built-in biases. Since quantitative science indicators are often used in connection with e.g. funding decisions, career advancement decisions, and hiring processes, it is important that they be used in responsible ways, and that possible biases are addressed. For example, Katz and Matter (2019) argued that metrics-based evaluation can both reproduce and amplify inequalities in research. Similarly, Li et al. (2019) called for the use of more nuanced bibliometric indicators that ensure improved assessment of individuals working e.g. in larger research teams or with co-authors in the 'scientific elite', to allow for a fairer assessment of the impact achieved by individual scientists across different conditions for producing research. Waaijer et al. (2018) argued that the emphasis on measurable outputs and indicators (e.g. on publications, citations, and grants) leads to assessment practices that fail to grasp the entirety of scientists' impact; they also recommended incorporating age as a factor in research assessments, to ensure fair comparisons of researchers at different stages of their career.

Fair evaluation is, however, not just about responsible use of metrics, but also about the assessment criteria applied in the selection of talent and proposals. Wöhrer (2014) argued that part of the reason for the high level of insecurity among early career researchers was to be found in contradictory policies in academic institutions and unclear assessment criteria. However, as pointed out by Helgesson and Sjögren (2019), formalizing assessment criteria is not free from neither challenge nor unintended effects. In a study of the formalization of promotion criteria and procedures in connection with a new tenure track system in a Swedish higher education institution, they concluded that formalized criteria reproduced gender inequality through the choice of explicitly gendered metrics across all areas of assessment (research, teaching, and service). They also found that the formalization of a 'good enough' standard, in addition to a standard of 'excellence', strengthened the scope for interpretational flexibility among assessors. Ultimately, according to the authors, the combination of gendered metrics and dual standards of performance meant that the discretion and power held by crucial gatekeepers were increased rather than restricted by formalization.

The question of how to ensure fair assessments for researchers across all career stages has also been addressed in e.g. DORA (The Declaration on Research Assessment), signed by 19,000 individuals and organizations worldwide. DORA presents recommendations for, among others, research funders. A general recommendation is that the Journal Impact Factor should not be used as a surrogate measure of the quality of individual articles. In addition, the declaration recommends that funders are "…explicit about the criteria used in evaluating the scientific productivity of grant applicants and highlight, especially for early-stage investigators, that the scientific content of a paper is much more important than publication metrics or the identity of the journal in which it was published." Furthermore, the declaration recommends that the value of not just research publications, but also e.g. datasets, are considered and that a broad range of impact measures are included.[7] The Leiden Manifesto for research metrics (Hicks et al. 2015) goes even further, recommending that quantitative assessment methods should only be used as a supplement to qualitative, expert-based assessment. Also, since bibliometric indicators such as the h-index generally increase with researchers' age, the manifesto points out that assessments should be based on a qualitative judgment of their entire research portfolio rather than simplistic bibliometric indicators.

[7] https://sfdora.org/read/ (accessed February 4, 2021)

Offering support for professional development

Several contributions from the literature stress the importance of supporting professional development. Thus, Browning, Thompson, and Dawson (2017) called for greater focus on the importance of professional development for young researchers, urging research institutions to nurture researchers from the start of their career by providing resources, professional development, and mentoring rather than leaving researchers to the 'survival of the fittest', which they argued was still the case in some organizations.

Heffernan and Heffernan (2019) drew on a survey of over 100 working academics in Australia, North America, and the United Kingdom to conclude that the professional development and career support available to academics played major roles in their career satisfaction and thus willingness to remain in an academic career.

Several contributions in the literature underline the potential of effective mentoring programs (e.g. Steele, Fisman and Davidson 2013; Decastro et al. 2014; Muschallik and Pull 2016; Morton and Gil 2019; Stuckey et al. 2019), as reviewed by Fountain and Newcomer (2016), who based on a subsequent US-based survey also pointed to the importance of visible support for mentoring for its success, and to the prevalence of both formal mentoring programs and informal mentoring.

Indeed, research suggests that formal mentoring arrangements for early career researchers are often challenged by competing demands for the time of the mentors; as such, peer support and informal mentoring may serve as important complementary forms of professional learning (McKay and Monk 2017). In a study among research group leaders in the biomedical and health sciences in the Netherlands, van der Weijden et al. (2015) found that mentoring can benefit not only early career researchers but also young tenured professors, with mentoring being associated with having a more positive view on the work environment, more active management of research activities, and better average performance in terms of acquired grants.

Supporting early-career researchers with family obligations

Some authors have emphasized the importance of supporting (especially early career) researchers in taking and returning from parental leave. For instance, in a study among early career researchers in selected departments in the UK, Akram and Pflaeger Young (2020) found that though some departments had informal policies for supporting permanent members of staff who return from parental leave, these policies did not always extend to early career researchers on fixed-term or hourly contracts. In addition, they found that informal and ad hoc forms of support often replaced formal and systematic support mechanisms for all parents, including e.g. inter alia research leave, reduced teaching commitments, access to mentoring, and access to wider institutional support such as sabbaticals and funding. However, the approach taken was generally decided on a case-by-case basis, tailored to the individual researcher, and thus also up for negotiation by the individual. The authors argued in favor of consistent, transparent, and widely accessible policies to offer equal opportunities to all staff members, and to avoid judging individual cases based on a subjective assessment of the staff member's merit. Moreover, they proposed a series of principles to ensure adequate and comprehensive support for researchers taking parental leave, including offering a dedicated research leave following maternity/parental leave; providing dedicated funding to support post-maternity/parental research leave to ensure the burden (e.g. from other duties) does not fall on existing staff; ensuring access to parental pay schemes from the start of all employment periods; offering mentoring (from academic staff who are parents) to help parents manage their return to work; ensuring a supportive environment; early confirmation of timetabling and teaching allocation, etc.

Chesser (2015) also proposed a series of actions that can be taken to improve working conditions for young researchers with family obligations, including providing work schedule flexibility and increased institutional support policies. However, flexible work arrangements may also have unintended negative effects for those who make use of them. Cech and Blair-Loy (2014) described a phenomenon referred to as ‘flexibility stigma’, that is, the tendency to devalue workers who seek or are presumed to need flexible work arrangements; they found that staff working at a top research university who reported this stigma had lower intentions to persist in academia and reported worse work-life balance and lower job satisfaction.

4.3 Demands and expectations of international mobility

It has also been pointed out that researchers, and particularly early-stage researchers, face growing pressure for international mobility, which may conflict with family priorities, as many researchers are building their academic careers at the same time as starting a family or having small children or even lead researchers to postpone the decision to have children (Brechelmacher et al. 2015).

Several contributions in the literature highlight that demands or expectations of international mobility have increased (e.g. in connection with doctoral training or as part of the criteria for recruitment or advancement), becoming a central feature in the training and early careers of academics (particularly in the natural sciences) and can pose challenges to early-stage researchers (e.g. Tzanakou 2020; Herschberg, Benschop, and van den Brink 2018; Brechelmacher et al. 2015; Fontes, Videira, and Calapez 2013). International mobility is seen as a means of reducing the risk of ‘academic in-breeding’ and building researchers’ international networks but may also have an important signaling effect to future potential employers, with international mobility seen as a key component of many ‘excellent’ early-career researchers’ professional development (Fontes, Videira and Calapez 2013).

Indeed, international mobility is most prominent among early-career researchers, where mobility can play a crucial role in the ability to enter into and advance in an academic career; this may also have to do with the fact that individuals may become less inclined to engage in international mobility over time, as family and community commitments increase (Tzanakou 2020).

Mobility can also be seen as a response by researchers to structural issues in their countries of origin, e.g. the lack of research funds, limited opportunities to pursue attractive academic careers, lack of transparency in recruitment processes, poor working conditions, or institutions with lower academic prestige (Tzanakou 2020; Fahey and Kenway 2010; Morano-Foadi 2005; Millard 2005). As such, Morano-Foadi (2005) argued that international mobility decisions can be driven by necessity more than by choice and that it may be complicated for researchers to return to academic careers in less attractive research systems, particularly after long periods of international mobility. This contributes to ‘uneven flows’ whereby researchers flow from less attractive research systems to research systems offering better-perceived opportunities for an academic career either within the European research area (Morano-Foadi 2005) or globally speaking (Fahey and Kenway 2010). Yang and Welch (2010) also drew attention to the flow of academic researchers from the global South to the powerful research systems of the North but pointed out that academic researchers from some countries are sought after; as such, international mobility can also be seen as a response to attractive opportunities abroad (and not just as a response to a lack of opportunities in the country of origin).

On a related note, Grogger and Hanson (2015) analyzed the location choices of foreign-born science and engineering students receiving PhDs from US universities and found that foreign students tend to stay in the US during periods of strong US economic growth and during periods of weak home country economic growth, while foreign students from higher-income countries and recently democratized countries tend not to remain in the US.

As pointed out by Tzanakou (2020), some contributions in the literature have put forth critical perspectives on international academic mobility, questioning e.g. the espoused benefits of mobility, pointing to the emergence of an overly simplistic binary distinction between 'mobility' (often associated with longer periods of relocation and employment abroad) and 'immobility', but also addressing possible inequalities e.g. that women tend to be less geographically mobile, as described in chapter 3. For instance, Netz and Kaksztat (2017) found that parenthood decreases the likelihood of plans for international mobility among female scientists.

Yet international mobility may have different types of impact on academic careers, depending on the nature of that mobility. Ryazanova and McNamara (2019) examined the impact of mobility on academic careers using a sample of 376 tenured faculty members from 20 research-intensive European business schools in ten countries. They found that while mobility had a positive impact on research-career capital, multiple moves delayed academic promotion. They also found that moving internationally for the first post-Ph.D. position undermined research productivity while moving internationally between year 2 and year 7 post-Ph.D. was more beneficial than moving later in the career.

Nonetheless, international mobility is increasingly used as a criterion in academic recruitment. For instance, Herschberg, Benschop, and van den Brink (2018) found, based on two case studies of a natural science department and a social science department at a university in the Netherlands, that selection committees tend to limit the pool of candidates for consideration for a position to those who fit the narrow definition of the internationally mobile and 'excellent' early-career researcher, at the risk of excluding talented scholars who do not readily fit into this definition.

Finally, one study has investigated the effects of funding on international mobility. Buruffaldi, Marino, and Visentin (2020) examined the impact of a grant program promoting international mobility on researchers' scientific outcomes and careers using data from the Swiss National Foundation. They found that the grant effectively supported periods of research abroad that often extended beyond the duration of the grant, yet without increasing the probability of permanent migration. Researchers who were awarded a mobility grant increased their output quality, but no significant effects on output quantity or careers were found. The authors moreover argued that international mobility grants likely affected output quality by reducing the cost of exploring new collaboration opportunities and research topics. Finally, the grants mainly benefitted researchers receiving a mobility grant for the first time.

4.4 Research on foreign-born academics

On the performance and experiences of foreign-born academics

In this section, we turn our attention away from factors that matter for the retention and career opportunities of scientists of different age groups and academic ranks and focus instead on conditions for foreign-born academics.

The growing internationalization of academic staff has been underlined by e.g. Lawson et al. (2019), Lepori, Seeber, and Bonaccorsi (2015) and Franzoni, Scellato, and Stephan (2014). It has been argued in the literature that foreign-born academics make important contributions to the research systems in which they work. For instance, Stephan and Levin (2001) found that foreign-born researchers (particularly from Great Britain and Germany) were disproportionately represented among individuals making exceptional contributions to science and engineering in the US. They also found that individuals making exceptional contributions were, in many instances, disproportionately foreign-educated, both at the undergraduate and at the graduate level (though it's likely that the best researchers are most likely to find academic employment abroad, particularly at prestigious institutions).

A large proportion of postdocs in the US and UK are temporary visa holders, while most adjunct faculty are citizens, which influences the project and laboratory-level organization of research in such countries (Cantwell 2011). International postdocs are often funded by external grants rather than institutional funding, and the conditions of their work are typically determined by the characteristics and demands of the specific projects and laboratories to which they are associated and only loosely associated with work and priorities in the departments in which they are embedded (ibid.).

A stream of research has focused on investigating the scientific performance of foreign-born academics. For instance, Lee (2004) examined survey data collected from approximately 1,000 National Science Foundation and Department of Energy scientists in the US and found that foreign-born academic researchers produced significantly more peer-reviewed articles per year than native-born researchers. However, Lee found few substantial differences in research collaborations or receipt of grants among foreign-born and native-born faculty.

Libaers (2007) found that foreign-born scientists among public sector researchers in nanoscience and technology were consistently more productive than their native-born counterparts. On a similar note, Corley and Sabharwal (2007) used the 2001 Survey of Doctorate Recipients data from the National Science Foundation in the US to compare productivity levels, work satisfaction levels, and career trajectories of foreign-born scientists and US-born scientists. Like Libaers, they found that foreign-born academic scientists and engineers were consistently more productive than their US-born peers, though their average salaries and work satisfaction levels were lower. In line with Corley and Sabharwal (2007), Sabharwal (2011) found that foreign-born faculty members across all citizenship categories expressed lower job satisfaction than native-born faculty members.

Mamiseishvili and Rosser (2009) used data from the 2004 National Study of Postsecondary Faculty in the US to find that international faculty members were significantly more productive in research, but less productive in teaching and service than their US citizen-colleagues. Similarly, using data from the US National Study of Postsecondary Faculty, both Webber (2012) and Webber and Yang (2014) found that foreign-born faculty members were more productive and spent more time on research and less time on teaching than their US-born counterparts, suggesting that this difference in the use of time at least partially explain their higher levels of productivity (Webber 2012).

Franzoni, Scellato, and Stephan (2014) confirmed prior findings that foreign-born academics are more scientifically productive than domestic scientists. However, as pointed out by Kim, Wolf-Wendel, and Twombly (2011), studies such as the ones mentioned above are highly sensitive to the approach used to identify international faculty as foreign-born or non-citizens. For instance, using citizenship as the definition will include faculty who were born and educated abroad but who have become citizens (leading to underreporting of the number of international faculty); Kim and colleagues pointed out that two-thirds of the foreign-born faculty in the 2003 US Survey of Doctoral Recipients were US citizens. Similarly, the authors pointed out, using country of birth provides no information on whether an individual immigrated to another country as e.g. a child or as a graduate student. Kim and colleagues argued that data indicate that a sizeable proportion of foreign-born faculty in the US came to the country at an early age and may thus be expected to differ (e.g. educationally, culturally, linguistically, or socially speaking) from foreign-born faculty who completed their undergraduate studies in their home country; yet such differences may have important implications for studies and policies aimed at foreign-born researchers. Indeed, like prior studies, Kim et al. (2011) found that foreign-born faculty who earned undergraduate degrees in their country of birth were significantly more productive than their US counterparts. They also found that foreign-born faculty who earned undergraduate degrees in their country of birth were significantly more productive than their foreign-born counterparts who received their undergraduate education in the US. However, foreign-born faculty who earned undergraduate degrees in their country of birth were also less satisfied than foreign-born researchers who completed their undergraduate education in the US.

On a similar note, Maximova-Mentzoni and Egeland (2019) argued that the way in which ‘nationality diversity’ is defined in the Nordic countries potentially leaves some groups of researchers overlooked: the typical distinction between ‘local’ and ‘international’ hires is relatively clear-cut but does not fully capture the situation experienced by researchers who migrated to the country for reasons other than to pursue an academic career, who have lived in their country of residence since an early age, or researchers who have a non-dominant ethnicity or race in their country of employment. These researchers may experience both some of the advantages of ‘native’ staff and some of the challenges or barriers experienced by international hires – and the extent to which they encounter difficulties related to e.g. language barriers, access to local networks, insights into local norms and culture will differ depending on their situation. These distinctions, therefore, have implications for employers and research funders looking to support nationality diversity.

As mentioned above, several studies have found that foreign-born academics were likely to experience lower levels of job satisfaction than their native counterparts. Reporting on a symposium on foreign-born geographers pursuing academic careers in the US, Foote et al. (2008) noted that the needs and concerns of foreign-born scholars often differ from those of their native-born counterparts, even if some or all of their college and graduate education occurred in the US. The authors reviewed studies indicating that foreign-born scientists were likely to experience a sense of isolation and lack of support from their institution in dealing with e.g. academic, teaching, cultural and legal obstacles – experiences which were argued can contribute to a marginalization of international researchers. The authors also pointed out that foreign-born scholars may experience difficulty in acquiring explicit and tacit knowledge in the academic environment in which they work. Similar concerns regarding the work conditions and job satisfaction levels experienced by foreign-born academics have been described in more detail by e.g. Collins (2008) and Alberts (2008).

Foreign-born academics may also differ in their interactions with the wider community. Libaers (2014) examined how foreign-born tenured and tenure-track academic scientists in 150 research-intensive US universities interacted with the private sector. They found that foreign-born academic scientists – relative to their US-born counterparts – had lower odds of having been approached by private firms regarding their research activities, of having provided paid consulting to firms, and of having been engaged in transfer and commercialization of technologies with private firms. However, foreign-born scientists had significantly higher odds of having coauthored scientific articles with private firms than their US-born counterparts. As also reviewed by Libaers, prior research has overall yielded mixed evidence on the existence of differences in e.g. industry engagement and patenting between foreign-born and native scientists, but the literature does suggest that foreign-born academic scientists are likely to have smaller nonacademic networks and to be less familiar with cultural and business norms in their country of employment, and that they may be more likely to pursue a traditional academic career focused on publishing scientific publishing – all factors which could help to explain some of the differences observed in the study by Libaers. It is worth noting that both Libaers (2014) and Franzoni, Scellato, and Stephan (2014) have argued that foreign-born academics are likely to be have a strong focus on maintaining their scientific productivity in order to preserve their ability to remain employed in their host country.

More recently, Lawson et al. (2019) examined survey data on non-academic engagement activities of over 14,000 UK academics and found that foreign-born academics were relatively more engaged internationally but less engaged within the UK than UK-born academics. However, differences in UK-based engagement diminished with years spent in the UK (although foreign-born researchers remained more likely to engage internationally), indicating that the longer foreign-born researchers reside in a given country, the less dissimilar from native-born academics they become in terms of their interactions with domestic non-academic stakeholders. Lawson and colleagues also found that foreign-born scientists' ethnicity and language skills were associated with their engagement with non-academic actors in the UK. Adding to arguments put forth in some of the abovementioned papers that foreign-born academics are likely to have smaller nonacademic networks in their country of residence and to lack institutional knowledge about local cultural and business norms, Lawson et al. pointed out, drawing on prior work by Jonkers and Cruz-Castro (2013), that foreign-born and native scientists may differ in their research orientation, as foreign-born researchers are likely to have non-local research orientations, whereas their native-born counterparts may have greater incentive to frame their research within the context of domestic needs and priorities.

Finally, a stream of research focuses on the impact of the widespread use of English as the dominant language of scientific research writing (e.g. Corcoran 2019). This research indicates that researchers who have published extensively in a language other than English may be placed at a disadvantage in connection with applications for positions or funding outside their home country, as assessment panels may be unable to read the research and unfamiliar with the profile and quality of the outlets in which the research was published.

Nationality diversity at Nordic institutions of higher education and research

Maximova-Mentzoni and Egeland (2019) examined how nationality diversity is presented as an issue at higher education and research institutions in Nordic countries. The authors define 'nationality diversity' as referring "to different nationalities among academic staff that increases language, value and information diversity in organizations." They argued that nationality diversity among staff in higher education and research institutions is increasingly being formulated as an ambition or value in the Nordic countries, similar to how gender diversity is approached. However, as the authors pointed out, research on nationality diversity and the experiences of foreign-born researchers constitutes a relatively recent and small field of research. Based on a review (of mostly Nordic studies), they stressed several insights, including, first, that the proportion of foreign-born academics in the Nordic countries varies across subject areas, indicating that efforts to support nationality diversity should take differences in the proportion of foreign-born staff across disciplines and sub-disciplines into account, as this is likely to affect the extent and nature of possible challenges encountered by foreign-born researchers. Second, Maximova-Mentzoni and Egeland highlighted prior work indicating that foreign-born researchers can be a disadvantage in connection with recruitment to academic positions within some disciplines – not due to discrimination, but rather due to the existence of exclusionary institutional mechanisms, including e.g. a tendency to recruit internally, hire candidates who share characteristics of existing faculty members, to hire through informal and personal networks, and candidates' knowledge of tacit rules in higher education institutions in the country, etc. Third, foreign-born academics may experience challenges related to workplace inclusion, for instance, associated with the impact of an inability to master the local language on the likelihood of accessing influential networks or gaining recognition for written work; they may also experience difficulties in teaching students due to cultural and/or language barriers. The authors also pointed to prior studies that have documented foreign-born academics' experiences with 'invisibility' or a sense of isolation. In conclusion, the authors called for greater attention to issues and possible diversity-supporting actions related not just to *recruitment* but also to the *inclusion* of foreign-born staff.

Can mobility be a disadvantage?

As shown above, research points to advantages for nations of having foreign-born academics in terms of research productivity and overall performance. However, studies also point to advantages and disadvantages to the individual mobile academic. Canibano et al. (2020) found, using data from a large-scale survey among researchers based in European universities, that for researchers in the established mid-career phase who are working internationally, there are career advancement benefits associated with return mobility to their home country – although these benefits may be reduced if the timing of return is too delayed. However, there are also many studies pointing to a range of disadvantages with being mobile, especially in terms of being able to return to the home country.

Bauder (2020) examined the relationship between the international mobility of academic researchers and social capital through 42 interviews with academics in Canada and Germany. The author found that social capital facilitated international mobility, and that mobility sometimes created social capital, but also noted that mobility could lead to the loss of national social capital which could negatively affect early-career researchers in particular.

Examining academic mobility within the European Union, Morano-Foadi (2005) found that the longer scientists were abroad, the more complicated it was for them to return to their country of origin. On a related note, Matanle and Mcintosh (2020) found that early career British-trained scholars in Japanese studies experienced significant challenges in navigating their imagined career paths, including the potential to become marooned abroad. Finally, Sanz-Menéndez, Cruz-Castro, and Alva (2013) found that mobility increased the time to tenure for Spanish faculty.

4.5 Mid and late-career perspectives on an academic career

A handful of studies focus on the role of late-career researchers. George and Maguire (2020) examined academics at the very late stages of their career, namely those who remain in academic positions past the normal retirement age. They argued that when academic positions are in short supply, this may limit employment and advancement opportunities for younger academics. However, the authors also pointed to potential benefits of senior academics 'staying on', including the positive contribution they can make to their institution through their expertise and experience. On a related note, Ghaffarzadegan and Xu (2018) argued, based on a simulation model, that late retirement in academia is a significant factor in explaining the growth in the average age of academics and a decline in hiring.

The literature search yielded few publications focusing on later career stages; by far most of the publications identified focused on challenges and issues related to early career stages. Indeed, some researchers call for greater attention to factors that can improve the work climate and career opportunities for mid-career researchers (Awando et al. 2014).

Despite the focus in the literature on early career performance, research indicates that performance remains high over the span of a lifetime in academia. For instance, Sugimoto et al. (2016) pointed out that aging can have an important effect on scientists' propensity to innovate, produce and collaborate, and they lamented the lack of insight into the relationship between aging and researchers' scientific performance. In a study of the complete publication profiles of more than 1,000 authors from sociology, economics, and political science, they found that scholars remain highly productive across the lifespan of their career (i.e. approx. 40 years). Their scientific productivity increases steeply until they are promoted to a mid-rank position (associate professor) after which it remains stable for the remainder of their career. Moreover, their involvement in collaborative work increases with age and has increased over time. Finally, they found that scientists' work obtains its highest impact directly around the time of their promotion and then decreases over time. Meanwhile, other studies have found that researchers' productivity is highest in the early and mid-career stages, while older scientists see a decline in their productivity or shift to more publications in the form of books or contributions to books (as opposed to journal publications).

