Gender bias in grant allocation shows a decline over time[1]

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Abstract
Findings about gender bias in grant allocation differ, over time, between qualitative and quantitative studies, and between small and large studies. Conclusions about the existence of bias and causal processes also depend on the methodological design and covariates included in the analysis. In a recent project, we conducted a series of case studies covering a long period in several countries, and using a variety of methods, from observational to experimental, in order to arrive at more robust findings and conclusions about the causal role of gender in the evaluation and the funding outcomes. The results in most cases suggest that gender bias in evaluation and grant allocation has declined substantially since the classical studies in the field, and that currently it may be almost absent. Policy implications are briefly discussed.

Introduction

In this paper we compare nine funding instruments across six European countries. The analysis was conducted at the instrument level (encompassing all fields) and was further disaggregated at the (field specific) panel level – in order to reduce heterogeneity. The cases vary: longitudinal studies, cross sectional (correlational) studies, and experiments. In this short paper we do not have the space to go into details of the individual studies, and only describe them very briefly. We then give an overview of the findings and draw some conclusions. The grant application process consists of (i) the application phase, (ii) the selection process (often in panels), and (iii) the decision-making process in the context of

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organizational procedures. All these phases may lead to gender differences and possibly gender bias, and in this paper we focus on the last two[2].

Gender bias

Gender differences do not necessarily indicate bias, as they can be based on gender differences in *merit*, and (gender) bias in grant allocation should therefore be defined as a deviation of merit-based selection. Gender bias is then conceived as a residual: if one controls for merit and other relevant criteria and covariates, the remaining effect of gender can be interpreted as *direct* gender bias.

Building on their earlier review (Williams et al. 2011), Ceci and coauthors have published an updated review which analyzed the state of the art on gender bias in six relevant domains, among those domains research grant allocation (Ceci et al. 2023). Although there may have been gender bias in grant allocation in the past, the authors find that since 2000 the issue of gender bias in grant allocation appears to have been resolved. This is confirmed by a recent study showing that gender differences in funding tend to diminish almost in all countries (Cruz-Castro et al. 2023b). As Ceci's review is focusing on quantitative studies, it confirms earlier meta-analyses (Marsh et al. 2009, 2011) and is in line with a recent review concluding that large scale quantitative studies generally do not find gender bias in grant allocation, whereas small scale qualitative studies tend to do (Sato et al. 2021). This, by the way, suggests that findings seem to be influenced by the research designs and the methods used. However, the review of Ceci and colleagues has been criticized by Mary Catherine Kropinski (2023), who claims that Ceci and his coauthors are blind for many