Stroebe (2010) examined the impact of increasing average age of university faculty members in the United States and in Europe by reviewing prior work from the preceding four decades on the relationship between age and scientific productivity in North America and Europe. The author first reviewed arguments for why a decrease in productivity might be seen over the course of an academic's life span, including: a change in the cognitive ability required to undertake high-level research; changes in the motivation to invest time in research rather than in alternative activities; changes in the availability of resources such as funding or working conditions needed for research; and, finally, in some countries, compulsory retirement forcing academics to curtail their research activities. The author however found no evidence in prior work of a universal age-related decline in cognitive ability and argued that any age-related decline in scientific productivity that might exist was more likely to be explained by changes in motivation or the availability of resources. Based on a review of prior empirical studies, the author moreover concluded that early research typically showed a decline in productivity after the ages of 40 to 45 years, but that evidence of such a decline has been absent in recent studies. Past performance was found to be a much more reliable predictor of scientific productivity than age, as researchers who have been highly productive early in their careers were found to be much more likely to also be more productive in their later career stages. Finally, the author argued that the lack of evidence of an age-related decline in productivity in older researchers could be explained by factors such as the abolition of compulsory retirement in parts of North America, changes in publication norms (with a growing, widespread focus on continuous publication in peer-reviewed scientific journals at all stages of the academic career), and a general increase in life expectancy, but called for longitudinal studies to confirm this hypothesis.

On a related note, in a study of publications from Norwegian research universities, Kyvik and Aksnes (2015) documented a large individual increase in scientific and scholarly publishing over the last 30 years. The authors attributed this increase to better qualified new generations of academic staff, an increase in research collaboration, improved funding and research conditions, and the introduction of incentive systems for scientific publishing. These factors, the authors argued, could help contribute to explaining the continued productivity of older researchers.

As a supplement to studies on the relationship between age and academics' *research* productivity, Goel and Göktepe-Hultén (2020) examined the *innovation* productivity of academic researchers (as indicated by patents and invention disclosures) across the span of their careers. Using data on researchers from a large German public research organization, the authors found that an early leadership position consistently enhanced innovation productivity during the life cycle.

4.6 Is there bias in peer review related to age, career stage, or nationality?

Guthrie, Ghiga, and Wooding (2018) reviewed prior literature on the existence of bias in peer review. Overall, they concluded that the evidence base with regards to bias related to age, career stage, or nationality was small. More specifically, Guthrie, Ghiga, and Wooding (2018) concluded that there is conflicting evidence on whether peer review is biased by age. On the one hand, they argued, some prior research has indicated that review and assessment processes that take into consideration applicants' publication record or funding history may be biased against early career researchers who have yet to demonstrate convincing results and lack a substantial portfolio of work. On the other hand, prior work cited in their review found little or no evidence of bias in peer review related to age, career stage, or nationality; rather, only scientific performance indicators (i.e. prior scientific productivity and impact) were significant predictors of funding decisions. Moreover, two studies based on data from the US National Institutes of Health indicated decreases in early career success rates or an increasing average age of first-time grant recipients, though these findings could be explained by other factors than age bias. However, Guthrie, Ghiga, and Wooding (2018) concluded that there was evidence that peer review suffers from ‘cronyism’, i.e. that chances of obtaining a grant increase when applicants e.g. have prior affiliation with a reviewer or stem from the same institution as a reviewer.

5

The literature on diversity with regards to research field

5 The literature on diversity with regards to research field

While the previous two chapters focused on diversity with regards to characteristics of the individual researcher – including demographic attributes such as gender, age and nationality, and job-related attributes i.e. career stage – this chapter focuses on diversity with regards to insights, methods, or approaches across research fields.

Overall, the literature on diversity with regards to field is much less coherent than the literature on diversity with regards to e.g. gender. Given the relatively small amount of studies identified on this topic, the conclusions presented below should be seen as tentative and as a starting point for further discussion and research.

In this final chapter, we begin by discussing what 'diversity with regards to research field' means (section 5.1), before discussing *why* it matters (5.2). We briefly review studies arguing that cognitive diversity is most productive in moderation (5.3), then turn to a series of factors, which are argued in the literature to affect scientists' propensity to pursue divergent or more diverse research paths (5.4). Finally, we ask whether there is evidence of bias in peer review processes against projects or research teams with a cognitively diverse research profile (5.5).

5.1 What does 'diversity with regards to research field' mean?

For the purposes of this literature mapping, diversity with regards to research field is treated as one of several types of diversity that can contribute to increased variation and relevance in research. In the literature, however, studies on research that spans research fields come from a variety of more or less distinct streams of research, including for instance studies of inter- and transdisciplinary collaborations and efforts to measure the interdisciplinarity of research, but also studies focusing on individual researchers' propensity to specialize or diversify into multiple research fields.

Diversity with regards to research field may be pursued by an individual, e.g. a *single researcher* moving into a new research field, e.g. one that is adjacent or complementary to the field(s) in which the researcher has formerly been active (e.g. Rhoten and Pfirman 2007). Diversity with regards to research fields is however more often associated with *a collective of researchers* working together (Rousseau, Zhang and Hu 2019) – either within the same research group or in collaboration among researchers affiliated with different groups, departments, institutions, and/or research fields, potentially also including non-academic stakeholders.

While collaboration among academic researchers with different disciplinary specializations is often referred to as *multi- or interdisciplinary research*, a collaboration involving non-academic stakeholders is sometimes described as *transdisciplinary research* (e.g. Lyall, Meagher, and Bruce 2015). In practice, however, the distinction between multidisciplinary, interdisciplinary, and transdisciplinary research is blurry at best, which makes it difficult to distinguish between these types of research (Rousseau, Zhang and Hu 2019). For the purposes of this report, we will use the term 'interdisciplinary' to refer to all instances of research that draw on multiple scientific fields or disciplines.

While there is much debate on how to define interdisciplinarity as well as on how to operationalize and measure it (see e.g. Abramo, D'Angelo, and Zhang 2018; Nichols 2014; Wagner et al. 2011), most scholarly contributions associate it with some form and level of integration of knowledge, concepts and methods across specialized bodies of knowledge, which may, in turn, lead to the creation of new knowledge, concepts and methods (Rousseau, Zhang, and Hu 2019; Mugabushaka, Kyriakou, and Papazoglou 2016; Lyall, Meagher, and Bruce 2015; Cummings and Kiesler 2005).

It should be noted that diversity with regards to research field may also refer to *variation within a portfolio of research projects or grants*, i.e. the extent to which the grants awarded from a given research funding organization are concentrated within certain research fields or dispersed across a wide range of research fields. In this chapter, however, we focus on diversity which results from interdisciplinary research, as this was the subject of almost all the literature identified in connection with this literature mapping.

5.2 Why does diversity with regards to research field matter?

Engaging in research that spans multiple research fields is argued to be central in three distinct but related respects, which are described in the following.

Field-spanning research may contribute to more effective problem-solving in science

Research that involves crossing the boundaries of established research fields is often argued as central to providing insights and, potentially, solutions to complex problems. Such arguments are often invoked in studies on interdisciplinarity in research, motivated by the expectation that research that draws on or integrates insights and methods from multiple fields is more effective in addressing complex scientific or societally relevant problems than research relying on single-field approaches (e.g. Leydesdorff and Ivanova 2020; Rocha et al. 2020; Gibson et al. 2019; Garner et al. 2012; Carley and Porter 2012; Wagner et al. 2011; Rhoten and Pfirman 2007; Rhoten and Parker 2004). This is based on an expectation that knowledge and actions within an interdisciplinary team are more likely to consider the full range of perspectives and approaches relevant to solve the problem that the team is addressing (Ma et al. 2014).

Field-spanning research is crucial to the development of scientific disciplines and specializations

Scientific fields are not given or static – they develop over time, and field-spanning research is crucial in the development of new research fields and, thus, of new professional academic communities (see e.g. references in Chakraborty et al. 2015). The term ‘scientific field’ is used in a variety of ways in the literature, ranging from referring to small ‘pockets’ of the research community (e.g. sub-fields) to scientific disciplines to broad aggregations of multiple, related disciplines. For our purposes, the salient common feature of these different definitions is that they have to do with where we draw the boundaries between scientific disciplines. Following Rousseau, Zhang, and Hu (2019), we will therefore use the term ‘research field’ as a synonym for ‘research specialty’, ‘discipline’ or ‘knowledge domain’.

Scientific disciplines can be understood as having a central problem (or set of problems), which they explore using certain knowledge, concepts, theories, and methods (Wagner et al. 2011), within a community of academic researchers which is typically associated with a given set of academic conferences, scientific journals, etc. The problems that researchers pursue, as well as the means by which they pursue them, are all subject to change over time. Indeed, scientific disciplines as we know them are a relatively recent concept in academia, and although some of the well-recognized disciplines today have been used to organize scientific inquiry since the Middle Ages (Leydesdorff and Ivanova 2020), disciplinary distinctions only grew more robust and distinct from each other as the academic system grew from the 19th century onwards (Wagner et al. 2011). Disciplines often play an important role in the formal organization of universities (Wagner et al. 2011; Cummings and Kiesler 2005) and, since the middle of the 19th century, also of the organization of peer review and the distribution of research funding (Leydesdorff and Ivanova 2020).

Stopar et al. (2016) argued that scientific disciplines are becoming increasingly diversified, as new specialty areas are continuously emerging, and that substantial 'communication' can moreover be observed across fields and specialty areas. Indeed, it has been argued that any attempt at categorizing scientific production requires drawing some boundaries, which can be quite arbitrary, and the rigid nature of which can hinder proper description of the often fluid nature of research – particularly in emerging fields (Rousseau, Zhang, and Hu 2019; Liu, Rafols, and Rousseau 2012; Rafols and Meyer 2010; Zitt 2005).

Field-spanning research can contribute to greater variation in questions and methods in science

Finally, a stream of research focuses on the role of interdisciplinarity or cognitive diversity in increasing heterogeneity in research and/or in increasing the likelihood of achieving novel and important scientific advances or 'breakthroughs' (e.g. Rousseau, Zhang, and Hu 2019; Garner et al. 2012; Rafols and Meyer 2010).

An often cited paper by Stirling (2007) argued that diversity can be seen as consisting of three dimensions:

- *Variety* (referring to the number of different types, species, or categories present – e.g. distinct disciplines or research fields),
- *Balance* (referring to how individuals or elements are distributed across these categories – e.g. the extent to which researchers are concentrated within a few fields or more evenly distributed across many), and
- *Disparity* (referring to the extent to which the types are considered similar different from each other in terms of some given features or characteristics – which could e.g. be used to refer to the degree of similarity between research fields).

Regardless of the type of diversity in question, diversity in perspectives, research questions, theories, and research methods matter for the cumulative progress of science. For instance, Borg et al. (2019) emphasized the often touted role of heterogeneity in driving parallel exploration of competing theories, allowing the scientific community to identify and converge on preferred theories

Yet, science, left to its own, has strong conservative tendencies (i.e. for each scientist to opt in favor of promising but 'safe' projects rather than radical but risky alternative paths), which may call for active efforts to promote novel, risky paths of scientific inquiry (Kummerfeld and Zollman 2016). The literature on why risk-taking matters for science, and which factors strengthen or weaken incentives for risk-taking in science, have been reviewed in another report from the Think Tank DEA and the Independent Research Fund (DEA and Independent Research Fund Denmark 2019).

Pöyhönen (2017) argued that cognitive diversity – here defined as variation in individual scientists' background beliefs, concepts used, and reasoning styles – is beneficial to the advancement of science, when the scientific community is faced with sufficiently difficult problems, suggesting that heterogeneity is most crucial or beneficial in dealing with complex problems, while homogeneity may be conducive to driving incremental progress along established research paths formed around well-defined problems.

Ideally, a research community should have an appropriate balance between researchers who engage in potentially revolutionary science (aka. high-risk, high-reward projects) and those who work within the context of established research programs or paradigms, using standard methodologies to make incremental progress on well-defined pre-existing problems (Heesen 2019). Both types of research(ers) are crucial to the development of scientific knowledge (DEA and Independent Research Fund Denmark 2019). Yet, as pointed out by Heesen (2019), scholars differ as to whether they believe that scientists decide in advance whether to pursue a high-risk, high-reward project, or whether they choose projects for other reasons (e.g. intellectual interest or the availability of research instruments, funding or other resources) and only later can determine whether they were engaging in evolutionary or revolutionary science. As proposed by Heesen (2019), the truth probably lies somewhere in between the two, as scientists are likely to be at least partially guided in their choice of research path by their expectations of the possible contribution of their research (even though they will not always be able to foresee which avenues of research could lead to revolutionary advances).

5.3 Can you have too much of a good thing when it comes to heterogeneity?

As previously described, the possible benefits of heterogeneity in research approaches and methods, e.g. as realized from the dispersal and/or integration of research activities across research fields, have been laid out in several scholarly publications. However, some authors have pointed out, that high levels of heterogeneity can come with costs that can outweigh its benefits.

For instance, while several studies have found that research teams with disciplinary heterogeneity showed higher productivity levels, as reviewed by e.g. Martín-Alcázar, Ruiz-Martínez, and Sánchez-Gardey (2020a), other studies found no such evidence (ibid.); some authors argued that these mixed findings can be explained by a curvilinear relationship between heterogeneity and performance in scientific research groups, i.e. that lower or moderate levels of heterogeneity is beneficial while high levels of disciplinary heterogeneity entail excessive coordination and collaboration challenges that hamper the performance of the group (Martín-Alcázar, Ruiz-Martínez and Sánchez-Gardey 2020a, 2020b).

Certainly, collaboration across disciplines can come with high coordination costs (Cummings and Kiesler 2007; 2005). As mentioned earlier, the formal organization of universities often divides activities according to established disciplines (Wagner et al. 2011; Cummings and Kiesler 2005); as such, multi- or interdisciplinary collaboration often requires collaborating researchers to cross organizational boundaries (Cummings and Kiesler 2005). They also have to manage interpersonal relationships between individuals or groups who may have few or no prior ties or experience in working together (Cummings and Kiesler 2005).

Knowledge integration in a heterogeneous team depends on its integrative capacity, which in turn is conditioned by social and cognitive processes that shape the team's ability to combine diverse knowledge (Salazar et al. 2012). Meaningful integration of divergent types of expertise in research projects requires the development of a shared language and purpose as well as management and coordination of tasks within the project, as discussed in detail by Cummings and Kiesler (2007). Cognitive diversity within a group can be counterproductive to the performance of a group, particularly if differences are not properly managed and integrated (Martín-Alcázar, Ruiz-Martínez and Sánchez-Gardey 2020a). And coordination costs increase with the size of the group, alongside the psychological distance between members of the group, which may further increase the need to promote trust-building, effective communication, a common language, a sense of shared goals, etc. within heterogeneous groups (Cummings et al. 2013).

Building on Stirling's (2007) aforementioned distinction between three aspects of diversity – variety, balance, and disparity – Ma et al. (2014) introduced a distinction between 'expertise knowledge disparity' and 'experience knowledge variety' to better understand when research teams' performance benefits from consisting of an interdisciplinary group. They moreover conceptualized knowledge creation work as a cognitive task based on novel recombination of knowledge components accessible to the team (e.g. by integrating knowledge that was previously unconnected or by reconfiguring the ways in which existing knowledge leads to the creation of new knowledge). Based on a study of 237 papers in top management journals, Ma et al. (2014) concluded that a moderate level of expertise knowledge disparity (meaning that there is a moderate level of disparity between represented disciplines, and therefore also some common overlap in knowledge and methods to build on, which they argued improves communication and the ease with which team members can understand and utilize the knowledge of other team members) was associated with novel combinations of knowledge. They also found that a higher level of experience knowledge variety was beneficial to teams, arguably as greater variation in team members' past experiences allowed them to draw on a larger variety of cognitive resources in their problem solving and promoted communication frequency by promoting tacit knowledge exchanges, ultimately strengthening the quality of knowledge creation within the group.

5.4 What makes researchers pursue divergent research paths?

Given that crossing field boundaries is one mechanism that can stimulate heterogeneity and variation in research, it is relevant to ask what makes researchers pursue research paths that diverge from the fields in which they are specialized. The literature points to a series of factors that may affect researchers' decision to work across research fields, which are described below. For a more in-depth discussion of factors associated with novelty in science, please see the review on risk-taking in science by DEA and Independent Research Fund Denmark (2019).

Factors that influence young researchers' likelihood of pursuing independent or novel research paths

Some contributions in the literature emphasize that pursuing interdisciplinary or otherwise novel research paths entails a particular set of challenges for young researchers. For instance, they have yet to develop a strong disciplinary standing (Jaeger-Erben et al. 2018), which may influence e.g. their ability to make a distinct contribution to cognitively heterogeneous teams, but also potentially place them at a disadvantage in their later career, vis-à-vis e.g. candidates with a strong disciplinary profile and potentially a higher number of publications in esteemed journals, while interdisciplinary work is often associated with a longer time to publication, publication in less prestigious journals, and a longer time to gain citations (see DEA and Independent Research Fund Denmark 2019). Indeed, it has been pointed out that academic recruitment is often organized within established disciplines and driven by discipline-derived standards, which can place field-spanning researchers – and particularly early-career researchers – at a disadvantage (e.g. see references in Donina, Seeber, and Paleari 2017). In contrast, Bridle (2018) argued that interdisciplinary encounters could be beneficial to young researchers, e.g. in terms of skills and career development and in building a broad network of peers and potential collaborators.

Interdisciplinary work may place young researchers at a disadvantage in their subsequent careers. Based on a study of postdocs and assistant professors in an environmental science research center in Sweden, for instance, Müller and Kaltenbrunner (2019) found that interdisciplinary academics often face barriers e.g. to their career advancement and ability to attract prestigious research grants in research evaluations, because researchers with strong disciplinary profiles are associated with scientific rigor, while interdisciplinarity is associated with application-oriented work and a lack of theoretical basis, but also because academics with a disciplinary specialization are more likely to have a consistent, strong publication record in prestigious journals.

The role of training in scientists' propensity to forge independent research careers

A stream of research is concerned with how early career researchers can be supported in pursuing independent research careers. For instance, some studies examine the role of the training that early career researchers receive. In a study of life scientists in Japanese universities, Yoshioka-Kobayashi and Shibayama (2020) found that supervisors apply different approaches to early-career research training and that these approaches can exert different influences on the degree of trainees' independence in their later careers. More specifically, they found that scientists that were allowed higher autonomy in upstream research functions in early-career training tended to attain greater organizational independence with higher organizational ranks later in their careers. They also found that scientists encouraged to deviate from conventional research topics during early-career training, tended to later achieve greater cognitive independence by producing original research output. Finally, differences in the training approaches applied by supervisors were influenced by the training that they themselves had received in their early-career training, pointing to the importance of socialization in local training contests, where training approaches are passed down from one generation of researchers to the next.

Research also indicated that mentorship i.e. working with top researchers can influence younger scientists' likelihood of pursuing original research paths. In a large-scale study on nearly 40,000 scientists who published 1,167,518 papers in biomedicine, chemistry, math, or physics between 1960 and 2017, Ma, Mukherjee, and Uzzi (2020) investigated the link between mentorship and protégé success. They found that mentorship strongly predicted protégé success across diverse disciplines, and that mentorship was significantly associated with an increase in the likelihood that protégés would pioneer their own research topics and be midcareer late bloomers. In addition, they found that protégés generally did not succeed by following their mentors' research topics but by studying original topics and coauthoring no more than a small fraction of papers with their mentors.

On the influence of gender, thinking styles, and personal preferences on research agendas

Are scientists' preferences for specialization vs. diversification in research gendered? Rhoten and Pfirman (2007) examined prior research on whether women scientists are more likely to engage in interdisciplinary research. They referenced prior work indicating, among other things, that men tend to isolate explanations and gravitate towards abstract and theoretical arguments, while women tend to assimilate diverse forms of information and to see and make connections between ideas and the larger context. In on a review of prior research, the authors also echoed arguments that women may prefer less 'crowded' domains to traditional and well-established fields, and problem-oriented domains that can advance knowledge oriented toward human needs and the community to theoretically oriented fields in e.g. the biological, physical or engineering sciences.

Shifting focus from *gendered* differences to *individual* differences in thinking styles, Santos, Horta, and Zhang (2020) called for more research on how research agendas take shape and argued that whether researchers opt for specialization or diversification in their research agendas may have to do with differences in individual cognitive thinking styles or preferences. The authors distinguished between *convergence* (i.e. a preference for single-discipline research agendas, based on mastery built up for an extended period of time) and *divergence* (i.e. a preference for multidisciplinary approaches, e.g. driven by a desire to address complex problems from multiple perspectives or to establish a foothold in different topics or disciplines) as two dimensions that shape the development of research paths. However, divergence can incur transaction costs for researchers who switch between topics and fields.

Santos et al. also invoked another two dimensions with which to characterize researchers' preferences, which were previously coined by two of the authors: *discovery* (i.e. a preference for cutting-edge research) and *conservative* (i.e. a preference for working in an established field). They argued that individuals' choices of a discovery-based or conservative approach may be rooted in explicit preferences, with the discovery dimension being associated with a more holistic mode of thinking, and the conservative dimension being associated with a more analytical mode of thinking. It may also be influenced by perceived funding options (where proposals within established domains are generally viewed as having a higher likelihood of securing a favorable assessment), or even reflect intrinsic risk-aversion tendencies, e.g.

leading some scientists to avoid emerging fields where the outcomes of research and options for publication and career advancement are more uncertain. Moreover, Santos et al. argued that scientists' choice of research strategies is also likely to be influenced by their degree of tolerance for low funding, i.e. the extent to which they are reliant on their ability to attract external funding to advance in their careers or to undertake research at all. Based on a study of academics in the social sciences, Santos et al. concluded that there was a significant relationship between researchers' thinking styles and their research agendas.

The role of the academic career life cycle, prior specialization, and publication pressures

The academic career lifecycle may influence scientists' research paths. Work by Horlings and Gurney (2013) has indicated that academic researchers tend to focus on singular topics at the beginning and the end of their careers, while often diverging into varied topics and disciplines during the mid-career stage.[8]

Reviewing prior work on how researchers select which research paths to pursue, Horta and Santos (2016a) argued that the more a researcher has invested in a given field, the less likely that researcher is to move into another field, as doing so is typically associated with lower productivity. Moreover, moving into a new field is particularly risky when that field is emerging rather than well-established and thus associated with greater uncertainty. Nonetheless, they pointed out, many researchers do spend part of their career exploring issues and fields beyond their immediate area of specialization.

Other work indicates that early specialization may be an advantage in interdisciplinary research. For instance, some studies have investigated what characterizes the researchers that take on a pioneering role in science, i.e. leading to significant changes in how scientific problems are addressed and/or in how research fields are organized. For example, using bibliometric and survey data on 495 French nanotechnology researchers, Sabatier and Chollet (2017) found that pioneering research behavior in nanotechnology was more probable among scientists who were already well-established in their discipline of origin before they entered into nanotechnology, who had a strong collaboration network and had easy access to field-specific resources. They also found that – despite the potential risks associated with highly novel, pioneering research (DEA and Independent Research Fund Denmark 2019) – pioneering French researchers in the field of nanotechnology demonstrated high levels of scientific productivity after their pioneering research. However, as the authors themselves pointed out, their study focused solely on successful, published research pioneers; they called for further research in the form of a longitudinal study focused on both successful and unsuccessful efforts to undertake highly novel research.

Chakraborty et al. (2015) found that the most prominent (i.e. highly cited) researchers in computer science tended to pursue a characteristic 'scatter-gather' strategy, engaging briefly in a variety of fields but essentially remaining focused on one or two fields over the course of their career. Meanwhile, low-cited researchers work on various areas at a time as well as over the course of their entire careers.

Schweitzer and Brendel (2020) examined publications by researchers who have published in journals in the field of economics during a period of 45 years from 1970 to 2014. Among other things, their results

[8] However, other studies have found that both very young and very established researchers. For instance, through surveys and interviews with researchers in five university-based programs funded under the US National Science Foundation's Environmental Research and Education portfolio, Rhoten and Parker (2004) found that graduate students and full professors (who were principal investigators) were overrepresented among scientists engaged in interdisciplinary research. The authors expected young researchers to be more likely to engage in interdisciplinary research because they are likely to have had more interdisciplinary exposure and less intellectual commitment to a particular field, while professors have acquired professional freedom and more resources that for instance allow them to join interdisciplinary programs.

showed an increase in the age of researchers at the time of their first publication (which the authors argued could be attributed to a growth in the quantity of knowledge that researchers process prior to publishing their first article) and in the number of co-authors. They also observed a decline in the probability of researchers changing research fields and found indications that researchers develop strategies of specialization to deal with the challenges stemming from addressing a growing body of scientific work. These strategies included refraining from changing between research fields and distributing work within larger teams of co-authors. The authors furthermore argued that the need for researchers to be aware of and relate their work to a growing body of literature and to identify relevant open problems that can be solved with a reasonable effort creates strong incentives to specialize in selected areas of research.

Such findings are not surprising because many researchers have strong incentives to adopt a 'play-it-safe' research and publication strategy to increase their chances of maintaining high productivity levels and rapid career advancement, even though this may decrease their likelihood of producing high impact or breakthrough research (Kolesnikov, Fukumoto and Bozeman 2018; see also DEA and Independent Research Fund Denmark 2019).

More generally speaking, several contributions in the literature point to possible disincentives for academics to expand their research activities into new research fields. For example, Santos, Horta, and Zhang (2020) pointed out that there is a mismatch between many policymakers' and research funders' desire to promote interdisciplinary research on the one hand and the formal organization of universities and incentive structures in science on the other, which generally speaking favor disciplinary work. Several studies moreover find support for the hypothesis that field-spanning work is associated with lower productivity (e.g. Kolesnikov, Fukumoto, and Bozeman 2018; Abramo, D'Angelo, and Di Costa 2017; Leahey, Beckman, and Stanko 2017). Moreover, a study of publications by all Italian professors indicated that research outputs in a field other than the scientist's prevalent one were associated with lower impact than those produced in their own field Abramo, D'Angelo, and Di Costa 2017).

Several contributions in the literature have also focused on the relationship between interdisciplinarity and citations. For instance, Chen, Arsenault, and Larivière (2015) found that the top 1 percent most cited papers exhibit higher levels of interdisciplinarity than other papers and that this finding held across the vast majority of research specialties. Generally speaking, however, evidence on the relationship between interdisciplinarity and citations is mixed (Wang, Thijs, and Glänzel 2015). This is in part due to variations in how interdisciplinarity is defined and measured (Wang, Thijs, and Glänzel 2015); and in part at least probably simply because of the sheer complexity of this relationship. Yegros-Yegros, Rafols, and D'Este (2015) examined the effect of interdisciplinarity on the citation impact of individual publications for four different scientific fields and operationalized interdisciplinarity as disciplinary diversity in the references of a publication, distinguishing between different aspects of diversity: *variety, balance,* and *disparity (as introduced by Stirling 2007)*. They found that variety had a positive effect on impact, whereas balance and disparity had a negative effect, but underlined that their results might indicate either that successful discipline-spanning research is more likely to be achieved through research efforts that draw on a relatively proximal range of fields (as opposed to distant fields), or that scientific audiences are reluctant to cite papers that mix highly disparate bodies of knowledge. Similarly, Wang, Thijs, and Glänzel (2015) found that long-term (i.e. 13-year) citations to papers (1) increased at an increasing rate with variety, (2) decreased with balance, and (3) increased at a decreasing rate with disparity. Meanwhile, they also found e.g. that although variety and disparity had positive effects on long-term citations, they had negative effects on short-term (i.e. 3-year) citations.

5.5 Is there a bias against researchers with cognitively diverse research strategies?

Guthrie, Ghiga, and Wooding (2018) relayed concerns that increasing competition in academia has created incentives for researchers to submit more conservative applications for funding and pursue low-risk research strategies. They drew attention to prior literature emphasizing that research proposals or publications with a high degree of novelty are likely to have less preceding work to build on, which may disadvantage them in the peer-review process. The authors argued that highly novel proposals from young researchers may suffer a double disadvantage in the sense that not only does their proposed idea lack a strong foundation of previous work: early career researchers also typically lack strong track records, which may increase the difficulty involved in reliably assessing their ideas.

The discipline-based organization of universities and funding bodies can pose a barrier to interdisciplinarity – because it rewards knowledge separation over integration, e.g. rewarding activities within the department/discipline rather than across, and making it difficult to change behavior (Donina, Seeber and Paleari 2017). Moreover, research assessment, which is often based on bibliometric indicators and discipline-derived standards can act as a further deterrent to interdisciplinary research (e.g. see references in Donina, Seeber, and Paleari 2017).

In an extensive review of research on the peer review process, Guthrie, Ghiga, and Wooding (2018) examined the evidence on the existence of bias in peer review vis-à-vis interdisciplinary research. The careful conclusion of their review reads: "It is not clear if peer-review treats interdisciplinary research fairly." Drawing on several prior contributions, the authors summarize the main arguments for why interdisciplinary ideas and work could be disadvantaged in peer review as follows: (1) reviewers must often combine multiple, distinct (and not necessarily compatible) understandings of what constitutes 'quality' in research; and (2) finding 'peers' capable of reviewing interdisciplinary work can be more difficult.

Guthrie and colleagues cited prior work indicating that interdisciplinary research is associated with lower success rates but called for more research on this topic. More generally speaking, Guthrie, Ghiga, and Wooding (2018) reflect on the usefulness of peer review and concluded, based on their review of prior work on the topic, that peer review can weed out research and research proposals of *inferior quality*, but it is unclear whether it can effectively identify the *best* research. They cited several studies finding no significant relationship, or only a weak relationship, between peer review assessments and subsequently the bibliometric performance of the research or researchers under assessment. Guthrie and colleagues also stressed that assessments vary considerably between reviewers, particularly when reviewers differ in their disciplinary or career-wise background.

Finally, Guthrie and colleagues also concluded that the evidence on whether peer review is affected by a tendency among reviewers to favor their own field or way of thinking is unclear. The idea behind this concern is that reviewers are better able to understand and assess the potential contribution of research positioned within their own field; they may even tend to overvalue it. Though some studies offer some support for the hypothesis that reviewers are more likely to be favorably inclined towards research in their own field, other studies find the opposite – presumably because assessing proposals within your area of expertise may e.g. allow reviewers to better identify shortcomings or possible pitfalls and/or increase the risk that they will undervalue the potential contribution of the proposed research.

On a related note, Banal-Estañol, Macho-Stadler, and Pérez-Castrillo (2019) examined grants from the UK's Engineering and Physical Sciences Research Council (EPSRC) and found that structurally diverse teams were penalized and biased against. More precisely, their study concluded that teams that exhibit greater diversity in knowledge and skills, education, and/or scientific ability were significantly less likely to obtain funding; however, they were generally more likely to be successful. However, the effects of these biases were weaker and even disappeared for teams led by prestigious researchers.

On the subject of funding, it is worth noting that many academics actively opt for ‘unfunded’ research to e.g. pursue ideas out of intellectual curiosity (Edwards 2020). It has been argued that interdisciplinary and/or novel research has epistemic properties that demand conditions that are not met by standardized grant funding (Laudel and Gläser 2014), indicating that the increase in competitive research funding at the expense of flexible institutional sponsorship may pose a threat to creative or unconventional science (Laudel and Gläser 2014; Heinze et al. 2009).

References

Abramo, G., and C.A. D'Angelo. 2017. "Gender Differences in Research Diversification Behavior." 16th International Society of Scientometrics and Informetrics Conference - (ISSI - 2017). Wuhan, China, 16-20 October 2017. 2017.

Abramo, G., C.A. D'Angelo, and F. Di Costa. 2017. "Specialization versus Diversification in Research Activities: The Extent, Intensity and Relatedness of Field Diversification by Individual Scientists." *Scientometrics* 112 (3): 1403–18. https://doi.org/10.1007/s11192-017-2426-7.

———. 2018. "The Effects of Gender, Age and Academic Rank on Research Diversification." *Scientometrics* 114 (2): 373–87. https://doi.org/10.1007/s11192-017-2529-1.

———. 2019. "A Gender Analysis of Top Scientists' Collaboration Behavior: Evidence from Italy." *Scientometrics* 120 (2): 405–18. https://doi.org/10.1007/s11192-019-03136-6.

Abramo, G., C.A. D'Angelo, and F. Rosati. 2014. "Career Advancement and Scientific Performance in Universities." *Scientometrics* 98 (2): 891–907. https://doi.org/10.1007/s11192-013-1075-8.

Abramo, G., C.A. D'Angelo, and L. Zhang. 2018. "A Comparison of Two Approaches for Measuring Interdisciplinary Research Output: The Disciplinary Diversity of Authors vs the Disciplinary Diversity of the Reference List." *Journal of Informetrics* 12 (4): 1182–93. https://doi.org/10.1016/j.joi.2018.09.001.

Abramo, Giovanni, Ciriaco Andrea D'Angelo, and Alessandro Caprasecca. 2009a. "The Contribution of Star Scientists to Overall Sex Differences in Research Productivity." *Scientometrics* 81 (1): 137. https://doi.org/10.1007/s11192-008-2131-7.

———. 2009b. "Gender Differences in Research Productivity: A Bibliometric Analysis of the Italian Academic System." *Scientometrics* 79 (3): 517–39. https://doi.org/10.1007/s11192-007-2046-8.

Abramo, Giovanni, Ciriaco Andrea D'Angelo, and Francesco Rosati. 2016. "Gender Bias in Academic Recruitment." *Scientometrics* 106 (1): 119–41. https://doi.org/10.1007/s11192-015-1783-3.

Abreu, M., and V. Grinevich. 2017. "Gender Patterns in Academic Entrepreneurship." *Journal of Technology Transfer* 42 (4): 763–94. https://doi.org/10.1007/s10961-016-9543-y.

Ahmad, S. 2017. "Family or Future in the Academy?" *Review of Educational Research* 87 (1): 204–39. https://doi.org/10.3102/0034654316631626.

Åkerlind, G.S. 2005. "Postdoctoral Researchers: Roles, Functions and Career Prospects." *Higher Education Research & Development* 24 (1): 21–40. https://doi.org/10.1080/0729436052000318550.

Akram, S., and Z. Pflaeger Young. 2020. "Early Career Researchers' Experiences of Post-Maternity and Parental Leave Provision in UK Politics and International Studies Departments: A Heads of Department and Early Career Researcher Survey." *Political Studies Review*. https://doi.org/10.1177/1478929920910363.

Aksnes, D.W., F.N. Piro, and K. Rørstad. 2019. "Gender Gaps in International Research Collaboration: A Bibliometric Approach." *Scientometrics* 120 (2): 747–74. https://doi.org/10.1007/s11192-019-03155-3.

Albers, Casper J. 2015. "Dutch Research Funding, Gender Bias, and Simpson's Paradox." *Proceedings of the National Academy of Sciences* 112 (50): E6828. https://doi.org/10.1073/pnas.1518936112.

Alberts, Bruce, Marc W. Kirschner, Shirley Tilghman, and Harold Varmus. 2014. "Rescuing US Biomedical Research from Its Systemic Flaws." *Proceedings of the National Academy of Sciences* 111 (16): 5773–77. https://doi.org/10.1073/pnas.1404402111.

Alberts, Heike C. 2008. "The Challenges and Opportunities of Foreign-Born Instructors in the Classroom." *Journal of Geography in Higher Education* 32 (2): 189–203. https://doi.org/10.1080/03098260701731306.

Alvarez, Sindy N Escobar, Reshma Jagsi, Stephanie B Abbuhl, Carole J Lee, and Elizabeth R Myers. 2019. "Promoting Gender Equity in Grant Making: What Can a Funder Do?" *The Lancet* 393 (10171): e9–11. https://doi.org/10.1016/S0140-6736(19)30211-9.

Andersen, Jens Peter, Mathias Wullum Nielsen, Nicole L Simone, Resa E Lewiss, and Reshma Jagsi. 2020. "COVID-19 Medical Papers Have Fewer Women First Authors than Expected." Edited by Peter Rodgers. *ELife* 9 (June): e58807. https://doi.org/10.7554/eLife.58807.

Andersen, Jens Peter, Jesper Wiborg Schneider, Reshma Jagsi, and Mathias Wullum Nielsen. 2019. "Gender Variations in Citation Distributions in Medicine Are Very Small and Due to Self-Citation and Journal Prestige." Edited by Peter Rodgers, Willem M Otte, Neven Caplar, Marc Lerchenmueller, and Rinita Dam. *ELife* 8 (July): e45374. https://doi.org/10.7554/eLife.45374.

Angervall, P., and D. Beach. 2018. "The Exploitation of Academic Work: Women in Teaching at Swedish Universities." *Higher Education Policy* 31 (1): 1–17. https://doi.org/10.1057/s41307-017-0041-0.

———. 2020. "Dividing Academic Work: Gender and Academic Career at Swedish Universities." *Gender and Education* 32 (3): 347–62. https://doi.org/10.1080/09540253.2017.1401047.

Angervall, P., D. Beach, and J. Gustafsson. 2015. "The Unacknowledged Value of Female Academic Labour Power for Male Research Careers." *Higher Education Research and Development* 34 (5): 815–27. https://doi.org/10.1080/07294360.2015.1011092.

Angervall, P., and J. Gustafsson. 2014. *European Educational Research Journal* 13 (6): 601–15. https://doi.org/10.2304/eerj.2014.13.6.601.

Angervall, P., J. Gustafsson, and E. Silfver. 2018. "Academic Career: On Institutions, Social Capital and Gender." *Higher Education Research and Development* 37 (6): 1095–1108. https://doi.org/10.1080/07294360.2018.1477743.

Arensbergen, P. van, I. van der Weijden, and P. van den Besselaar. 2012. "Gender Differences in Scientific Productivity: A Persisting Phenomenon?" *Scientometrics* 93 (3): 857–68. https://doi.org/10.1007/s11192-012-0712-y.

Arensbergen, Pleun van, Inge van der Weijden, and Peter van den Besselaar. 2014. "The Selection of Talent as a Group Process. A Literature Review on the Social Dynamics of Decision Making in Grant Panels." *Research Evaluation* 23 (4): 298–311. https://doi.org/10.1093/reseval/rvu017.

Ates, G., and A. Brechelmacher. 2013. "Academic Career Paths." In *The Work Situation of the Academic Profession in Europe: Findings of a Survey in Twelve Countries*, 13–35. https://doi.org/10.1007/978-94-007-5977-0_2.

Awando, M., A. Wood, E. Camargo, and P. Layne. 2014. *Advancement of Mid-Career Faculty Members: Perceptions, Experiences, and Challenges*. Vol. 19. Advances in Gender Research. https://doi.org/10.1108/S1529-212620140000019009.

Azevedo, L., W. Shi, P.S. Medina, and M.T. Bagwell. 2020. "Examining Junior Faculty Work-Life Balance in Public Affairs Programs in the United States." *Journal of Public Affairs Education*, 1–21. https://doi.org/10.1080/15236803.2020.1788372.

Azoulay, Pierre, Toby Stuart, and Yanbo Wang. 2013. "Matthew: Effect or Fable?" *Management Science* 60 (1): 92–109. https://doi.org/10.1287/mnsc.2013.1755.

Bagues, Manuel, Mauro Sylos-Labini, and Natalia Zinovyeva. 2014. "Do Gender Quotas Pass the Test? Evidence from Academic Evaluations in Italy." SSRN Scholarly Paper ID 2457487. Rochester, NY: Social Science Research Network. https://doi.org/10.2139/ssrn.2457487.

———. 2017. "Does the Gender Composition of Scientific Committees Matter?" *American Economic Review* 107 (4): 1207–38. https://doi.org/10.1257/aer.20151211.

Baker, M. 2010a. "Career Confidence and Gendered Expectations of Academic Promotion." *Journal of Sociology* 46 (3): 317–34. https://doi.org/10.1177/1440783310371402.

———. 2010b. "Choices or Constraints? Family Responsibilities, Gender and Academic Career." *Journal of Comparative Family Studies* 41 (1): 1–18. https://doi.org/10.3138/jcfs.41.1.1.

Banal-Estañol, Albert, Inés Macho-Stadler, and David Pérez-Castrillo. 2019. "Evaluation in Research Funding Agencies: Are Structurally Diverse Teams Biased Against?" *Research Policy* 48 (7): 1823–40. https://doi.org/10.1016/j.respol.2019.04.008.

Barrett, L., and P. Barrett. 2011. "Women and Academic Workloads: Career Slow Lane or Cul-de-Sac?" *Higher Education* 61 (2): 141–55. https://doi.org/10.1007/s10734-010-9329-3.

Baruffaldi, Stefano H., Marianna Marino, and Fabiana Visentin. 2020. "Money to Move: The Effect on Researchers of an International Mobility Grant." *Research Policy* 49 (8): 104077. https://doi.org/10.1016/j.respol.2020.104077.

Bauder, Harald. 2020. "International Mobility and Social Capital in the Academic Field." *Minerva* 58 (3): 367–87. https://doi.org/10.1007/s11024-020-09401-w.

Beaudry, C., and V. Larivière. 2016. "Which Gender Gap? Factors Affecting Researchers' Scientific Impact in Science and Medicine." *Research Policy* 45 (9): 1790–1817. https://doi.org/10.1016/j.respol.2016.05.009.

Bentley, P. 2012. "Gender Differences and Factors Affecting Publication Productivity among Australian University Academics." *Journal of Sociology* 48 (1): 85–103. https://doi.org/10.1177/1440783311411958.

Benz, T. 2014. "Flanking Gestures: Gender and Emotion in Fieldwork." *Sociological Research Online* 19 (2). https://doi.org/10.5153/sro.3326.

Berryman, S. 1983. *Who Will Do Science? Minority and Female Attainment of Science and Mathematics Degrees: Trends and Causes*. New York: Rockefeller Foundation.

Besselaar, P. van den, and U. Sandström. 2015. "Early Career Grants, Performance, and Careers: A Study on Predictive Validity of Grant Decisions." *Journal of Informetrics* 9 (4): 826–38. https://doi.org/10.1016/j.joi.2015.07.011.

———. 2016. "Gender Differences in Research Performance and Its Impact on Careers: A Longitudinal Case Study." *Scientometrics* 106 (1): 143–62. https://doi.org/10.1007/s11192-015-1775-3.

Besselaar, P.V.D., and U. Sandström. 2017. "Vicious Circles of Gender Bias, Lower Positions, and Lower Performance: Gender Differences in Scholarly Productivity and Impact." *PLoS ONE* 12 (8). https://doi.org/10.1371/journal.pone.0183301.

Best Kathinka, Sinell Anna, Heidingsfelder Marie Lena, and Schraudner Martina. 2016. "The Gender Dimension in Knowledge and Technology Transfer – the German Case." *European Journal of Innovation Management* 19 (1): 2–25. https://doi.org/10.1108/EJIM-07-2015-0052.

Bhattacharjee, Yudhijit. 2012. "NSF's 'Big Pitch' Tests Anonymized Grant Reviews." *Science* 336 (6084): 969. https://doi.org/10.1126/science.336.6084.969.

Biernat, M., M. Carnes, A. Filut, and A. Kaatz. 2020. "Gender, Race, and Grant Reviews: Translating and Responding to Research Feedback." *Personality and Social Psychology Bulletin* 46 (1): 140–54. https://doi.org/10.1177/0146167219845921.

Biggs, J., P.H. Hawley, and M. Biernat. 2018. "The Academic Conference as a Chilly Climate for Women: Effects of Gender Representation on Experiences of Sexism, Coping Responses, and Career Intentions." *Sex Roles* 78 (5–6): 394–408. https://doi.org/10.1007/s11199-017-0800-9.

Bird, Sharon, Jacquelyn Litt, and Yong Wang. 2004. "Creating Status of Women Reports: Institutional Housekeeping as 'Women's Work.'" *NWSA Journal* 16 (1): 194–206.

Blake, M., and I. LaValle. 2000. "Who Applies for Research Funding?" National Centre for Social Research.

Blau, Francine D., Janet M. Currie, Rachel T. A. Croson, and Donna K. Ginther. 2010. "Can Mentoring Help Female Assistant Professors? Interim Results from a Randomized Trial." *The American Economic Review* 100 (2): 348–52.

Bloch, Carter, Ebbe Krogh Graversen, and Heidi Skovgaard Pedersen. 2014. "Competitive Research Grants and Their Impact on Career Performance." *Minerva* 52 (1): 77–96. https://doi.org/10.1007/s11024-014-9247-0.

Bloch, Carter, and Dorte Henriksen. 2013. "Køn Og Forskning i Det Frie Forskningsråd." Udarbejdet Af Dansk Center for Forskningsanalyse for Styrelsen for Forsknings Og Innovation. https://ufm.dk/publikationer/2013/filer-2013/kon-og-forskning-i-det-frie-forskningsrad.pdf.

Borg, A.M., D. Frey, D. Šešelja, and C. Straßer. 2019. "Theory-Choice, Transient Diversity and the Efficiency of Scientific Inquiry." *European Journal for Philosophy of Science* 9 (2). https://doi.org/10.1007/s13194-019-0249-5.

Bornmann, Lutz, Rüdiger Mutz, and Hans-Dieter Daniel. 2007. "Gender Differences in Grant Peer Review: A Meta-Analysis." *Journal of Informetrics*, The Hirsch Index, 1 (3): 226–38. https://doi.org/10.1016/j.joi.2007.03.001.

Bosquet, C., P.-P. Combes, and C. García-Peñalosa. 2019. "Gender and Promotions: Evidence from Academic Economists in France." *Scandinavian Journal of Economics* 121 (3): 1020–53. https://doi.org/10.1111/sjoe.12300.

Bowman, Joann K., and Sean Ulm. 2009. "Grants, Gender and Glass Ceilings? An Analysis of ARC-Funded Archaeology Projects." *Australian Archaeology*, no. 68: 31–36.

Brady, Emer, Mathias Wullum Nielsen, Jens Peter Andersen, and Sabine Oertelt-Prigione. 2020. "Lack of Consideration of Sex and Gender in Clinical Trials for COVID-19." *MedRxiv*, January, 2020.09.13.20193680. https://doi.org/10.1101/2020.09.13.20193680.

Brandth, Berit, and Elin Kvande. 2001. "Flexible Work and Flexible Fathers." *Work, Employment and Society* 15 (2): 251–67. https://doi.org/10.1177/09500170122118940.

Brechelmacher, Angelika, Elke Park, Gülay Ates, and David F. J. Campbell. 2015. "The Rocky Road to Tenure – Career Paths in Academia." In *Academic Work and Careers in Europe: Trends, Challenges, Perspectives*, edited by Tatiana Fumasoli, Gaële Goastellec, and Barbara M. Kehm, 13–40. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-10720-2_2.

Bridle, H. 2018. "Following Up on Interdisciplinary Encounters: Benefits for Early Career Researchers." *European Review* 26 (S2): S6–20. https://doi.org/10.1017/S1062798718000236.

Brink, M. van den, Y. Benschop, and W. Jansen. 2010. "Transparency in Academic Recruitment: A Problematic Tool for Gender Equality?" *Organization Studies* 31 (11): 1459–83. https://doi.org/10.1177/0170840610380812.

Brink, Marieke van den, and Yvonne Benschop. 2011. "Gender Practices in the Construction of Academic Excellence: Sheep with Five Legs." *Organization* 19 (4): 507–24. https://doi.org/10.1177/1350508411414293.

Broder, Ivy E. 1993. "Review of NSF Economics Proposals: Gender and Institutional Patterns." *The American Economic Review* 83 (4): 964–70.

Brooks, C., E.M. Fenton, and J.T. Walker. 2014. "Gender and the Evaluation of Research." *Research Policy* 43 (6): 990–1001. https://doi.org/10.1016/j.respol.2013.12.005.

Broström, Anders. 2019. "Academic Breeding Grounds: Home Department Conditions and Early Career Performance of Academic Researchers." *Research Policy*, April. https://doi.org/10.1016/j.respol.2019.03.009.

Brouns, Margo. 2000. "The Gendered Nature of Assessment Procedures in Scientific Research Funding: The Dutch Case." *Higher Education in Europe* 25 (2): 193–99. https://doi.org/10.1080/713669261.

Browning, L., K. Thompson, and D. Dawson. 2017. "From Early Career Researcher to Research Leader: Survival of the Fittest?" *Journal of Higher Education Policy and Management* 39 (4): 361–77. https://doi.org/10.1080/1360080X.2017.1330814.

Bührer, S., and R. Frietsch. 2020. "How Do Public Investments in Gender Equality Initiatives and Publication Patterns Interrelate? The Case of Germany." *Evaluation and Program Planning* 79. https://doi.org/10.1016/j.evalprogplan.2019.101752.

Bührer, S., E. Kalpazidou Schmidt, R. Palmén, and S. Reidl. 2020. "Evaluating Gender Equality Effects in Research and Innovation Systems." *Scientometrics*. https://doi.org/10.1007/s11192-020-03596-1.

Bührer, S., and A. Wroblewski. 2019. "The Practice and Perceptions of RRI—A Gender Perspective." *Evaluation and Program Planning* 77. https://doi.org/10.1016/j.evalprogplan.2019.101717.

Burnett, A., C. Bilen-Green, C.R. McGeorge, and C.L. Anicha. 2012. "Examining the Complexities of Faculty Attrition: An Analysis of STEM and Non-STEM Faculty Who Remain and Faculty Who Leave the Institution." *Journal of Women and Minorities in Science and Engineering* 18 (1): 1–19. https://doi.org/10.1615/JWomenMinorScienEng.2012003100.

Cain, Cindy L., and Erin Leahey. 2014. "Cultural Correlates of Gender Integration in Science." *Gender, Work & Organization* 21 (6): 516–30. https://doi.org/10.1111/gwao.12052.

Calvo, N., S. Fernández-López, and D. Rodeiro-Pazos. 2019. "Is University-Industry Collaboration Biased by Sex Criteria?" *Knowledge Management Research and Practice* 17 (4): 408–20. https://doi.org/10.1080/14778238.2018.1557024.

Campbell, Lesley G., Siya Mehtani, Mary E. Dozier, and Janice Rinehart. 2013. "Gender-Heterogeneous Working Groups Produce Higher Quality Science." *PLOS ONE* 8 (10): e79147. https://doi.org/10.1371/journal.pone.0079147.

Cañibano, C., P. D'Este, F.J. Otamendi, and R. Woolley. 2020. "Scientific Careers and the Mobility of European Researchers: An Analysis of International Mobility by Career Stage." *Higher Education*. https://doi.org/10.1007/s10734-020-00536-z.

Cantwell, B. 2011. "Academic In-Sourcing: International Postdoctoral Employment and New Modes of Academic Production." *Journal of Higher Education Policy and Management* 33 (2): 101–14. https://doi.org/10.1080/1360080X.2011.550032.

Caprile, M. et al. 2012. "Meta-Analysis on Gender and Science. Synthesis Report." European Commission. https://ec.europa.eu/research/swafs/pdf/pub_gender_equality/meta-analysis-of-gender-and-science-research-synthesis-report.pdf.

Carley, S., and A.L. Porter. 2012. "A Forward Diversity Index." *Scientometrics* 90 (2): 407–27. https://doi.org/10.1007/s11192-011-0528-1.

Carnes, Molly, Patricia G Devine, Linda Baier Manwell, Angela Byars-Winston, Eve Fine, Cecilia E Ford, Patrick Forscher, et al. 2015. "The Effect of an Intervention to Break the Gender Bias Habit for Faculty at One Institution: A Cluster Randomized, Controlled Trial." *Academic Medicine : Journal of the Association of American Medical Colleges* 90 (2): 221–30. https://doi.org/10.1097/ACM.0000000000000552.

Carr, Phyllis L., Arlene S. Ash, Robert H. Friedman, Laura Szalacha, Rosalind C. Barnett, Anita Palepu, and Mark M. Moskowitz. 2000. "Faculty Perceptions of Gender Discrimination and Sexual Harassment in Academic Medicine." *Annals of Internal Medicine* 132 (11): 889–96. https://doi.org/10.7326/0003-4819-132-11-200006060-00007.

Carr, Phyllis L., Laura Szalacha, Rosalind Barnett, Cheryl Caswell, and Thomas Inui. 2003. "A 'Ton of Feathers': Gender Discrimination in Academic Medical Careers and How to Manage It." *Journal of Women's Health* 12 (10): 1009–18. https://doi.org/10.1089/154099903322643938.

Carrigan, C., K. Quinn, and E.A. Riskin. 2011. "The Gendered Division of Labor among STEM Faculty and the Effects of Critical Mass." *Journal of Diversity in Higher Education* 4 (3): 131–46. https://doi.org/10.1037/a0021831.

Carter, S.D., and C.D. Tully. 2019. "Pushback: Negative Career Development Experiences of United States Post-Tenure Female Faculty 19882011." In *Women, Business and Leadership: Gender and Organisations*, 273–97. https://doi.org/10.4337/9781786432711.00024.

Casad, B.J., Z.W. Petzel, and E.A. Ingalls. 2019. "A Model of Threatening Academic Environments Predicts Women STEM Majors' Self-Esteem and Engagement in STEM." *Sex Roles* 80 (7–8): 469–88. https://doi.org/10.1007/s11199-018-0942-4.

Castellacci, Fulvio, and Clara Viñas-Bardolet. 2020. "Permanent Contracts and Job Satisfaction in Academia: Evidence from European Countries." *Studies in Higher Education*, January, 1–15. https://doi.org/10.1080/03075079.2019.1711041.

Cech, E.A., and M. Blair-Loy. 2014. "Consequences of Flexibility Stigma Among Academic Scientists and Engineers." *Work and Occupations* 41 (1): 86–110. https://doi.org/10.1177/0730888413515497.

Ceci, S.J., D.K. Ginther, S. Kahn, and W.M. Williams. 2014. "Women in Academic Science: A Changing Landscape." *Psychological Science in the Public Interest, Supplement* 15 (3): 75–141. https://doi.org/10.1177/1529100614541236.

Ceci, S.J., and W.M. Williams. 2011. "Understanding Current Causes of Women's Underrepresentation in Science." *Proceedings of the National Academy of Sciences of the United States of America* 108 (8): 3157–62. https://doi.org/10.1073/pnas.1014871108.

Cervia, S., and R. Biancheri. 2017. "Women in Science: The Persistence of Traditional Gender Roles. A Case Study on Work–Life Interface." *European Educational Research Journal* 16 (2–3): 215–29. https://doi.org/10.1177/1474904116654701.

Chakraborty, Tanmoy, Vihar Tammana, Niloy Ganguly, and Animesh Mukherjee. 2015. "Understanding and Modeling Diverse Scientific Careers of Researchers." *Journal of Informetrics* 9 (1): 69–78. https://doi.org/10.1016/j.joi.2014.11.008.

Chambers, D., L. Preston, A. Topakas, S. de Saille, S. Salway, A. Booth, J. Dawson, and J. Wilsdon. 2017. "Review of Diversity and Inclusion Literature and an Evaluation of Methodologies and Metrics Relating to Health Research." University of Sheffield. Working paper. In partnership with the Wellcome Trust.

Chan, Ho Fai, and Benno Torgler. 2020. "Gender Differences in Performance of Top Cited Scientists by Field and Country." *Scientometrics*, October. https://doi.org/10.1007/s11192-020-03733-w.

Chang, E.H., K.L. Milkman, D.M. Gromet, R.W. Rebele, C. Massey, A.L. Duckworth, and A.M. Grant. 2019. "The Mixed Effects of Online Diversity Training." *Proceedings of the National Academy of Sciences of the United States of America* 116 (16): 7778–83. https://doi.org/10.1073/pnas.1816076116.

Chapman, S., F.F. Dixon, N. Foster, V.J. Kuck, D.A. McCarthy, N.M. Tooney, J.P. Buckner, S.A. Nolan, and C.H. Marzabadi. 2011. "Female Faculty Members in University Chemistry Departments: Observations and Conclusions Based on Site Visits." *Journal of Chemical Education* 88 (6): 716–20. https://doi.org/10.1021/ed100098q.

Checchi, Daniele, Simona Cicognani, and Nevena Kulic. 2019. "Gender Quotas or Girls' Networks? Evidence from an Italian Research Selection." *Work, Employment and Society* 33 (3): 462–82. https://doi.org/10.1177/0950017018813071.

Chen, Shiji, Clément Arsenault, and Vincent Larivière. 2015. "Are Top-Cited Papers More Interdisciplinary?" *Journal of Informetrics* 9 (4): 1034–46. https://doi.org/10.1016/j.joi.2015.09.003.

Chesser, S. 2015. "Intersection of Family, Work and Leisure during Academic Training." *Annals of Leisure Research* 18 (3): 308–22. https://doi.org/10.1080/11745398.2015.1060579.

Chiswell, H.M., and R. Wheeler. 2016. "'As Long as You're Easy on the Eye': Reflecting on Issues of Positionality and Researcher Safety during Farmer Interviews." *Area* 48 (2): 229–35. https://doi.org/10.1111/area.12257.

Chubb, J., and G.E. Derrick. 2020. "The Impact A-Gender: Gendered Orientations towards Research Impact and Its Evaluation." *Palgrave Communications* 6 (1). https://doi.org/10.1057/s41599-020-0438-z.

Clauset, Aaron, Samuel Arbesman, and Daniel B. Larremore. 2015. “Systematic Inequality and Hierarchy in Faculty Hiring Networks.” *Science Advances* 1 (1): e1400005. https://doi.org/10.1126/sciadv.1400005.

Clayton, Janine Austin, and Cara Tannenbaum. 2016. “Reporting Sex, Gender, or Both in Clinical Research?” *JAMA* 316 (18): 1863–64. https://doi.org/10.1001/jama.2016.16405.

Coate, Kelly, and Camille Kandiko Howson. 2016. “Indicators of Esteem: Gender and Prestige in Academic Work.” *British Journal of Sociology of Education* 37 (4): 567–85. https://doi.org/10.1080/01425692.2014.955082.

Cole, Jonathan, R., and Harriet Zuckerman. 1984. “The Productivity Puzzle: Persistence and Change in Patterns of Publication of Men and Women Scientists." (Jonathan R. Cole and Harriet Zuckerman) Pp. 217-258 Greenwich, Connecticut:” In *In Marjorie W. Steinkempt and Martin L. Maehr (Editors). Advances in Motivation and Achievement A Research Journal Women in Science. Volume 2.*, 217–58. Greenwich, Connecticut: JAI PRESS INC.

Collins, Jennifer M. 2008. “Coming to America: Challenges for Faculty Coming to United States’ Universities.” *Journal of Geography in Higher Education* 32 (2): 179–88. https://doi.org/10.1080/03098260701731215.

Collins, R., and N. Steffen-Fluhr. 2019. “Hidden Patterns: Using Social Network Analysis to Track Career Trajectories of Women STEM Faculty.” *Equality, Diversity and Inclusion* 38 (2): 265–82. https://doi.org/10.1108/EDI-09-2017-0183.

Colyvas, Jeannette A., Kaisa Snellman, Janet Bercovitz, and Maryann Feldman. 2012. “Disentangling Effort and Performance: A Renewed Look at Gender Differences in Commercializing Medical School Research.” *The Journal of Technology Transfer* 37 (4): 478–89. https://doi.org/10.1007/s10961-011-9235-6.

Conway, C.S., Y. Sims, A. McCrary-Quarles, C.S. Nicholson, G. Ethridge, M. Maultsby, T. Thomas, and S. Smith. 2018. “Strategies to Mentor Female Faculty: A Global Issue.” In *Faculty Mentorship at Historically Black Colleges and Universities*, 126–50. https://doi.org/10.4018/978-1-5225-4071-7.ch007.

Corcoran, J. 2019. “Addressing the ‘Bias Gap’: A Research-Driven Argument for Critical Support of Plurilingual Scientists’ Research Writing.” *Written Communication* 36 (4): 538–77. https://doi.org/10.1177/0741088319861648.

Corley, Elizabeth A., and Meghna Sabharwal. 2007. “Foreign-Born Academic Scientists and Engineers: Producing More and Getting Less than Their U.S.-Born Peers?” *Research in Higher Education* 48 (8): 909–40. https://doi.org/10.1007/s11162-007-9055-6.

Corley, Elizabeth, and Monica Gaughan. 2005. “Scientists’ Participation in University Research Centers: What Are the Gender Differences?” *The Journal of Technology Transfer* 30 (4): 371–81. https://doi.org/10.1007/s10961-005-2582-4.

Correll, Shelley J. 2004. “Constraints into Preferences: Gender, Status, and Emerging Career Aspirations.” *American Sociological Review* 69 (1): 93–113. https://doi.org/10.1177/000312240406900106.

Correll, Shelley J. 2001. “Gender and the Career Choice Process: The Role of Biased Self-Assessments.” *American Journal of Sociology* 106 (6): 1691–1730. https://doi.org/10.1086/321299.

Crabb, Shona, and Stuart Ekberg. 2014. “Retaining Female Postgraduates in Academia: The Role of Gender and Prospective Parenthood.” *Higher Education Research & Development* 33 (6): 1099–1112. https://doi.org/10.1080/07294360.2014.911251.

Cross, M., S. Lee, H. Bridgman, D.K. Thapa, M. Cleary, and R. Kornhaber. 2019. “Benefits, Barriers and Enablers of Mentoring Female Health Academics: An Integrative Review.” *PLoS ONE* 14 (4). https://doi.org/10.1371/journal.pone.0215319.

Cruz-Castro, Laura, and Luis Sanz-Menéndez. 2019. “Grant Allocation Disparities from a Gender Perspective: Literature Review. Synthesis Report.” GRANteD Project D.11. http://dx.doi.org./10.20350/digitalCSIC/10548.

Cummings, Jonathon N., and Sara Kiesler. 2005. “Collaborative Research Across Disciplinary and Organizational Boundaries.” *Social Studies of Science* 35 (5): 703–22. https://doi.org/10.1177/0306312705055535.

———. 2007. “Coordination Costs and Project Outcomes in Multi-University Collaborations.” *Research Policy* 36 (10): 1620–34. https://doi.org/10.1016/j.respol.2007.09.001.

Cummings, Jonathon N., Sara Kiesler, Reza Bosagh Zadeh, and Aruna D. Balakrishnan. 2013. “Group Heterogeneity Increases the Risks of Large Group Size: A Longitudinal Study of Productivity in Research Groups.” *Psychological Science* 24 (6): 880–90. https://doi.org/10.1177/0956797612463082.

D. P. Libaers. 2007. “Role and Contribution of Foreign-Born Scientists and Engineers to the Public U.S. Nanoscience and Technology Research Enterprise.” *IEEE Transactions on Engineering Management* 54 (3): 423–32. https://doi.org/10.1109/TEM.2007.900789.

Dalen, Hendrik P. van, and Kène Henkens. 2012. “Intended and Unintended Consequences of a Publish-or-Perish Culture: A Worldwide Survey.” *Journal of the American Society for Information Science and Technology* 63 (7): 1282–93. https://doi.org/10.1002/asi.22636.

Danell, R., and M. Hjerm. 2013a. “Career Prospects for Female University Researchers Have Not Improved.” *Scientometrics* 94 (3): 999–1006. https://doi.org/10.1007/s11192-012-0840-4.

———. 2013b. “The Importance of Early Academic Career Opportunities and Gender Differences in Promotion Rates.” *Research Evaluation* 22: 210–14. https://doi.org/10.1093/RESEVAL/RVT011.

Davies, C., and R. Healey. 2019. “Hacking through the Gordian Knot: Can Facilitating Operational Mentoring Untangle the Gender Research Productivity Puzzle in Higher Education?” *Studies in Higher Education* 44 (1): 31–44. https://doi.org/10.1080/03075079.2017.1333494.

Day, Suzanne, Robin Mason, Cara Tannenbaum, and Paula A. Rochon. 2017. "Essential Metrics for Assessing Sex & Gender Integration in Health Research Proposals Involving Human Participants." *PLOS ONE* 12 (8): e0182812. https://doi.org/10.1371/journal.pone.0182812.

De Paola, Maria, and Vincenzo Scoppa. 2015. "Gender Discrimination and Evaluators' Gender: Evidence from Italian Academia." *Economica* 82 (325): 162–88. https://doi.org/10.1111/ecca.12107.

DEA and Independent Research Fund Denmark. 2019. "What Do We Know about Risk-Taking in Science and Science Funding? A Policy-Oriented Survey of the Literature." Background Report from the Project "Risktaking in Science Funding". Copenhagen and Odense. https://www.datocms-assets.com/22590/1586161266-appendixsurveyofthelitterature.pdf.

Decastro, R., K.A. Griffith, P.A. Ubel, A. Stewart, and R. Jagsi. 2014. "Mentoring and the Career Satisfaction of Male and Female Academic Medical Faculty." *Academic Medicine* 89 (2): 301–11. https://doi.org/10.1097/ACM.0000000000000109.

Dehdarirad, T., A. Villarroya, and M. Barrios. 2015. "A Bibliometric Analysis." *Scientometrics* 103 (3): 795–812. https://doi.org/10.1007/s11192-015-1574-x.

Devine, P.G., P.S. Forscher, W.T.L. Cox, A. Kaatz, J. Sheridan, and M. Carnes. 2017. "A Gender Bias Habit-Breaking Intervention Led to Increased Hiring of Female Faculty in STEMM Departments." *Journal of Experimental Social Psychology* 73: 211–15. https://doi.org/10.1016/j.jesp.2017.07.002.

DFiR. 2019. "Karrierer i Forskningen." Danmarks Forsknings- Og Innovationspolitiske Råd (DFiR) / Danish Council for Research and Innovation Policy. https://ufm.dk/publikationer/2019/karrierer-i-forskningen.

Di Paola, N. 2020. "Pathways to Academic Entrepreneurship: The Determinants of Female Scholars' Entrepreneurial Intentions." *Journal of Technology Transfer*. https://doi.org/10.1007/s10961-020-09824-3.

Ding, W.W., F. Murray, and T.E. Stuart. 2013. "From Bench to Board: Gender Differences in University Scientists' Participation in Corporate Scientific Advisory Boards." *Academy of Management Journal* 56 (5): 1443–64. https://doi.org/10.5465/amj.2011.0020.

Dion, M.L., J.L. Sumner, and S.M. Mitchell. 2018. "Gendered Citation Patterns across Political Science and Social Science Methodology Fields." *Political Analysis* 26 (3): 312–27. https://doi.org/10.1017/pan.2018.12.

Dobele, A.R., and S. Rundle-Theile. 2015. "Progression through Academic Ranks: A Longitudinal Examination of Internal Promotion Drivers." *Higher Education Quarterly* 69 (4): 410–29. https://doi.org/10.1111/hequ.12081.

Dolado, J.J., F. Felgueroso, and M. Almunia. 2012. "Are Men and Women-Economists Evenly Distributed across Research Fields? Some New Empirical Evidence." *SERIEs* 3 (3): 367–93. https://doi.org/10.1007/s13209-011-0065-4.

Donina, D., M. Seeber, and S. Paleari. 2017. "Inconsistencies in the Governance of Interdisciplinarity: The Case of the Italian Higher Education System." *Science and Public Policy* 44 (6): 865–75. https://doi.org/10.1093/scipol/scx019.

Dorenkamp, I., and S. Süß. 2017. "Work-Life Conflict among Young Academics: Antecedents and Gender Effects." *European Journal of Higher Education* 7 (4): 402–23. https://doi.org/10.1080/21568235.2017.1304824.

Dover, T.L., C.R. Kaiser, and B. Major. 2020. "Mixed Signals: The Unintended Effects of Diversity Initiatives." *Social Issues and Policy Review* 14 (1): 152–81. https://doi.org/10.1111/sipr.12059.

Duch, J., X.H.T. Zeng, M. Sales-Pardo, F. Radicchi, S. Otis, T.K. Woodruff, and L.A. Nunes Amaral. 2012. "The Possible Role of Resource Requirements and Academic Career-Choice Risk on Gender Differences in Publication Rate and Impact." *PLoS ONE* 7 (12). https://doi.org/10.1371/journal.pone.0051332.

Dunham, C.C., L.H. Weathers, K. Hoo, and C. Heintz. 2012. "I Just Need Someone Who Knows the Ropes: Mentoring and Female Faculty in Science and Engineering." *Journal of Women and Minorities in Science and Engineering* 18 (1): 79–96. https://doi.org/10.1615/JWomenMinorScienEng.2012002193.

Ecklund, E.H., and A.E. Lincoln. 2011. "Scientists Want More Children." *PLoS ONE* 6 (8). https://doi.org/10.1371/journal.pone.0022590.

Edwards, R. 2020. "Why Do Academics Do Unfunded Research? Resistance, Compliance and Identity in the UK Neo-Liberal University." *Studies in Higher Education*. https://doi.org/10.1080/03075079.2020.1817891.

Ehrenberg, R.G., G.H. Jakubson, M.L. Martin, J.B. Main, and T. Eisenberg. 2012. "Diversifying the Faculty across Gender Lines: Do Trustees and Administrators Matter?" *Economics of Education Review* 31 (1): 9–18. https://doi.org/10.1016/j.econedurev.2011.10.003.

Epstein, N., and M.R. Fischer. 2017. "Academic Career Intentions in the Life Sciences: Can Research Self-Efficacy Beliefs Explain Low Numbers of Aspiring Physician and Female Scientists?" *PLoS ONE* 12 (9). https://doi.org/10.1371/journal.pone.0184543.

Evers, A., and M. Sieverding. 2015. "Academic Career Intention beyond the PhD: Can the Theory of Planned Behavior Explain Gender Differences?" *Journal of Applied Social Psychology* 45 (3): 158–72. https://doi.org/10.1111/jasp.12285.

Eversole, B.A.W., and C.L. Crowder. 2020. "Toward a Family-Friendly Academy: HRD's Role in Creating Healthy Work–Life Cultural Change Interventions." *Advances in Developing Human Resources* 22 (1): 11–22. https://doi.org/10.1177/1523422319886287.

Faber, Stine Thidemann, Helene Pristed Nielsen, and Anna Stegger Gemzøe. 2019. "Gender Balance Initiatives in Research Funding: Barriers and Possible Measures to Increase the Share of Women within Natural Science and Technology." Research Memorandum Commissioned by Villum Fonden. https://vbn.aau.dk/en/publications/gender-balance-initiatives-in-research-funding-barriers-and-possi.

Fahey, Johannah, and Jane Kenway. 2010. "International Academic Mobility: Problematic and Possible Paradigms." *Discourse: Studies in the Cultural Politics of Education* 31 (5): 563–75. https://doi.org/10.1080/01596306.2010.516937.

Fang, Ferric C., and Arturo Casadevall. 2012. "Reforming Science: Structural Reforms." Edited by R. P. Morrison. *Infection and Immunity* 80 (3): 897. https://doi.org/10.1128/IAI.06184-11.

Fassa, F., and S. Kradolfer. 2013. "The Gendering of Excellence Through Quality Criteria: The Case of the Swiss National Science Foundation Professorships in Switzerland." *Tertiary Education and Management* 19 (3): 189–204. https://doi.org/10.1080/13583883.2013.793379.

Fell, C.B., and C.J. König. 2016. "Is There a Gender Difference in Scientific Collaboration? A Scientometric Examination of Co-Authorships among Industrial–Organizational Psychologists." *Scientometrics* 108 (1): 113–41. https://doi.org/10.1007/s11192-016-1967-5.

Fernandez-Mateo, Isabel, and Sarah Kaplan. 2018. "Gender and Organization Science: Introduction to a Virtual Special Issue." *Organization Science* 29 (6): 1229–36. https://doi.org/10.1287/orsc.2018.1249.

Fernández-Pérez, V., P.E. Alonso-Galicia, M.D.M. Fuentes-Fuentes, and L. Rodriguez-Ariza. 2014. "Business Social Networks and Academics' Entrepreneurial Intentions." *Industrial Management and Data Systems* 114 (2): 292–320. https://doi.org/10.1108/IMDS-02-2013-0076.

Fernando, D., and A. Prasad. 2019. "Sex-Based Harassment and Organizational Silencing: How Women Are Led to Reluctant Acquiescence in Academia." *Human Relations* 72 (10): 1565–94. https://doi.org/10.1177/0018726718809164.

Filandri, M., and S. Pasqua. 2019. "'Being Good Isn't Good Enough': Gender Discrimination in Italian Academia." *Studies in Higher Education*. https://doi.org/10.1080/03075079.2019.1693990.

Filardo, Giovanni, Briget da Graca, Danielle M Sass, Benjamin D Pollock, Emma B Smith, and Melissa Ashley-Marie Martinez. 2016. "Trends and Comparison of Female First Authorship in High Impact Medical Journals: Observational Study (1994-2014)." *BMJ* 352 (March): i847. https://doi.org/10.1136/bmj.i847.

Fine Eve, Sheridan Jennifer, Carnes Molly, Handelsman Jo, Pribbenow Christine, Savoy Julia, and Wendt Amy. 2014. "Minimizing the Influence of Gender Bias on the Faculty Search Process." In *Gender Transformation in the Academy*, 19:267–89. Advances in Gender Research. Emerald Group Publishing Limited. https://doi.org/10.1108/S1529-212620140000019012.

Fontes, Margarida, Pedro Videira, and Teresa Calapez. 2013. "The Impact of Long-Term Scientific Mobility on the Creation of Persistent Knowledge Networks." *Mobilities* 8 (3): 440–65. https://doi.org/10.1080/17450101.2012.655976.

Foote, Kenneth E., Wei Li, Janice Monk, and Rebecca Theobald. 2008. "Foreign-Born Scholars in US Universities: Issues, Concerns, and Strategies." *Journal of Geography in Higher Education* 32 (2): 167–78. https://doi.org/10.1080/03098260701731322.

Fotaki, Marianna. 2013. "No Woman Is Like a Man (in Academia): The Masculine Symbolic Order and the Unwanted Female Body." *Organization Studies* 34 (9): 1251–75. https://doi.org/10.1177/0170840613483658.

Fountain, J., and K.E. Newcomer. 2016. "Developing and Sustaining Effective Faculty Mentoring Programs." *Journal of Public Affairs Education* 22 (4): 483–506. https://doi.org/10.1080/15236803.2016.12002262.

Fox, Mary Frank, and Sushanta Mohapatra. 2007. "Social-Organizational Characteristics of Work and Publication Productivity among Academic Scientists in Doctoral-Granting Departments." *Journal of Higher Education* 78 (5): 542–71.

Frandsen, Tove Faber, Rasmus Højbjerg Jacobsen, and Jakob Ousager. 2020. "Gender Gaps in Scientific Performance: A Longitudinal Matching Study of Health Sciences Researchers." *Scientometrics* 124 (2): 1511–27. https://doi.org/10.1007/s11192-020-03528-z.

Franssen, T.P., and S. de Rijcke. 2019. "The Rise of Project Funding and Its Effects on the Social Structure of Academia." In *Fabian Cannizzo and Nick Osbaldiston (Eds.). The Social Structures of Global Academia*, 144–61. Routledge. https://doi.org/10.4324/9780429465857-9.

Franzoni, Chiara, Giuseppe Scellato, and Paula Stephan. 2014. "The Mover's Advantage: The Superior Performance of Migrant Scientists." *Economics Letters* 122 (1): 89–93. https://doi.org/10.1016/j.econlet.2013.10.040.

Fritsch, N.-S. 2015. "At the Leading Edge – Does Gender Still Matter? A Qualitative Study of Prevailing Obstacles and Successful Coping Strategies in Academia." *Current Sociology* 63 (4): 547–65. https://doi.org/10.1177/0011392115576527.

Gaiaschi, C., and R. Musumeci. 2020. "Just a Matter of Time? Women's Career Advancement in Neo-Liberal Academia. An Analysis of Recruitment Trends in Italian Universities." *Social Sciences* 9 (9). https://doi.org/10.3390/SOCSCI9090163.

Garner, J.G., A.L. Porter, N.C. Newman, and T.A. Crowl. 2012. "Assessing Research Network and Disciplinary Engagement Changes Induced by an NSF Program." *Research Evaluation* 21 (2): 89–104. https://doi.org/10.1093/reseval/rvs004.

George, R., and M. Maguire. 2020. "ACADEMICS 'STAYING ON' POST RETIREMENT AGE IN ENGLISH UNIVERSITY DEPARTMENTS OF EDUCATION: OPPORTUNITIES, THREATS AND EMPLOYMENT POLICIES." *British Journal of Educational Studies*. https://doi.org/10.1080/00071005.2020.1814951.

Ghaffarzadegan, N., and R. Xu. 2018. "Late Retirement, Early Careers, and the Aging of U.S. Science and Engineering Professors." *PLoS ONE* 13 (12). https://doi.org/10.1371/journal.pone.0208411.

Gibson, Chris, Tamantha Stutchbury, Victoria Ikutegbe, and Nicole Michielin. 2019. "Challenge-Led Interdisciplinary Research in Practice: Program Design, Early Career Research, and a Dialogic Approach to Building Unlikely Collaborations." *Research Evaluation* 28 (1): 51–62. https://doi.org/10.1093/reseval/rvy039.

Glass, C., and K.L. Minnotte. 2010. "Recruiting and Hiring Women in STEM Fields." *Journal of Diversity in Higher Education* 3 (4): 218–29. https://doi.org/10.1037/a0020581.

Gloor, J.L., X. Li, S. Lim, and A. Feierabend. 2018. “An Inconvenient Truth? Interpersonal and Career Consequences of ‘Maybe Baby’ Expectations.” *Journal of Vocational Behavior* 104: 44–58. https://doi.org/10.1016/j.jvb.2017.10.001.

Goel, Rajeev K., and Devrim Göktepe-Hultén. 2020. “Drivers of Innovation Productivity of Academic Researchers through Career Advancement.” *The Journal of Technology Transfer* 45 (2): 414–29. https://doi.org/10.1007/s10961-018-9689-x.

Goel, R.K., D. Göktepe-Hultén, and R. Ram. 2015. “Academics’ Entrepreneurship Propensities and Gender Differences.” *Journal of Technology Transfer* 40 (1): 161–77. https://doi.org/10.1007/s10961-014-9372-9.

González-Álvarez, Julio, and Teresa Cervera-Crespo. 2019. “Contemporary Psychology and Women: A Gender Analysis of the Scientific Production.” *International Journal of Psychology* 54 (1): 135–43. https://doi.org/10.1002/ijop.12433.

Goulden, M., M.A. Mason, and K. Frasch. 2011. “Keeping Women in the Science Pipeline.” *Annals of the American Academy of Political and Social Science* 638 (1): 141–62. https://doi.org/10.1177/0002716211416925.

Grogger, Jeffrey, and Gordon H. Hanson. 2015. “Attracting Talent: Location Choices of Foreign-Born PhDs in the United States.” *Journal of Labor Economics* 33 (S1): S5–38. https://doi.org/10.1086/679062.

Guarino, Cassandra M., and Victor M. H. Borden. 2017. “Faculty Service Loads and Gender: Are Women Taking Care of the Academic Family?” *Research in Higher Education* 58 (6): 672–94. https://doi.org/10.1007/s11162-017-9454-2.

Guthrie, Susan, Ioana Ghiga, and Steven Wooding. 2018. “What Do We Know about Grant Peer Review in the Health Sciences?” *F1000Research* 6 (March): 1335. https://doi.org/10.12688/f1000research.11917.2.

Hallonsten, O., and O. Hugander. 2014. “Supporting ‘future Research Leaders’ in Sweden: Institutional Isomorphism and Inadvertent Funding Agglomeration.” *Research Evaluation* 23 (3): 249–60. https://doi.org/10.1093/reseval/rvu009.

Hardy, A., J. McDonald, R. Guijt, E. Leane, A. Martin, A. James, M. Jones, M. Corban, and B. Green. 2018. “Academic Parenting: Work–Family Conflict and Strategies across Child Age, Disciplines and Career Level.” *Studies in Higher Education* 43 (4): 625–43. https://doi.org/10.1080/03075079.2016.1185777.

Harford, J. 2018. “The Perspectives of Women Professors on the Professoriate: A Missing Piece in the Narrative on Gender Equality in the University.” *Education Sciences* 8 (2). https://doi.org/10.3390/educsci8020050.

Healey, R.L., and C. Davies. 2019. “Conceptions of ‘Research’ and Their Gendered Impact on Research Activity: A UK Case Study.” *Higher Education Research and Development* 38 (7): 1386–1400. https://doi.org/10.1080/07294360.2019.1657804.

Hechtman, L.A., N.P. Moore, C.E. Schulkey, A.C. Miklos, A.M. Calcagno, R. Aragon, and J.H. Greenberg. 2018. “NIH Funding Longevity by Gender.” *Proceedings of the National Academy of Sciences of the United States of America* 115 (31): 7943–48. https://doi.org/10.1073/pnas.1800615115.

Heesen, R. 2019. “The Credit Incentive to Be a Maverick.” *Studies in History and Philosophy of Science Part A* 76: 5–12. https://doi.org/10.1016/j.shpsa.2018.11.007.

Heffernan, T.A., and A. Heffernan. 2019. “The Academic Exodus: The Role of Institutional Support in Academics Leaving Universities and the Academy.” *Professional Development in Education* 45 (1): 102–13. https://doi.org/10.1080/19415257.2018.1474491.

Heijstra, T., T. Bjarnason, and G.L. Rafnsdóttir. 2015. “Predictors of Gender Inequalities in the Rank of Full Professor.” *Scandinavian Journal of Educational Research* 59 (2): 214–30. https://doi.org/10.1080/00313831.2014.904417.

Heilman, Madeline E. 2001. “Description and Prescription: How Gender Stereotypes Prevent Women’s Ascent Up the Organizational Ladder.” *Journal of Social Issues* 57 (4): 657–74. https://doi.org/10.1111/0022-4537.00234.

Helgesson, K.S., and E. Sjögren. 2019. “No Finish Line: How Formalization of Academic Assessment Can Undermine Clarity and Increase Secrecy.” *Gender, Work and Organization* 26 (4): 558–81. https://doi.org/10.1111/gwao.12355.

Henderson, E.F., and M.-P. Moreau. 2020. “Carefree Conferences? Academics with Caring Responsibilities Performing Mobile Academic Subjectivities.” *Gender and Education* 32 (1): 70–85. https://doi.org/10.1080/09540253.2019.1685654.

Herschberg, C., Y. Benschop, and M. van den Brink. 2018. “Selecting Early-Career Researchers: The Influence of Discourses of Internationalisation and Excellence on Formal and Applied Selection Criteria in Academia.” *Higher Education* 76 (5): 807–25. https://doi.org/10.1007/s10734-018-0237-2.

Hicks, Diana, Paul Wouters, Ludo Waltman, Sarah de Rijcke, and Ismael Rafols. 2015. “Bibliometrics: The Leiden Manifesto for Research Metrics.” *Nature News* 520 (7548): 429. https://doi.org/10.1038/520429a.

Hill, M.E. 2020. “‘You Can Have It All, Just Not at the Same Time’: Why Doctoral Students Are Actively Choosing Singlehood.” *Gender Issues* 37 (4): 315–39. https://doi.org/10.1007/s12147-020-09249-0.

Hillard, A.L., T.R. Schneider, S.M. Jackson, and D. LaHuis. 2014. *Critical Mass or Incremental Change? The Effects of Faculty Gender Composition in Stem*. Vol. 19. Advances in Gender Research. https://doi.org/10.1108/S1529-212620140000019016.

Holman, L., and C. Morandin. 2019. “Researchers Collaborate with Same-Gendered Colleagues More Often than Expected across the Life Sciences.” *PLoS ONE* 14 (4). https://doi.org/10.1371/journal.pone.0216128.

Hoorens, V., G. Dekkers, and E. Deschrijver. 2020. “Gender Bias in Student Evaluations of Teaching: Students’ Self-Affirmation Reduces the Bias by Lowering Evaluations of Male Professors.” *Sex Roles*. https://doi.org/10.1007/s11199-020-01148-8.

Horlings, Edwin, and Thomas Gurney. 2013. “Search Strategies along the Academic Lifecycle.” *Scientometrics* 94 (3): 1137–60. https://doi.org/10.1007/s11192-012-0789-3.

Horta, H., and J.M. Santos. 2016a. “An Instrument to Measure Individuals’ Research Agenda Setting: The Multi-Dimensional Research Agendas Inventory.” *Scientometrics* 108 (3): 1243–65. https://doi.org/10.1007/s11192-016-2012-4.

———. 2016b. “The Impact of Publishing During PhD Studies on Career Research Publication, Visibility, and Collaborations.” *Research in Higher Education* 57 (1): 28–50. https://doi.org/10.1007/s11162-015-9380-0.

Hosek, Susan D., Amy G. Cox, Bonnie Ghosh-Dastidar, Aaron Kofner, Nishal Ray Ramphal, Jon Scott, and Sandra H. Berry. 2005. *Gender Differences in Major Federal External Grant Programs*. RAND Corporation. https://www.rand.org/pubs/technical_reports/TR307.html.

Hottenrott, H., and C. Lawson. 2017. “Flying the Nest: How the Home Department Shapes Researchers’ Career Paths.” *Studies in Higher Education* 42 (6): 1091–1109. https://doi.org/10.1080/03075079.2015.1076782.

Huang, Junming, Alexander J. Gates, Roberta Sinatra, and Albert-László Barabási. 2020. “Historical Comparison of Gender Inequality in Scientific Careers across Countries and Disciplines.” *Proceedings of the National Academy of Sciences*. https://doi.org/10.1073/pnas.1914221117.

Huisman, Jeroen, Egbert de Weert, and Jeroen Bartelse. 2002. “Academic Careers from a European Perspective.” *Journal of Higher Education* 73 (1): 141–60.

Hunter, L.A., and E. Leahey. 2010. “Parenting and Research Productivity: New Evidence and Methods.” *Social Studies of Science* 40 (3): 433–51. https://doi.org/10.1177/0306312709358472.

Hyde, Janet Shibley, and Marcia C. Linn. 2006. “Gender Similarities in Mathematics and Science.” *Science* 314 (5799): 599. https://doi.org/10.1126/science.1132154.

Iffländer, V., A. Sinell, and M. Schraudner. 2018. *Does Gender Make a Difference? Gender Differences in the Motivations and Strategies of Female and Male Academic Entrepreneurs*. FGF Studies in Small Business and Entrepreneurship. https://doi.org/10.1007/978-3-319-96373-0_4.

Ismail, Sharif, Alice Farrands, and Steven Wooding. 2009. *Evaluating Grant Peer Review in the Health Sciences: A Review of the Literature*. RAND Corporation. https://doi.org/10.7249/TR742.

Jaeger-Erben, M., J. Kramm, M. Sonnberger, C. Völker, C. Albert, A. Graf, K. Hermans, et al. 2018. “Building Capacities for Transdisciplinary Research Challenges and Recommendations for Early-Career Researchers.” *GAIA* 27 (4): 379–86. https://doi.org/10.14512/gaia.27.4.10.

Jagsi, Reshma, Elizabeth A. Guancial, Cynthia Cooper Worobey, Lori E. Henault, Yuchiao Chang, Rebecca Starr, Nancy J. Tarbell, and Elaine M. Hylek. 2006. “The ‘Gender Gap’ in Authorship of Academic Medical Literature — A 35-Year Perspective.” *New England Journal of Medicine* 355 (3): 281–87. https://doi.org/10.1056/NEJMsa053910.

James, Katy L., Nicola P. Randall, and Neal R. Haddaway. 2016. “A Methodology for Systematic Mapping in Environmental Sciences.” *Environmental Evidence* 5 (1): 7. https://doi.org/10.1186/s13750-016-0059-6.

Jappelli, T., C.A. Nappi, and R. Torrini. 2017. “Gender Effects in Research Evaluation.” *Research Policy* 46 (5): 911–24. https://doi.org/10.1016/j.respol.2017.03.002.

Javdani, M., and A. McGee. 2019. “Moving Up or Falling Behind? Gender, Promotions, and Wages in Canada.” *Industrial Relations* 58 (2): 189–228. https://doi.org/10.1111/irel.12231.

Jefferson, Tom, Philip Alderson, Elizabeth Wager, and Frank Davidoff. 2002. “Effects of Editorial Peer Review: A Systematic Review.” *JAMA* 287 (21): 2784–86. https://doi.org/10.1001/jama.287.21.2784.

Jenkins, K. 2020. “Academic Motherhood and Fieldwork: Juggling Time, Emotions, and Competing Demands.” *Transactions of the Institute of British Geographers* 45 (3): 693–704. https://doi.org/10.1111/tran.12376.

Jenner, Sabine, Pia Djermester, Judith Prügl, Christine Kurmeyer, and Sabine Oertelt-Prigione. 2019. “Prevalence of Sexual Harassment in Academic Medicine.” *JAMA Internal Medicine* 179 (1): 108–11. https://doi.org/10.1001/jamainternmed.2018.4859.

Joecks, J., K. Pull, and U. Backes-Gellner. 2014. “Childbearing and (Female) Research Productivity: A Personnel Economics Perspective on the Leaky Pipeline.” *Journal of Business Economics* 84 (4): 517–30. https://doi.org/10.1007/s11573-013-0676-2.

Johnson, Joy, Zena Sharman, Bilkis Vissandjée, and Donna E. Stewart. 2014. “Does a Change in Health Research Funding Policy Related to the Integration of Sex and Gender Have an Impact?” *PLOS ONE* 9 (6): e99900. https://doi.org/10.1371/journal.pone.0099900.

Johnson, S.J., S.M. Willis, and J. Evans. 2019. “An Examination of Stressors, Strain, and Resilience in Academic and Non-Academic U.K. University Job Roles.” *International Journal of Stress Management* 26 (2): 162–72. https://doi.org/10.1037/str0000096.

Jones, R.D., K.A. Griffith, P.A. Ubel, A. Stewart, and R. Jagsi. 2016. “A Mixed-Methods Investigation of the Motivations, Goals, and Aspirations of Male and Female Academic Medical Faculty.” *Academic Medicine* 91 (8): 1089–97. https://doi.org/10.1097/ACM.0000000000001244.

Jonkers, Koen, and Laura Cruz-Castro. 2013. “Research upon Return: The Effect of International Mobility on Scientific Ties, Production and Impact.” *Research Policy* 42 (8): 1366–77. https://doi.org/10.1016/j.respol.2013.05.005.

Jöns, H. 2011. “Transnational Academic Mobility and Gender.” *Globalisation, Societies and Education* 9 (2): 183–209. https://doi.org/10.1080/14767724.2011.577199.

Joshi, A. 2014. “By Whom and When Is Women’s Expertise Recognized? The Interactive Effects of Gender and Education in Science and Engineering Teams.” *Administrative Science Quarterly* 59 (2): 202–39. https://doi.org/10.1177/0001839214528331.

Juraqulova, Z.H., J.J. McCluskey, and R.C. Mittelhammer. 2019. “Work–Life Policies and Female Faculty Representation in US Doctoral-Granting Economics Departments.” *Industrial Relations Journal* 50 (2): 168–96. https://doi.org/10.1111/irj.12246.

Kaatz, A., B. Gutierrez, and M. Carnes. 2014. "Threats to Objectivity in Peer Review: The Case of Gender." *Trends in Pharmacological Sciences* 35 (8): 371–73. https://doi.org/10.1016/j.tips.2014.06.005.

Kaatz, Anna, You-Geon Lee, Aaron Potvien, Wairimu Magua, Amarette Filut, Anupama Bhattacharya, Renee Leatherberry, Xiaojin Zhu, and Molly Carnes. 2016. "Analysis of National Institutes of Health R01 Application Critiques, Impact, and Criteria Scores: Does the Sex of the Principal Investigator Make a Difference?" *Academic Medicine* 91 (8): 1080–88. https://doi.org/10.1097/ACM.0000000000001272.

Kaiser, K.A., and T.C. Pratt. 2016. "Crystal Ball or Moneyball: Does Publishing Success during Graduate School Predict Career Publication Productivity?" *Journal of Crime and Justice* 39 (3): 438–54. https://doi.org/10.1080/0735648X.2014.992801.

Katz, Y., and U. Matter. 2019. "Metrics of Inequality: The Concentration of Resources in the U.S. Biomedical Elite." *Science as Culture*. https://doi.org/10.1080/09505431.2019.1694882.

Kelly, B.T., and J.S. Fetridge. 2012. "The Role of Students in the Experience of Women Faculty on the Tenure Track." *NASPA Journal About Women in Higher Education* 5 (1): 22–45. https://doi.org/10.1515/1940-7890.1095.

Kelly, K., and L. Grant. 2012. "Penalties and Premiums: The Impact of Gender, Marriage, and Parenthood on Faculty Salaries in Science, Engineering and Mathematics (Sem) and Non-Sem Fields." *Social Studies of Science* 42 (6): 869–96. https://doi.org/10.1177/0306312712457111.

Kim, D., L. Wolf-Wendel, and S. Twombly. 2011. "International Faculty: Experiences of Academic Life and Productivity in U.S. Universities." *Journal of Higher Education* 82 (6): 720–47. https://doi.org/10.1353/jhe.2011.0038.

Kindsiko, E., and Y. Baruch. 2019. *Journal of Vocational Behavior* 112: 122–40. https://doi.org/10.1016/j.jvb.2019.01.010.

King, Molly M., Carl T. Bergstrom, Shelley J. Correll, Jennifer Jacquet, and Jevin D. West. 2017. "Men Set Their Own Cites High: Gender and Self-Citation across Fields and over Time." *Socius* 3 (January): 2378023117738903. https://doi.org/10.1177/2378023117738903.

Kloß, S.T. 2017. "Sexual(Ized) Harassment and Ethnographic Fieldwork: A Silenced Aspect of Social Research." *Ethnography* 18 (3): 396–414. https://doi.org/10.1177/1466138116641958.

Kolesnikov, Sergey, Eriko Fukumoto, and Barry Bozeman. 2018. "Researchers' Risk-Smoothing Publication Strategies: Is Productivity the Enemy of Impact?" *Scientometrics*, June, 1–23. https://doi.org/10.1007/s11192-018-2793-8.

Kolev, Julian, Yuly Fuentes-Medel, and Fiona Murray. 2019. "Is Blinded Review Enough? How Gendered Outcomes Arise Even Under Anonymous Evaluation." Working Paper 25759. National Bureau of Economic Research. https://doi.org/10.3386/w25759.

Kozhevnikov, Maria, Carol Evans, and Stephen M. Kosslyn. 2014. "Cognitive Style as Environmentally Sensitive Individual Differences in Cognition: A Modern Synthesis and Applications in Education, Business, and Management." *Psychological Science in the Public Interest* 15 (1): 3–33. https://doi.org/10.1177/1529100614525555.

Krapf, M., H.W. Ursprung, and C. Zimmermann. 2017. "Parenthood and Productivity of Highly Skilled Labor: Evidence from the Groves of Academe." *Journal of Economic Behavior and Organization* 140: 147–75. https://doi.org/10.1016/j.jebo.2017.05.010.

Kretschmer, H., and T. Kretschmer. 2013. "Gender Bias and Explanation Models for the Phenomenon of Women's Discriminations in Research Careers." *Scientometrics* 97 (1): 25–36. https://doi.org/10.1007/s11192-013-1023-7.

Kulis, Stephen, and Diane Sicotte. 2002. "Women Scientists in Academia: Geographically Constrained to Big Cities, College Clusters, or the Coasts?" *Research in Higher Education* 43 (1): 1–30. https://doi.org/10.1023/A:1013097716317.

Kulp, A.M., L.E. Wolf-Wendel, and D.G. Smith. 2019. "The Possibility of Promotion: How Race and Gender Predict Promotion Clarity for Associate Professors." *Teachers College Record* 121 (5). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85065772593&partnerID=40&md5=85f0ecc74da7545a7d3c5b656439745d.

Kummerfeld, Erich, and Kevin J. S. Zollman. 2016. "Conservatism and the Scientific State of Nature." *The British Journal for the Philosophy of Science* 67 (4): 1057–76. https://doi.org/10.1093/bjps/axv013.

Kwiek, M. 2016. "The European Research Elite: A Cross-National Study of Highly Productive Academics in 11 Countries." *Higher Education* 71 (3): 379–97. https://doi.org/10.1007/s10734-015-9910-x.

Kyvik, S., and D.W. Aksnes. 2015. "Explaining the Increase in Publication Productivity among Academic Staff: A Generational Perspective." *Studies in Higher Education* 40 (8): 1438–53. https://doi.org/10.1080/03075079.2015.1060711.

Kyvik, Svein, and Mari Teigen. 1996. "Child Care, Research Collaboration, and Gender Differences in Scientific Productivity." *Science, Technology, & Human Values* 21 (1): 54–71. https://doi.org/10.1177/016224399602100103.

Larivière, Vincent, Chaoqun Ni, Yves Gingras, Blaise Cronin, and Cassidy R. Sugimoto. 2013. "Bibliometrics: Global Gender Disparities in Science." *Nature News* 504 (7479): 211. https://doi.org/10.1038/504211a.

Larivière, Vincent, Etienne Vignola-Gagné, Christian Villeneuve, Pascal Gélinas, and Yves Gingras. 2011. "Sex Differences in Research Funding, Productivity and Impact: An Analysis of Québec University Professors." *Scientometrics* 87 (3): 483–98. https://doi.org/10.1007/s11192-011-0369-y.

Laudel, G., and J. Bielick. 2018. "The Emergence of Individual Research Programs in the Early Career Phase of Academics." *Science Technology and Human Values* 43 (6): 972–1010. https://doi.org/10.1177/0162243918763100.

Laudel, Grit, and Jochen Gläser. 2014. "Beyond Breakthrough Research: Epistemic Properties of Research and Their Consequences for Research Funding." *Research Policy* 43 (7): 1204–16. https://doi.org/10.1016/j.respol.2014.02.006.

Lauring, Jakob, and Florence Villesèche. 2019. "The Performance of Gender Diverse Teams: What Is the Relation between Diversity Attitudes and Degree of Diversity?" *European Management Review* 16 (2): 243–54. https://doi.org/10.1111/emre.12164.

Lawson, Cornelia, Ammon Salter, Alan Hughes, and Michael Kitson. 2019. "Citizens of Somewhere: Examining the Geography of Foreign and Native-Born Academics' Engagement with External Actors." *Research Policy* 48 (3): 759–74. https://doi.org/10.1016/j.respol.2018.11.008.

Leahey, Erin. 2006. "Gender Differences in Productivity: Research Specialization as a Missing Link." *Gender & Society* 20 (6): 754–80. https://doi.org/10.1177/0891243206293030.

Leahey, Erin, Christine M. Beckman, and Taryn L. Stanko. 2017. "Prominent but Less Productive: The Impact of Interdisciplinarity on Scientists' Research." *Administrative Science Quarterly* 62 (1): 105–39. https://doi.org/10.1177/0001839216665364.

Leberman, S.I., B. Eames, and S. Barnett. 2016. "'Unless You Are Collaborating with a Big Name Successful Professor, You Are Unlikely to Receive Funding.'" *Gender and Education* 28 (5): 644–61. https://doi.org/10.1080/09540253.2015.1093102.

Lee, D.H. 2019. "Predicting the Research Performance of Early Career Scientists." *Scientometrics* 121 (3): 1481–1504. https://doi.org/10.1007/s11192-019-03232-7.

Lee, Romy van der, and Naomi Ellemers. 2015a. "Gender Contributes to Personal Research Funding Success in The Netherlands." *Proceedings of the National Academy of Sciences* 112 (40): 12349. https://doi.org/10.1073/pnas.1510159112.

———. 2015b. "Reply to Albers: Acceptance of Empirical Evidence for Gender Disparities in Dutch Research Funding." *Proceedings of the National Academy of Sciences* 112 (50): E6830. https://doi.org/10.1073/pnas.1521336112.

———. 2015c. "Reply to Volker and Steenbeek: Multiple Indicators Point toward Gender Disparities in Grant Funding Success in The Netherlands." *Proceedings of the National Academy of Sciences* 112 (51): E7038. https://doi.org/10.1073/pnas.1521331112.

Lee, S. 2004. *Foreign-Born Scientists in the United States – Do They Perform Differently than Native-Born Scientists? Doctoral Dissertation, Georgia Institute of Technology.* Dissertation and Theses: A&I AAT 3155279.

Lee, Y.-J., and D. Won. 2014. "Trailblazing Women in Academia: Representation of Women in Senior Faculty and the Gender Gap in Junior Faculty's Salaries in Higher Educational Institutions." *Social Science Journal* 51 (3): 331–40. https://doi.org/10.1016/j.soscij.2014.05.002.

Legato, Marianne J., Paula A. Johnson, and JoAnn E. Manson. 2016. "Consideration of Sex Differences in Medicine to Improve Health Care and Patient Outcomes." *JAMA* 316 (18): 1865–66. https://doi.org/10.1001/jama.2016.13995.

Lepori, B., M. Seeber, and A. Bonaccorsi. 2015. "Competition for Talent. Country and Organizational-Level Effects in the Internationalization of European Higher Education Institutions." *Research Policy* 44 (3): 789–802. https://doi.org/10.1016/j.respol.2014.11.004.

Lerchenmueller, Carolin, Marc J. Lerchenmueller, and Olav Sorenson. 2018. "Long-Term Analysis of Sex Differences in Prestigious Authorships in Cardiovascular Research Supported by the National Institutes of Health." *Circulation* 137 (8): 880–82. https://doi.org/10.1161/CIRCULATIONAHA.117.032325.

Lerchenmueller, Marc J., Olav Sorenson, and Anupam B. Jena. 2019. "Gender Differences in How Scientists Present the Importance of Their Research: Observational Study." *BMJ* 367 (December). https://doi.org/10.1136/bmj.l6573.

Lerchenmueller, M.J., and O. Sorenson. 2018. "The Gender Gap in Early Career Transitions in the Life Sciences." *Research Policy* 47 (6): 1007–17. https://doi.org/10.1016/j.respol.2018.02.009.

Leslie, Sarah-Jane, Andrei Cimpian, Meredith Meyer, and Edward Freeland. 2015. "Expectations of Brilliance Underlie Gender Distributions across Academic Disciplines." *Science* 347 (6219): 262. https://doi.org/10.1126/science.1261375.

Ley, Timothy J., and Barton H. Hamilton. 2008. "The Gender Gap in NIH Grant Applications." *Science* 322 (5907): 1472–74. https://doi.org/10.1126/science.1165878.

Leydesdorff, L., and I. Ivanova. 2020. "The Measurement of 'Interdisciplinarity' and 'Synergy' in Scientific and Extra-Scientific Collaborations." *Journal of the Association for Information Science and Technology*. https://doi.org/10.1002/asi.24416.

Li, Weihua, Tomaso Aste, Fabio Caccioli, and Giacomo Livan. 2019. "Early Coauthorship with Top Scientists Predicts Success in Academic Careers." *Nature Communications* 10 (1): 5170. https://doi.org/10.1038/s41467-019-13130-4.

Libaers, Dirk. 2014. "Foreign-Born Academic Scientists and Their Interactions with Industry: Implications for University Technology Commercialization and Corporate Innovation Management." *Journal of Product Innovation Management* 31 (2): 346–60. https://doi.org/10.1111/jpim.12099.

Light Ryan. 2013. "Gender Inequality and the Structure of Occupational Identity: The Case of Elite Sociological Publication." In *Networks, Work and Inequality*, edited by Steve Mcdonald, 24:239–68. Research in the Sociology of Work. Emerald Group Publishing Limited. https://doi.org/10.1108/S0277-2833(2013)0000024012.

Lindahl, Jonas, Cristian Colliander, and Rickard Danell. 2020. "Early Career Performance and Its Correlation with Gender and Publication Output during Doctoral Education." *Scientometrics* 122 (1): 309–30. https://doi.org/10.1007/s11192-019-03262-1.

Link, Albert N., Donald Siegel, and Barry Bozeman. 2007. "An Empirical Analysis of the Propensity of Academics to Engage in Informal University Technology Transfer." *Industrial and Corporate Change* 16 (4): 641–55. https://doi.org/10.1093/icc/dtm020.

Link, Albert N., and Derek R. Strong. 2016. "Gender and Entrepreneurship: An Annotated Bibliography." *Foundations and Trends® in Entrepreneurship* 12 (4–5): 287–441. https://doi.org/10.1561/0300000068.

Lipton, B. 2020. *Cruel Measures: Gendered Excellence in Research*. Palgrave Studies in Gender and Education. https://doi.org/10.1007/978-3-030-45062-5_3.

Liu, Y., I. Rafols, and R. Rousseau. 2012. "A Framework for Knowledge Integration and Diffusion." *Journal of Documentation* 68 (1): 31–44. https://doi.org/10.1108/00220411211200310.

Long, J. Scott. 1992. “Measures of Sex Differences in Scientific Productivity.” *Social Forces* 71 (1): 159–78. https://doi.org/10.2307/2579971.

Lörz, M., and K. Mühleck. 2019. “Gender Differences in Higher Education from a Life Course Perspective: Transitions and Social Inequality between Enrolment and First Post-Doc Position.” *Higher Education* 77 (3): 381–402. https://doi.org/10.1007/s10734-018-0273-y.

Lubitow, A., and K. Zippel. 2014. *Strategies of Academic Parents to Manage Work-Life Conflict in Research Abroad*. Vol. 19. Advances in Gender Research. https://doi.org/10.1108/S1529-212620140000019003.

Lyall, C., L. Meagher, and A. Bruce. 2015. “A Rose by Any Other Name? Transdisciplinarity in the Context of UK Research Policy.” *Futures* 65: 150–62. https://doi.org/10.1016/j.futures.2014.08.009.

Lynch, K., M. Ivancheva, M. O’Flynn, K. Keating, and M. O’Connor. 2020. “The Care Ceiling in Higher Education.” *Irish Educational Studies* 39 (2): 157–74. https://doi.org/10.1080/03323315.2020.1734044.

Lynn, C.D., M.E. Howells, and M.J. Stein. 2018. “Family and the Field: Expectations of a Field-Based Research Career Affect Researcher Family Planning Decisions.” *PLoS ONE* 13 (9). https://doi.org/10.1371/journal.pone.0203500.

Ma, Y., S. Mukherjee, and B. Uzzi. 2020. “Mentorship and Protégé Success in STEM Fields.” *Proceedings of the National Academy of Sciences of the United States of America* 117 (25): 14077–83. https://doi.org/10.1073/pnas.1915516117.

Ma, Y., C. Pang, H. Chen, N. Chi, and Y. Li. 2014. “Interdisciplinary Cooperation and Knowledge Creation Quality: A Perspective of Recombinatory Search.” *Systems Research and Behavioral Science* 31 (1): 115–26. https://doi.org/10.1002/sres.2163.

Mairesse, J., M. Pezzoni, and F. Visentin. 2019. “Impact of Family Characteristics on the Gender Publication Gap: Evidence for Physicists in France.” *Interdisciplinary Science Reviews* 44 (2): 204–20. https://doi.org/10.1080/03080188.2019.1603884.

Mairesse, Jacques, and Michele Pezzoni. 2015. “Does Gender Affect Scientific Productivity ?A Critical Review of the Empirical Evidence and a Panel Data Econometric Analysis for French Physicists.” *Revue économique* 66 (1): 65–113. https://doi.org/10.3917/reco.661.0065.

Mamiseishvili, Ketevan, and Vicki J. Rosser. 2009. “International and Citizen Faculty in the United States: An Examination of Their Productivity at Research Universities.” *Research in Higher Education* 51 (1): 88. https://doi.org/10.1007/s11162-009-9145-8.

Maranto, C.L., and A.E.C. Griffin. 2011. “The Antecedents of a ‘chilly Climate’ for Women Faculty in Higher Education.” *Human Relations* 64 (2): 139–59. https://doi.org/10.1177/0018726710377932.

Marchant, T., and M. Wallace. 2016. “Gender Balance in Teaching Awards: Evidence from 18 Years of National Data.” *Journal of Higher Education Policy and Management* 38 (4): 393–405. https://doi.org/10.1080/1360080X.2016.1181885.

Marsh, Herbert W., Lutz Bornmann, Rüdiger Mutz, Hans-Dieter Daniel, and Alison O’Mara. 2009. “Gender Effects in the Peer Reviews of Grant Proposals: A Comprehensive Meta-Analysis Comparing Traditional and Multilevel Approaches.” *Review of Educational Research* 79 (3): 1290–1326. https://doi.org/10.3102/0034654309334143.

Marsh, Herbert W., Upali W. Jayasinghe, and Nigel W. Bond. 2011. “Gender Differences in Peer Reviews of Grant Applications: A Substantive-Methodological Synergy in Support of the Null Hypothesis Model.” *Journal of Informetrics* 5 (1): 167–80. https://doi.org/10.1016/j.joi.2010.10.004.

Martell, Richard F., Cynthia G. Emrich, and James Robison-Cox. 2012. “From Bias to Exclusion: A Multilevel Emergent Theory of Gender Segregation in Organizations.” *Research in Organizational Behavior* 32 (January): 137–62. https://doi.org/10.1016/j.riob.2012.10.001.

Martin Reinhart. 2009. “Peer Review of Grant Applications in Biology and Medicine. Reliability, Fairness, and Validity.” *Scientometrics* 81 (3): 789–809. https://doi.org/10.1007/s11192-008-2220-7.

Martín-Alcázar, F., M. Ruiz-Martínez, and G. Sánchez-Gardey. 2020a. “Deepening the Consequences of Multidisciplinarity on Research: The Moderating Role of Social Capital.” *Minerva*. https://doi.org/10.1007/s11024-020-09404-7.

———. 2020b. “The Performance of Researchers in Multidisciplinary Research Groups: Does Social Capital Matter?” *International Review of Administrative Sciences*. https://doi.org/10.1177/0020852320919487.

Matanle, P., and E. Mcintosh. 2020. “International Mobility for Early Career Academics: Does It Help or Hinder Career Formation in Japanese Studies?” *Japan Forum*. https://doi.org/10.1080/09555803.2020.1792534.

Maximova-Mentzoni, T., and C. Egeland. 2019. “Nationality Diversity in Academia: What Is the Problem Represented to Be?” *Nordic Journal of Working Life Studies* 9 (3): 3–23. https://doi.org/10.18291/njwls.v9i3.116054.

McAlpine, L. 2016. “Becoming a PI: From ‘Doing’ to ‘Managing’ Research.” *Teaching in Higher Education* 21 (1): 49–63. https://doi.org/10.1080/13562517.2015.1110789.

McAlpine, Lynn, and Esma Emmioğlu. 2015. “Navigating Careers: Perceptions of Sciences Doctoral Students, Post-PhD Researchers and Pre-Tenure Academics.” *Studies in Higher Education* 40 (10): 1770–85. https://doi.org/10.1080/03075079.2014.914908.

McCutcheon, J.M., and M.A. Morrison. 2016. “‘eight Days a Week’: A National Snapshot of Academic Mothers’ Realities in Canadian Psychology Departments.” *Canadian Psychology* 57 (2): 92–100. https://doi.org/10.1037/cap0000049.

———. 2018. “It’s ‘like Walking on Broken Glass’: Pan-Canadian Reflections on Work–Family Conflict from Psychology Women Faculty and Graduate Students.” *Feminism and Psychology* 28 (2): 231–52. https://doi.org/10.1177/0959353517739641.

McKay, L., and S. Monk. 2017. “Early Career Academics Learning the Game in Whackademia.” *Higher Education Research and Development* 36 (6): 1251–63. https://doi.org/10.1080/07294360.2017.1303460.

Meng, Y. 2016. "Collaboration Patterns and Patenting: Exploring Gender Distinctions." *Research Policy* 45 (1): 56–67. https://doi.org/10.1016/j.respol.2015.07.004.

Meyer, M., A. Cimpian, and S.-J. Leslie. 2015. "Women Are Underrepresented in Fields Where Success Is Believed to Require Brilliance." *Frontiers in Psychology* 6 (MAR). https://doi.org/10.3389/fpsyg.2015.00235.

Miake-Lye, Isomi M., Susanne Hempel, Roberta Shanman, and Paul G. Shekelle. 2016. "What Is an Evidence Map? A Systematic Review of Published Evidence Maps and Their Definitions, Methods, and Products." *Systematic Reviews* 5 (1): 28. https://doi.org/10.1186/s13643-016-0204-x.

Millard, Debbie. 2005. "THE IMPACT OF CLUSTERING ON SCIENTIFIC MOBILITY." *Innovation: The European Journal of Social Science Research* 18 (3): 343–59. https://doi.org/10.1080/13511610500186714.

Miller Alan N., Taylor Shannon G., and Bedeian Arthur G. 2011. "Publish or Perish: Academic Life as Management Faculty Live It." *Career Development International* 16 (5): 422–45. https://doi.org/10.1108/13620431111167751.

Miller, C., and J. Roksa. 2020. "Balancing Research and Service in Academia: Gender, Race, and Laboratory Tasks." *Gender and Society* 34 (1): 131–52. https://doi.org/10.1177/0891243219867917.

Milojevic, S., F. Radicchi, and J.P. Walsh. 2018. "Changing Demographics of Scientific Careers: The Rise of the Temporary Workforce." *Proceedings of the National Academy of Sciences of the United States of America* 115 (50): 12616–23. https://doi.org/10.1073/pnas.1800478115.

Minello, A., S. Martucci, and L.K.C. Manzo. 2020. "The Pandemic and the Academic Mothers: Present Hardships and Future Perspectives." *European Societies*. https://doi.org/10.1080/14616696.2020.1809690.

Miner, K.N., S.C. January, K.K. Dray, and A.R. Carter-Sowell. 2019. "Is It Always This Cold? Chilly Interpersonal Climates as a Barrier to the Well-Being of Early-Career Women Faculty in STEM." *Equality, Diversity and Inclusion* 38 (2): 226–45. https://doi.org/10.1108/EDI-07-2018-0127.

Miranda, F.J., A. Chamorro-Mera, S. Rubio, and J. Pérez-Mayo. 2017. "Academic Entrepreneurial Intention: The Role of Gender." *International Journal of Gender and Entrepreneurship* 9 (1): 66–86. https://doi.org/10.1108/IJGE-10-2016-0037.

Mirick, R.G., and S. Wladkowski. 2020. "Women's Experiences with Parenting during Doctoral Education: Impact on Career Trajectory." *International Journal of Doctoral Studies* 15: 89–110. https://doi.org/10.28945/4484.

Mishra, Shubhanshu, Brent D. Fegley, Jana Diesner, and Vetle I. Torvik. 2018. "Self-Citation Is the Hallmark of Productive Authors, of Any Gender." *PLOS ONE* 13 (9): e0195773. https://doi.org/10.1371/journal.pone.0195773.

Misra, J., L. Smith-Doerr, N. Dasgupta, G. Weaver, and J. Normanly. 2017. "Collaboration and Gender Equity among Academic Scientists." *Social Sciences* 6 (1). https://doi.org/10.3390/socsci6010025.

Misra, Joya, Jennifer Hickes Lundquist, and Abby Templer. 2012. "Gender, Work Time, and Care Responsibilities Among Faculty." *Sociological Forum* 27 (2): 300–323. https://doi.org/10.1111/j.1573-7861.2012.01319.x.

Mitchell, K.M.W., and J. Martin. 2018. "Gender Bias in Student Evaluations." *PS - Political Science and Politics* 51 (3): 648–52. https://doi.org/10.1017/S104909651800001X.

Mitchell, Sara McLaughlin, and Vicki L. Hesli. 2013. "Women Don't Ask? Women Don't Say No? Bargaining and Service in the Political Science Profession." *PS: Political Science & Politics* 46 (2): 355–69. https://doi.org/10.1017/S1049096513000073.

Moore, S., C. Neylon, M. Paul Eve, D. Paul O'Donnell, and D. Pattinson. 2017. "'Excellence R Us': University Research and the Fetishisation of Excellence." *Palgrave Communications* 3 (1). https://doi.org/10.1057/palcomms.2016.105.

Moore, Samuel, Cameron Neylon, Martin Paul Eve, Daniel Paul O'Donnell, and Damian Pattinson. 2017. "'Excellence R Us': University Research and the Fetishisation of Excellence." *Palgrave Communications* 3 (January): 16105. https://doi.org/10.1057/palcomms.2016.105.

Morano-Foadi, Sonia. 2005. "Scientific Mobility, Career Progression, and Excellence in the European Research Area1." *International Migration* 43 (5): 133–62. https://doi.org/10.1111/j.1468-2435.2005.00344.x.

Moratti, S. 2020. "Do Low-Openness, Low-Transparency Procedures in Academic Hiring Disadvantage Women?" *Social Sciences* 9 (6). https://doi.org/10.3390/SOCSCI9060089.

Morton, B.C., and E. Gil. 2019. "Not a Solo Ride: Co-Constructed Peer Mentoring for Early-Career Educational Leadership Faculty." *International Journal of Mentoring and Coaching in Education* 8 (4): 361–77. https://doi.org/10.1108/IJMCE-02-2019-0026.

Moss-Racusin, C. A., J. F. Dovidio, V. L. Brescoll, M. J. Graham, and J. Handelsman. 2012. "Science Faculty's Subtle Gender Biases Favor Male Students." *Proceedings of the National Academy of Sciences* 109 (41): 16474–79. https://doi.org/10.1073/pnas.1211286109.

Mugabushaka, A.-M., A. Kyriakou, and T. Papazoglou. 2016. "Bibliometric Indicators of Interdisciplinarity: The Potential of the Leinster–Cobbold Diversity Indices to Study Disciplinary Diversity." *Scientometrics* 107 (2): 593–607. https://doi.org/10.1007/s11192-016-1865-x.

Müller, R., and W. Kaltenbrunner. 2019. "Re-Disciplining Academic Careers? Interdisciplinary Practice and Career Development in a Swedish Environmental Sciences Research Center." *Minerva* 57 (4): 479–99. https://doi.org/10.1007/s11024-019-09373-6.

Mumford, K., and C. Sechel. 2020. "Pay and Job Rank among Academic Economists in the UK: Is Gender Relevant?" *British Journal of Industrial Relations* 58 (1): 82–113. https://doi.org/10.1111/bjir.12468.

Munar, Ana María, and Florence Villesèche. 2016. "Gender and Academic Leadership Practices at Copenhagen Business School. An Action Research Project." The Diversity and Inclusion Council, Copenhagen Business School. Copenhagen.

Murray, Dakota, Kyle Siler, Vincent Larivière, Wei Mun Chan, Andrew M. Collings, Jennifer Raymond, and Cassidy R. Sugimoto. 2019. "Author-Reviewer Homophily in Peer Review." *BioRxiv*, January, 400515. https://doi.org/10.1101/400515.

Muschallik, J., and K. Pull. 2016. "Mentoring in Higher Education: Does It Enhance Mentees' Research Productivity?" *Education Economics* 24 (2): 210–23. https://doi.org/10.1080/09645292.2014.997676.

Mutz, R., L. Bornmann, and H.D. Daniel. 2012. "Does Gender Matter in Grant Peer Review?: An Empirical Investigation Using the Example of the Austrian Science Fund." *Zeitschrift Fur Psychologie* 220 (2): 121–29. https://doi.org/10.1027/2151-2604/a000103.

Neale, J., and K. White. 2014. "Australasian University Management, Gender and Life Course Issues." *Equality, Diversity and Inclusion* 33 (4): 384–95. https://doi.org/10.1108/EDI-05-2013-0024.

Netz, N., and S. Jaksztat. 2017. "Explaining Scientists' Plans for International Mobility from a Life Course Perspective." *Research in Higher Education* 58 (5): 497–519. https://doi.org/10.1007/s11162-016-9438-7.

Nichols, L.G. 2014. "A Topic Model Approach to Measuring Interdisciplinarity at the National Science Foundation." *Scientometrics* 100 (3): 741–54. https://doi.org/10.1007/s11192-014-1319-2.

Nielsen, Mathias Wullum. 2014. "Justifications of Gender Equality in Academia: Comparing Gender Equality Policies of Six Scandinavian Universities." *NORA - Nordic Journal of Feminist and Gender Research* 22 (3): 187–203. https://doi.org/10.1080/08038740.2014.905490.

———. 2017. "Reasons for Leaving the Academy: A Case Study on the 'Opt Out' Phenomenon among Younger Female Researchers." *Gender, Work & Organization* 24 (2): 134–55. https://doi.org/10.1111/gwao.12151.

Nielsen, Mathias Wullum, Sharla Alegria, Love Börjeson, Henry Etzkowitz, Holly J. Falk-Krzesinski, Aparna Joshi, Erin Leahey, Laurel Smith-Doerr, Anita Williams Woolley, and Londa Schiebinger. 2017. "Opinion: Gender Diversity Leads to Better Science." *Proceedings of the National Academy of Sciences of the United States of America* 114 (8): 1740–42. https://doi.org/10.1073/pnas.1700616114.

Nielsen, Mathias Wullum, Carter Walter Bloch, and Londa Schiebinger. 2018. "Making Gender Diversity Work for Scientific Discovery and Innovation." *Nature Human Behaviour* 2 (10): 726–34. https://doi.org/10.1038/s41562-018-0433-1.

Nielsen, M.W. 2016. "Gender Inequality and Research Performance: Moving beyond Individual-Meritocratic Explanations of Academic Advancement." *Studies in Higher Education* 41 (11): 2044–60. https://doi.org/10.1080/03075079.2015.1007945.

———. 2017a. "Gender and Citation Impact in Management Research." *Journal of Informetrics* 11 (4): 1213–28. https://doi.org/10.1016/j.joi.2017.09.005.

———. 2017b. "Gender Consequences of a National Performance-Based Funding Model: New Pieces in an Old Puzzle." *Studies in Higher Education* 42 (6): 1033–55. https://doi.org/10.1080/03075079.2015.1075197.

———. 2017c. "Scandinavian Approaches to Gender Equality in Academia: A Comparative Study." *Scandinavian Journal of Educational Research* 61 (3): 295–318. https://doi.org/10.1080/00313831.2016.1147066.

———. 2018. "Scientific Performance Assessments through a Gender Lens: A Case Study on Evaluation and Selection Practices in Academia." *Science and Technology Studies* 31 (1): 2–30.

Nielsen, M.W., J.P. Andersen, L. Schiebinger, and J.W. Schneider. 2017. "One and a Half Million Medical Papers Reveal a Link between Author Gender and Attention to Gender and Sex Analysis." *Nature Human Behaviour* 1 (11): 791–96. https://doi.org/10.1038/s41562-017-0235-x.

Nikunen, M. 2014. "The 'Entrepreneurial University', Family and Gender: Changes and Demands Faced by Fixed-Term Workers." *Gender and Education* 26 (2): 119–34. https://doi.org/10.1080/09540253.2014.888402.

Nittrouer, Christine L., Michelle R. Hebl, Leslie Ashburn-Nardo, Rachel C. E. Trump-Steele, David M. Lane, and Virginia Valian. 2018. "Gender Disparities in Colloquium Speakers at Top Universities." *Proceedings of the National Academy of Sciences* 115 (1): 104. https://doi.org/10.1073/pnas.1708414115.

O'Brien, R.A. 2019. "'Who's That Girl Sitting with the Boys?': Negotiating Researcher Identity in Fieldwork with Adolescent Boys." *Sport, Education and Society* 24 (9): 954–66. https://doi.org/10.1080/13573322.2018.1543653.

Odic, D., and E.H. Wojcik. 2019. "The Publication Gender Gap in Psychology." *American Psychologist*. https://doi.org/10.1037/amp0000480.

O'Keefe, T., and A. Courtois. 2019. "'Not One of the Family': Gender and Precarious Work in the Neoliberal University." *Gender, Work and Organization* 26 (4): 463–79. https://doi.org/10.1111/gwao.12346.

Oliveira, Diego F. M., Yifang Ma, Teresa K. Woodruff, and Brian Uzzi. 2019. "Comparison of National Institutes of Health Grant Amounts to First-Time Male and Female Principal Investigators." *JAMA* 321 (9): 898–900. https://doi.org/10.1001/jama.2018.21944.

Ollilainen, M. 2019. "Academic Mothers as Ideal Workers in the USA and Finland." *Equality, Diversity and Inclusion* 38 (4): 417–29. https://doi.org/10.1108/EDI-02-2018-0027.

Ollilainen, M., and C.R. Solomon. 2014. *Carving a "Third Path": Faculty Parents' Resistance to the Ideal Academic Worker Norm*. Vol. 19. Advances in Gender Research. https://doi.org/10.1108/S1529-212620140000019000.

O'Meara, K., L. Templeton, and G. Nyunt. 2018. "Earning Professional Legitimacy: Challenges Faced by Women, Underrepresented Minority, and Non-Tenure-Track Faculty." *Teachers College Record* 121 (12). https://www.scopus.com/inward/record.uri?eid=2-s2.0-85068429541&partnerID=40&md5=c32a8cf9a3c3f28223a6221aadb6342d.

O'Meara, KerryAnn, Alexandra Kuvaeva, Gudrun Nyunt, Chelsea Waugaman, and Rose Jackson. 2017. "Asked More Often: Gender Differences in Faculty Workload in Research Universities and the Work Interactions That Shape Them." *American Educational Research Journal* 54 (6): 1154–86. https://doi.org/10.3102/0002831217716767.

Paksi, V., B. Nagy, and G. Király. 2016. "The Timing of Motherhood While Earning a PhD in Engineering." *International Journal of Doctoral Studies* 11: 285–304. https://doi.org/10.28945/3544.

Palmén, R., and E. Kalpazidou Schmidt. 2019. "Analysing Facilitating and Hindering Factors for Implementing Gender Equality Interventions in R&I: Structures and Processes." *Evaluation and Program Planning* 77. https://doi.org/10.1016/j.evalprogplan.2019.101726.

Pan, Y., and J.Q. Zhang. 2014. "The Composition of the Editorial Boards of General Marketing Journals." *Journal of Marketing Education* 36 (1): 33–44. https://doi.org/10.1177/0273475313504298.

Phillips, Katherine. 2014. "How Diversity Works." *Scientific American* 311 (October): 42–47. https://doi.org/10.1038/scientificamerican1014-42.

Pohlhaus, J.R., H. Jiang, R.M. Wagner, W.T. Schaffer, and V.W. Pinn. 2011. "Sex Differences in Application, Success, and Funding Rates for NIH Extramural Programs." *Academic Medicine* 86 (6): 759–67. https://doi.org/10.1097/ACM.0b013e31821836ff.

Pololi, Linda H., Janet T. Civian, Robert T. Brennan, Andrea L. Dottolo, and Edward Krupat. 2013. "Experiencing the Culture of Academic Medicine: Gender Matters, A National Study." *Journal of General Internal Medicine* 28 (2): 201–7. https://doi.org/10.1007/s11606-012-2207-1.

Pöyhönen, S. 2017. "Value of Cognitive Diversity in Science." *Synthese* 194 (11): 4519–40. https://doi.org/10.1007/s11229-016-1147-4.

Preston, Anne. 2004. *Leaving Science*. New York: Russell Sage Foundation.

Pyke, J. 2013. "Women, Choice and Promotion or Why Women Are Still a Minority in the Professoriate." *Journal of Higher Education Policy and Management* 35 (4): 444–54. https://doi.org/10.1080/1360080X.2013.812179.

Pyke, K. 2011. "Service and Gender Inequity among Faculty." *PS - Political Science and Politics* 44 (1): 85–87. https://doi.org/10.1017/S1049096510001927.

Rafnsdóttir, G.L., and T.M. Heijstra. 2013. "Balancing Work-Family Life in Academia: The Power of Time." *Gender, Work and Organization* 20 (3): 283–96. https://doi.org/10.1111/j.1468-0432.2011.00571.x.

Rafols, I., and M. Meyer. 2010. "Diversity and Network Coherence as Indicators of Interdisciplinarity: Case Studies in Bionanoscience." *Scientometrics* 82 (2): 263–87. https://doi.org/10.1007/s11192-009-0041-y.

Ramos, A.M.G., J.N. Cortés, and E.C. Moreno. 2015. "Dancers in the Dark: Scientific Careers According to a Gender-Blind Model of Promotion." *Interdisciplinary Science Reviews* 40 (2): 182–203. https://doi.org/10.1179/0308018815Z.000000000112.

Rauhaus, B.M., and I.A.S. Carr. 2020. "The Invisible Challenges: Gender Differences among Public Administration Faculty." *Journal of Public Affairs Education* 26 (1): 31–50. https://doi.org/10.1080/15236803.2018.1565040.

Reddick, R.J., A.B. Rochlen, J.R. Grasso, E.D. Reilly, and D.D. Spikes. 2012. "Academic Fathers Pursuing Tenure: A Qualitative Study of Work-Family Conflict, Coping Strategies, and Departmental Culture." *Psychology of Men and Masculinity* 13 (1): 1–15. https://doi.org/10.1037/a0023206.

Reevy, G.M., and G. Deason. 2014. "Predictors of Depression, Stress, and Anxiety among Non-Tenure Track Faculty." *Frontiers in Psychology* 5 (JUL). https://doi.org/10.3389/fpsyg.2014.00701.

Régner, I., C. Thinus-Blanc, A. Netter, T. Schmader, and P. Huguet. 2019. "Committees with Implicit Biases Promote Fewer Women When They Do Not Believe Gender Bias Exists." *Nature Human Behaviour* 3 (11): 1171–79. https://doi.org/10.1038/s41562-019-0686-3.

Renzulli, L.A., J. Reynolds, K. Kelly, and L. Grant. 2013. *Pathways to Gender Inequality in Faculty Pay: The Impact of Institution, Academic Division, and Rank*. Vol. 34. Research in Social Stratification and Mobility. https://doi.org/10.1016/j.rssm.2013.08.004.

Reuben, Ernesto, Paola Sapienza, and Luigi Zingales. 2014. "How Stereotypes Impair Women's Careers in Science." *Proceedings of the National Academy of Sciences* 111 (12): 4403. https://doi.org/10.1073/pnas.1314788111.

Reynolds, A.C., C. O'Mullan, A. Pabel, A. Martin-Sardesai, S. Alley, S. Richardson, L. Colley, J. Bousie, and J. McCalman. 2018. "Perceptions of Success of Women Early Career Researchers." *Studies in Graduate and Postdoctoral Education* 9 (1): 2–18. https://doi.org/10.1108/SGPE-D-17-00019.

Rhoten, Diana, and Andrew Parker. 2004. "Risks and Rewards of an Interdisciplinary Research Path." *Science* 306 (5704): 2046. https://doi.org/10.1126/science.1103628.

Rhoten, Diana, and Stephanie Pfirman. 2007. "Women in Interdisciplinary Science: Exploring Preferences and Consequences." *Research Policy* 36 (1): 56–75. https://doi.org/10.1016/j.respol.2006.08.001.

Rivera, L.A. 2017. "When Two Bodies Are (Not) a Problem: Gender and Relationship Status Discrimination in Academic Hiring." *American Sociological Review* 82 (6): 1111–38. https://doi.org/10.1177/0003122417739294.

Roach, M., and H. Sauermann. 2017. "The Declining Interest in an Academic Career." *PLoS ONE* 12 (9). https://doi.org/10.1371/journal.pone.0184130.

Rocha, P.L.B., R. Pardini, B.F. Viana, and C.N. El-Hani. 2020. "Fostering Inter- and Transdisciplinarity in Discipline-Oriented Universities to Improve Sustainability Science and Practice." *Sustainability Science* 15 (3): 717–28. https://doi.org/10.1007/s11625-019-00761-1.

Ross, Joseph S., Cary P. Gross, Mayur M. Desai, Yuling Hong, Augustus O. Grant, Stephen R. Daniels, Vladimir C. Hachinski, Raymond J. Gibbons, Timothy J. Gardner, and Harlan M. Krumholz. 2006. "Effect of Blinded Peer Review on Abstract Acceptance." *JAMA* 295 (14): 1675–80. https://doi.org/10.1001/jama.295.14.1675.

Rossiter, Margaret W. 1993. "The Matthew Matilda Effect in Science." *Social Studies of Science* 23 (2): 325–41. https://doi.org/10.1177/030631293023002004.

Rousseau, R., L. Zhang, and X. Hu. 2019. *Knowledge Integration: Its Meaning and Measurement*. Springer Handbooks. https://doi.org/10.1007/978-3-030-02511-3_3.

Russell, E.J., and I.K. Weigold. 2020. "Work Stress and Comfort in University Faculty: Do Gender and Academic Field Matter?" *Journal of Employment Counseling* 57 (3): 130–42. https://doi.org/10.1002/joec.12150.

Ryazanova, O., and P. McNamara. 2019. "Choices and Consequences: Impact of Mobility on Research-Career Capital and Promotion in Business Schools." *Academy of Management Learning and Education* 18 (2): 186–212. https://doi.org/10.5465/amle.2017.0389.

Sabatier, Mareva, and Barthélemy Chollet. 2017. "Is There a First Mover Advantage in Science? Pioneering Behavior and Scientific Production in Nanotechnology." *Research Policy* 46 (2): 522–33. https://doi.org/10.1016/j.respol.2017.01.003.

Sabharwal, M. 2011. "High-Skilled Immigrants: How Satisfied Are Foreign-Born Scientists and Engineers Employed at American Universities?" *Review of Public Personnel Administration* 31 (2): 143–70. https://doi.org/10.1177/0734371X11408572.

Salazar, Maritza R., Theresa K. Lant, Stephen M. Fiore, and Eduardo Salas. 2012. "Facilitating Innovation in Diverse Science Teams Through Integrative Capacity." *Small Group Research* 43 (5): 527–58. https://doi.org/10.1177/1046496412453622.

Sallee, M., K. Ward, and L. Wolf-Wendel. 2016. "Can Anyone Have It All? Gendered Views on Parenting and Academic Careers." *Innovative Higher Education* 41 (3): 187–202. https://doi.org/10.1007/s10755-015-9345-4.

Sallee, M.W., and A.B. Pascale. 2012. "Multiple Roles, Multiple Burdens: The Experiences of Female Scientists with Children." *Journal of Women and Minorities in Science and Engineering* 18 (2): 135–52. https://doi.org/10.1615/JWomenMinorScienEng.2012001669.

Sandström, Ulf, and Martin Hällsten. 2007. "Persistent Nepotism in Peer-Review." *Scientometrics* 74 (2). https://akjournals.com/view/journals/11192/74/2/article-p175.xml.

Santos, G., and S.D. Van Phu. 2019. "Gender and Academic Rank in the UK." *Sustainability (Switzerland)* 11 (11). https://doi.org/10.3390/su11113171.

Santos, J.M., H. Horta, and L.-F. Zhang. 2020. "The Association of Thinking Styles with Research Agendas among Academics in the Social Sciences." *Higher Education Quarterly* 74 (2): 193–210. https://doi.org/10.1111/hequ.12240.

Sanz-Menéndez, L., L. Cruz-Castro, and K. Alva. 2013. "Time to Tenure in Spanish Universities: An Event History Analysis." *PLoS ONE* 8 (10). https://doi.org/10.1371/journal.pone.0077028.

Sardelis, S., and J.A. Drew. 2016. "Not 'Pulling up the Ladder': Women Who Organize Conference Symposia Provide Greater Opportunities for Women to Speak at Conservation Conferences." *PLoS ONE* 11 (7). https://doi.org/10.1371/journal.pone.0160015.

Schmidt, E.K., and M. Cacace. 2017. "Addressing Gender Inequality in Science: The Multifaceted Challenge of Assessing Impact." *Research Evaluation* 26 (2): 102–14. https://doi.org/10.1093/reseval/rvx003.

Schmidt, E.K., and S.T. Faber. 2016. "Benefits of Peer Mentoring to Mentors, Female Mentees and Higher Education Institutions." *Mentoring and Tutoring: Partnership in Learning* 24 (2): 137–57. https://doi.org/10.1080/13611267.2016.1170560.

Schneid, Matthias, Rodrigo Isidor, Chengguang Li, and Rüdiger Kabst. 2015. "The Influence of Cultural Context on the Relationship between Gender Diversity and Team Performance: A Meta-Analysis." *The International Journal of Human Resource Management* 26 (6): 733–56. https://doi.org/10.1080/09585192.2014.957712.

Schor, N.F. 2018. "The Decanal Divide: Women in Decanal Roles at U.S. Medical Schools." *Academic Medicine* 93 (2): 237–40. https://doi.org/10.1097/ACM.0000000000001863.

Schweitzer, S., and J. Brendel. 2020. "A Burden of Knowledge Creation in Academic Research: Evidence from Publication Data." *Industry and Innovation*. https://doi.org/10.1080/13662716.2020.1716693.

Sege, Robert, Linley Nykiel-Bub, and Sabrina Selk. 2015. "Sex Differences in Institutional Support for Junior Biomedical Researchers." *JAMA* 314 (11): 1175–77. https://doi.org/10.1001/jama.2015.8517.

Settles, I.H., L.M. Cortina, N.T. Buchanan, and K.N. Miner. 2013. "Derogation, Discrimination, and (Dis)Satisfaction With Jobs in Science: A Gendered Analysis." *Psychology of Women Quarterly* 37 (2): 179–91. https://doi.org/10.1177/0361684312468727.

Settles, I.H., and R.C. O'Connor. 2014. "Incivility at Academic Conferences: Gender Differences and the Mediating Role of Climate." *Sex Roles* 71 (1–2): 71–82. https://doi.org/10.1007/s11199-014-0355-y.

Sheltzer, Jason M., and Joan C. Smith. 2014. "Elite Male Faculty in the Life Sciences Employ Fewer Women." *Proceedings of the National Academy of Sciences* 111 (28): 10107–12. https://doi.org/10.1073/pnas.1403334111.

Shepherd, S. 2017. "Why Are There so Few Female Leaders in Higher Education: A Case of Structure or Agency?" *Management in Education* 31 (2): 82–87. https://doi.org/10.1177/0892020617696631.

Sieverding, M., C. Eib, A.B. Neubauer, and T. Stahl. 2018. "Can Lifestyle Preferences Help Explain the Persistent Gender Gap in Academia? The 'Mothers Work Less' Hypothesis Supported for German but Not for U.S. Early Career Researchers." *PLoS ONE* 13 (8). https://doi.org/10.1371/journal.pone.0202728.

Silander, C., U. Haake, and L. Lindberg. 2013. “The Different Worlds of Academia: A Horizontal Analysis of Gender Equality in Swedish Higher Education.” *Higher Education* 66 (2): 173–88. https://doi.org/10.1007/s10734-012-9597-1.

Smith-Doerr, Laurel. 2004. “Flexibility and Fairness: Effects of the Network Form of Organization on Gender Equity in Life Science Careers.” *Sociological Perspectives* 47 (1): 25–54. https://doi.org/10.1525/sop.2004.47.1.25.

Snell, Clete, Jon Sorensen, John J. Rodriguez, and Attapol Kuanliang. 2009. “Gender Differences in Research Productivity among Criminal Justice and Criminology Scholars.” *Journal of Criminal Justice* 37 (3): 288–95. https://doi.org/10.1016/j.jcrimjus.2009.04.009.

Solera, C., and R. Musumeci. 2017. “The Persisting Glass Ceiling in Academia: A Multidimensional Cross-National Perspective.” *Polis (Italy)* 31 (1): 17–44. https://doi.org/10.1424/86078.

Sotudeh, H., and N. Khoshian. 2014. “Gender, Web Presence and Scientific Productivity in Nanoscience and Nanotechnology.” *Scientometrics* 99 (3): 717–36. https://doi.org/10.1007/s11192-014-1234-6.

Soyer, M. 2014. “Off the Corner and into the Kitchen: Entering a Male-Dominated Research Setting as a Woman.” *Qualitative Research* 14 (4): 459–72. https://doi.org/10.1177/1468794113488130.

Stack, Steven. 2004. “Gender, Children and Research Productivity.” *Research in Higher Education* 45 (8): 891–920. https://doi.org/10.1007/s11162-004-5953-z.

Stage, Andreas. 2020. “Universities Are More than Just Their Professors: Understanding Organizational Transformation through Staff Changes.”

Steele, M.M., S. Fisman, and B. Davidson. 2013. “Mentoring and Role Models in Recruitment and Retention: A Study of Junior Medical Faculty Perceptions.” *Medical Teacher* 35 (5): e1130–38. https://doi.org/10.3109/0142159X.2012.735382.

Steinþórsdóttir, F.S., Þ. Einarsdóttir, G.M. Pétursdóttir, and S. Himmelweit. 2020. “Gendered Inequalities in Competitive Grant Funding: An Overlooked Dimension of Gendered Power Relations in Academia.” *Higher Education Research and Development* 39 (2): 362–75. https://doi.org/10.1080/07294360.2019.1666257.

Stephan, Paula E., and Sharon G. Levin. 2001. “Exceptional Contributions to US Science by the Foreign-Born and Foreign-Educated.” *Population Research and Policy Review* 20 (1): 59–79. https://doi.org/10.1023/A:1010682017950.

Stirling, Andy. 2007. “A General Framework for Analysing Diversity in Science, Technology and Society.” *Journal of The Royal Society Interface* 4 (15): 707–19. https://doi.org/10.1098/rsif.2007.0213.

Stopar, K., D. Drobne, K. Eler, and T. Bartol. 2016. “Citation Analysis and Mapping of Nanoscience and Nanotechnology: Identifying the Scope and Interdisciplinarity of Research.” *Scientometrics* 106 (2): 563–81. https://doi.org/10.1007/s11192-015-1797-x.

Storage, D., T.E.S. Charlesworth, M.R. Banaji, and A. Cimpian. 2020. “Adults and Children Implicitly Associate Brilliance with Men More than Women.” *Journal of Experimental Social Psychology* 90. https://doi.org/10.1016/j.jesp.2020.104020.

Straus, S.E., M.O. Johnson, C. Marquez, and M.D. Feldman. 2013. “Characteristics of Successful and Failed Mentoring Relationships: A Qualitative Study across Two Academic Health Centers.” *Academic Medicine* 88 (1): 82–89. https://doi.org/10.1097/ACM.0b013e31827647a0.

Stringer, R., D. Smith, R. Spronken-Smith, and C. Wilson. 2018. “‘My Entire Career Has Been Fixed Term’: Gender and Precarious Academic Employment at a New Zealand University.” *New Zealand Sociology* 33 (2): 169–201.

Stroebe, W. 2010. *American Psychologist* 65 (7): 660–73. https://doi.org/10.1037/a0021086.

Stuckey, S.M., B.T. Collins, S. Patrick, K.S. Grove, and E. Ward. 2019. “Thriving vs Surviving: Benefits of Formal Mentoring Program on Faculty Well-Being.” *International Journal of Mentoring and Coaching in Education* 8 (4): 378–96. https://doi.org/10.1108/IJMCE-02-2019-0024.

Su, X., and M. Gaughan. 2014. “Inclusion of Women Academics into American Universities: Analysis of Women Status Reports.” *Higher Education Policy* 27 (4): 529–44. https://doi.org/10.1057/hep.2013.40.

Su, X., J. Johnson, and B. Bozeman. 2015. “Gender Diversity Strategy in Academic Departments: Exploring Organizational Determinants.” *Higher Education* 69 (5): 839–58. https://doi.org/10.1007/s10734-014-9808-z.

Sugimoto, Cassidy R, Yong-Yeol Ahn, Elise Smith, Benoit Macaluso, and Vincent Larivière. 2019. “Factors Affecting Sex-Related Reporting in Medical Research: A Cross-Disciplinary Bibliometric Analysis.” *The Lancet* 393 (10171): 550–59. https://doi.org/10.1016/S0140-6736(18)32995-7.

Sugimoto, C.R., T.J. Sugimoto, A. Tsou, S. Milojević, and V. Larivière. 2016. “Age Stratification and Cohort Effects in Scholarly Communication: A Study of Social Sciences.” *Scientometrics* 109 (2): 997–1016. https://doi.org/10.1007/s11192-016-2087-y.

Yoshioka-Kobayashi, T., and S. Shibayama. 2020. “Early Career Training and Development of Academic Independence: A Case of Life Sciences in Japan.” *Studies in Higher Education*. https://doi.org/10.1080/03075079.2020.1817889.

Tagliaventi, M.R., G. Carli, and D. Cutolo. 2020. “Excellent Researcher or Good Public Servant? The Interplay between Research and Academic Citizenship.” *Higher Education* 79 (6): 1057–78. https://doi.org/10.1007/s10734-019-00456-7.

Tannenbaum, C., R.P. Ellis, F. Eyssel, J. Zou, and L. Schiebinger. 2019. “Sex and Gender Analysis Improves Science and Engineering.” *Nature* 575 (7781): 137–46. https://doi.org/10.1038/s41586-019-1657-6.

Tartari, Valentina, and Ammon Salter. 2015. “The Engagement Gap: Exploring Gender Differences in University – Industry Collaboration Activities.” *Research Policy* 44 (6): 1176–91. https://doi.org/10.1016/j.respol.2015.01.014.

Taylor, E.A., A.B. Smith, N.M. Welch, and R. Hardin. 2018. "'You Should Be Flattered!': Female Sport Management Faculty Experiences of Sexual Harassment and Sexism." *Women in Sport and Physical Activity Journal* 26 (1): 43–53. https://doi.org/10.1123/wspaj.2017-0038.

Taylor, Susan Washburn, Blakely Fox Fender, and Kimberly Gladden Burke. 2006. "Unraveling the Academic Productivity of Economists: The Opportunity Costs of Teaching and Service." *Southern Economic Journal* 72 (4): 846–59. https://doi.org/10.2307/20111856.

Teelken, C., Y. Taminiau, and C. Rosenmöller. 2019. "Career Mobility from Associate to Full Professor in Academia: Micro-Political Practices and Implicit Gender Stereotypes." *Studies in Higher Education*. https://doi.org/10.1080/03075079.2019.1655725.

Teelken, Christine, and Rosemary Deem. 2013. "All Are Equal, but Some Are More Equal than Others: Managerialism and Gender Equality in Higher Education in Comparative Perspective." *Comparative Education* 49 (4): 520–35. https://doi.org/10.1080/03050068.2013.807642.

Thelwall, M. 2018. "Do Females Create Higher Impact Research? Scopus Citations and Mendeley Readers for Articles from Five Countries." *Journal of Informetrics* 12 (4): 1031–41. https://doi.org/10.1016/j.joi.2018.08.005.

———. 2020. "Female Citation Impact Superiority 1996–2018 in Six out of Seven English-Speaking Nations." *Journal of the Association for Information Science and Technology* 71 (8): 979–90. https://doi.org/10.1002/asi.24316.

Thelwall, M., C. Bailey, C. Tobin, and N.-A. Bradshaw. 2019. "Gender Differences in Research Areas, Methods and Topics: Can People and Thing Orientations Explain the Results?" *Journal of Informetrics* 13 (1): 149–69. https://doi.org/10.1016/j.joi.2018.12.002.

Thomas, N., J. Bystydzienski, and A. Desai. 2015. "Changing Institutional Culture through Peer Mentoring of Women STEM Faculty." *Innovative Higher Education* 40 (2): 143–57. https://doi.org/10.1007/s10755-014-9300-9.

Thornton, M. 2013. "THE MIRAGE OF MERIT: Reconstituting the 'Ideal Academic.'" *Australian Feminist Studies* 28 (76): 127–43. https://doi.org/10.1080/08164649.2013.789584.

Thursby, Jerry G., and Marie C. Thursby. 2005. "Gender Patterns of Research and Licensing Activity of Science and Engineering Faculty." *The Journal of Technology Transfer* 30 (4): 343–53. https://doi.org/10.1007/s10961-005-2580-6.

Tijdink, Joeri K., Reinout Verbeke, and Yvo M. Smulders. 2014. "Publication Pressure and Scientific Misconduct in Medical Scientists." *Journal of Empirical Research on Human Research Ethics* 9 (5): 64–71. https://doi.org/10.1177/1556264614552421.

Tijdink, Joeri K., Anton C. M. Vergouwen, and Yvo M. Smulders. 2013. "Publication Pressure and Burn Out among Dutch Medical Professors: A Nationwide Survey." *PLOS ONE* 8 (9): e73381. https://doi.org/10.1371/journal.pone.0073381.

Timmers, Tanya, Tineke Willemsen, and Kea Tijdens. 2010. "Gender Diversity Policies in Universities: A Multi-Perspective Framework of Policy Measures." *Higher Education (00181560)* 59 (6): 719–35.

Titone, D., M. Tiv, and P.M. Pexman. 2018. "The Status of Women Cognitive Scientists in Canada: Insights from Publicly Available NSERC Funding Data." *Canadian Journal of Experimental Psychology* 72 (2): 81–90. https://doi.org/10.1037/cep0000150.

Tower, L.E., and M. Latimer. 2016. "Cumulative Disadvantage: Effects of Early Career Childcare Issues on Faculty Research Travel." *Affilia - Journal of Women and Social Work* 31 (3): 317–30. https://doi.org/10.1177/0886109915622527.

Traag, V., and L. Waltman. 2020. "The Causal Intricacies of Studying Gender Bias in Science." *Leiden Madtrics* (blog). December 10, 2020. https://leidenmadtrics.nl/articles/the-causal-intricacies-of-studying-gender-bias-in-science.

Treviño, Len J., Luis R. Gomez-Mejia, David B. Balkin, and Franklin G. Mixon. 2015. "Meritocracies or Masculinities? The Differential Allocation of Named Professorships by Gender in the Academy." *Journal of Management* 44 (3): 972–1000. https://doi.org/10.1177/0149206315599216.

Tricco, Andrea C., Sonia M. Thomas, Jesmin Antony, Patricia Rios, Reid Robson, Reena Pattani, Marco Ghassemi, et al. 2017. "Strategies to Prevent or Reduce Gender Bias in Peer Review of Research Grants: A Rapid Scoping Review." *PLOS ONE* 12 (1): e0169718. https://doi.org/10.1371/journal.pone.0169718.

Tzanakou, C. 2020a. "Stickiness in Academic Career Immobilities of STEM Early Career Researchers: An Insight from Greece." *Higher Education*. https://doi.org/10.1007/s10734-020-00596-1.

———. 2020b. *Higher Education*. https://doi.org/10.1007/s10734-020-00596-1.

Uhly, K.M., L.M. Visser, and K.S. Zippel. 2017. "Gendered Patterns in International Research Collaborations in Academia." *Studies in Higher Education* 42 (4): 760–82. https://doi.org/10.1080/03075079.2015.1072151.

Urbina-Garcia, A. 2020. "What Do We Know about University Academics' Mental Health? A Systematic Literature Review." *Stress and Health*. https://doi.org/10.1002/smi.2956.

Urquhart-Cronish, M., and S.P. Otto. 2019. "Gender and Language Use in Scientific Grant Writing." *Facets* 2019 (4): 442–58. https://doi.org/10.1139/facets-2018-0039.

Utoft, E.H. 2020. "'All the Single Ladies' as the Ideal Academic during Times of COVID-19?" *Gender, Work and Organization* 27 (5): 778–87. https://doi.org/10.1111/gwao.12478.

Valantine, Hannah A., and Francis S. Collins. 2015. "National Institutes of Health Addresses the Science of Diversity." *Proceedings of the National Academy of Sciences* 112 (40): 12240. https://doi.org/10.1073/pnas.1515612112.

Van Balen, Barbara, Pleun Van Arensbergen, Inge Van Der Weijden, and Peter Van Den Besselaar. 2012. "Determinants of Success in Academic Careers." *Higher Education Policy* 25 (3): 313–34. https://doi.org/10.1057/hep.2012.14.

Van den Brink, Marieke. 2011. “Scouting for Talent: Appointment Practices of Women Professors in Academic Medicine.” *Social Science & Medicine* 72 (12): 2033–40.

van den Brink Marieke, Brouns Margo, and Waslander Sietske. 2006. “Does Excellence Have a Gender? A National Research Study on Recruitment and Selection Procedures for Professorial Appointments in The Netherlands.” Edited by Liz Doherty and Simonetta Manfredi. *Employee Relations* 28 (6): 523–39. https://doi.org/10.1108/01425450610704470.

Van Miegroet, H., C. Glass, R.R. Callister, and K. Sullivan. 2019. “Unclogging the Pipeline: Advancement to Full Professor in Academic STEM.” *Equality, Diversity and Inclusion* 38 (2): 246–64. https://doi.org/10.1108/EDI-09-2017-0180.

Verbos, A.K., and D.V.E. Dykstra. 2014. “Female Business Faculty Attrition: Paths through the Labyrinth.” *Equality, Diversity and Inclusion* 33 (4): 372–83. https://doi.org/10.1108/EDI-10-2013-0083.

Vernos, Isabelle. 2013. “Quotas Are Questionable.” *Nature* 495 (7439): 39–39. https://doi.org/10.1038/495039a.

Vogels, C. 2019. “A Feminist and ‘Outsider’ in the Field: Negotiating the Challenges of Researching Young Men.” *International Journal of Qualitative Methods* 18. https://doi.org/10.1177/1609406919855907.

Volker, Beate, and Wouter Steenbeek. 2015. “No Evidence That Gender Contributes to Personal Research Funding Success in The Netherlands: A Reaction to van Der Lee and Ellemers.” *Proceedings of the National Academy of Sciences* 112 (51): E7036. https://doi.org/10.1073/pnas.1519046112.

Waaijer, C.J.F., R. Belder, H. Sonneveld, C.A. van Bochove, and I.C.M. van der Weijden. 2017. “Temporary Contracts: Effect on Job Satisfaction and Personal Lives of Recent PhD Graduates.” *Higher Education* 74 (2): 321–39. https://doi.org/10.1007/s10734-016-0050-8.

Waaijer, C.J.F., A. Heyer, and S. Kuli. 2016. “Effects of Appointment Types on the Availability of Research Infrastructure, Work Pressure, Stress, and Career Attitudes of PhD Candidates of a Dutch University.” *Research Evaluation* 25 (4): 349–57. https://doi.org/10.1093/reseval/rvw008.

Waaijer, C.J.F., H. Sonneveld, S.E. Buitendijk, C.A. Van Bochove, and I.C.M. Van Der Weijden. 2016. “The Role of Gender in the Employment, Career Perception and Research Performance of Recent PhD Graduates from Dutch Universities.” *PLoS ONE* 11 (10). https://doi.org/10.1371/journal.pone.0164784.

Waaijer, C.J.F., C. Teelken, P.F. Wouters, and I.C.M. Van Der Weijden. 2018. “Competition in Science: Links between Publication Pressure, Grant Pressure and the Academic Job Market.” *Higher Education Policy* 31 (2): 225–43. https://doi.org/10.1057/s41307-017-0051-y.

Wagner, C.S., J.D. Roessner, K. Bobb, J.T. Klein, K.W. Boyack, J. Keyton, I. Rafols, and K. Börner. 2011. “Approaches to Understanding and Measuring Interdisciplinary Scientific Research (IDR): A Review of the Literature.” *Journal of Informetrics* 5 (1): 14–26. https://doi.org/10.1016/j.joi.2010.06.004.

Waisbren, Susan E., Hannah Bowles, Tayaba Hasan, Kelly H. Zou, S. Jean Emans, Carole Goldberg, Sandra Gould, et al. 2008. “Gender Differences in Research Grant Applications and Funding Outcomes for Medical School Faculty.” *Journal of Women’s Health (2002)* 17 (2): 207–14. https://doi.org/10.1089/jwh.2007.0412.

Wang, Jian, Bart Thijs, and Wolfgang Glänzel. 2015. “Interdisciplinarity and Impact: Distinct Effects of Variety, Balance, and Disparity.” *PLOS ONE* 10 (5): e0127298. https://doi.org/10.1371/journal.pone.0127298.

Ward, Kelly, and Lisa Wolf-Wendel. 2004. “Academic Motherhood: Managing Complex Roles in Research Universities.” *Review of Higher Education* 27 (2): 233.

Watanabe, M., and C.D. Falci. 2016. “A Demands and Resources Approach to Understanding Faculty Turnover Intentions Due to Work–Family Balance.” *Journal of Family Issues* 37 (3): 393–415. https://doi.org/10.1177/0192513X14530972.

Webber, Karen L. 2012. “Research Productivity of Foreign- and US-Born Faculty: Differences by Time on Task.” *Higher Education* 64 (5): 709–29. https://doi.org/10.1007/s10734-012-9523-6.

Webber, Karen L., and Lijing Yang. 2014. “The Increased Role of Foreign-Born Academic Staff in US Higher Education.” *Journal of Higher Education Policy and Management* 36 (1): 43–61. https://doi.org/10.1080/1360080X.2013.844671.

Webber, K.L., and M. González Canché. 2018. “Is There a Gendered Path to Tenure? A Multi-State Approach to Examine the Academic Trajectories of U.S. Doctoral Recipients in the Sciences.” *Research in Higher Education* 59 (7): 897–932. https://doi.org/10.1007/s11162-018-9492-4.

Webber, K.L., and S.M. Rogers. 2018. “Gender Differences in Faculty Member Job Satisfaction: Equity Forestalled?” *Research in Higher Education* 59 (8): 1105–32. https://doi.org/10.1007/s11162-018-9494-2.

Weijden, Inge van der, Rosalie Belder, Pleun van Arensbergen, and Peter van den Besselaar. 2015. “How Do Young Tenured Professors Benefit from a Mentor? Effects on Management, Motivation and Performance.” *Higher Education* 69 (2): 275–87. https://doi.org/10.1007/s10734-014-9774-5.

Wennerås, Christine, and Agnes Wold. 1997. “Nepotism and Sexism in Peer-Review.” *Nature* 387 (6631): 341–43. https://doi.org/10.1038/387341a0.

West, Jevin D, Jennifer Jacquet, Molly M King, Shelley J Correll, and Carl T Bergstrom. 2013. “The Role of Gender in Scholarly Authorship.” *PloS One* 8 (7): e66212–e66212. https://doi.org/10.1371/journal.pone.0066212.

Westring, A.F., R.M. Speck, M.D. Sammel, P. Scott, L.W. Tuton, J.A. Grisso, and S. Abbuhl. 2012. “A Culture Conducive to Women’s Academic Success: Development of a Measure.” *Academic Medicine* 87 (11): 1622–31. https://doi.org/10.1097/ACM.0b013e31826dbfd1.

Wharton, A.S., and M. Estevez. 2014. *Department Chairs' Perspectives on Work, Family, and Gender: Pathways for Transformation*. Vol. 19. Advances in Gender Research. https://doi.org/10.1108/S1529-212620140000019006.

Wiedman, C. 2019. "Rewarding Collaborative Research: Role Congruity Bias and the Gender Pay Gap in Academe." *Journal of Business Ethics*. https://doi.org/10.1007/s10551-019-04165-0.

Williams, K.Y., and C.A. O'Reilly. 1998. "Demography and Diversity in Organizations: A Review of 40 Years of Research." In *In Cummings, L. L. (Ed.), Research in Organizational Behavior (Vol. 20)*, 77–140. Greenwich, CT: JAI Press.

Williams, Wendy M., and Stephen J. Ceci. 2015. "National Hiring Experiments Reveal 2:1 Faculty Preference for Women on STEM Tenure Track." *Proceedings of the National Academy of Sciences* 112 (17): 5360. https://doi.org/10.1073/pnas.1418878112.

Winslow, Sarah. 2010. "Gender Inequality and Time Allocations Among Academic Faculty." *Gender & Society* 24 (6): 769–93. https://doi.org/10.1177/0891243210386728.

Witteman, Holly O., Michael Hendricks, Sharon Straus, and Cara Tannenbaum. 2018. "Female Grant Applicants Are Equally Successful When Peer Reviewers Assess the Science, but Not When They Assess the Scientist." *BioRxiv*, January, 232868. https://doi.org/10.1101/232868.

Wladkowski, S.P., and R.G. Mirick. 2020. "Supports and Recommendations for Pregnant and Newly Parenting Doctoral Students in Health Professions." *Journal of Social Work Education* 56 (2): 312–26. https://doi.org/10.1080/10437797.2019.1656580.

Wöhrer, V. 2014. "To Stay or to Go? Narratives of Early-Stage Sociologists about Persisting in Academia." *Higher Education Policy* 27 (4): 469–87. https://doi.org/10.1057/hep.2014.22.

Wood, C.V., R.F. Jones, R.G. Remich, A.E. Caliendo, N.C. Langford, J.L. Keller, P.B. Campbell, and R. McGee. 2020. "The National Longitudinal Study of Young Life Scientists: Career Differentiation among a Diverse Group of Biomedical PhD Students." *PLoS ONE* 15 (6). https://doi.org/10.1371/journal.pone.0234259.

Woolley, Anita Williams, Ishani Aggarwal, and Thomas W. Malone. 2015. "Collective Intelligence and Group Performance." *Current Directions in Psychological Science* 24 (6): 420–24. https://doi.org/10.1177/0963721415599543.

Woolley, Anita Williams, Christopher F. Chabris, Alex Pentland, Nada Hashmi, and Thomas W. Malone. 2010. "Evidence for a Collective Intelligence Factor in the Performance of Human Groups." *Science* 330 (6004): 686. https://doi.org/10.1126/science.1193147.

Wullum Nielsen, M., and L. Börjeson. 2019. "Gender Diversity in the Management Field: Does It Matter for Research Outcomes?" *Research Policy* 48 (7): 1617–32. https://doi.org/10.1016/j.respol.2019.03.006.

Xie, Y., and K.A. Shauman. 2003. *Women in Science: Career Processes and Outcomes.* MA: Harvard University Press.

Xie, Yu, and Kimberlee A. Shauman. 1998. "Sex Differences in Research Productivity: New Evidence about an Old Puzzle." *American Sociological Review* 63 (6): 847–70. https://doi.org/10.2307/2657505.

Xing, Yanmeng, An Zeng, Ying Fan, and Zengru Di. 2019. "The Strong Nonlinear Effect in Academic Dropout." *Scientometrics* 120 (2): 793–805. https://doi.org/10.1007/s11192-019-03135-7.

Yang, Rui, and Anthony R. Welch. 2010. "Globalisation, Transnational Academic Mobility and the Chinese Knowledge Diaspora: An Australian Case Study." *Discourse: Studies in the Cultural Politics of Education* 31 (5): 593–607. https://doi.org/10.1080/01596306.2010.516940.

Yegros-Yegros, Alfredo, Ismael Rafols, and Pablo D'Este. 2015. "Does Interdisciplinary Research Lead to Higher Citation Impact? The Different Effect of Proximal and Distal Interdisciplinarity." *PLOS ONE* 10 (8): e0135095. https://doi.org/10.1371/journal.pone.0135095.

Yildirim, T.M., and H. Eslen-Ziya. 2020. "The Differential Impact of COVID-19 on the Work Conditions of Women and Men Academics during the Lockdown." *Gender, Work and Organization*. https://doi.org/10.1111/gwao.12529.

Zhang, H., J.A. Kmec, and T. Byington. 2019. "Gendered Career Decisions in the Academy: Job Refusal and Job Departure Intentions among Academic Dual-Career Couples." *Review of Higher Education* 42 (4): 1723–54. https://doi.org/10.1353/rhe.2019.0081.

Zinovyeva, Natalia, and Manuel Bagues. 2011. "Does Gender Matter for Academic Promotion? Evidence from a Randomized Natural Experiment." SSRN Scholarly Paper ID 1771259. Rochester, NY: Social Science Research Network. https://papers.ssrn.com/abstract=1771259.

Zitt, Michel. 2005. "Facing Diversity of Science: A Challenge for Bibliometric Indicators." *Measurement: Interdisciplinary Research and Perspectives* 3 (1): 38–49. https://doi.org/10.1207/s15366359mea0301_6.

Zuckerman, Harriet. 2001. "The Careers of Men and Women Scientists: Gender Differences in Career Attainment." In *In M. Wyer (Ed.) Women, Science and Technology: A Reader in Feminist Science Studies.*, 69–78. Routledge.

Zuckerman, Harriet A. 1968. "Patterns of Name Ordering Among Authors of Scientific Papers: A Study of Social Symbolism and Its Ambiguity." *American Journal of Sociology* 74 (3): 276–91. https://doi.org/10.1086/224641.

Tænketanken DEA
Fiolstræde 44
1171 København K
www.dea.nu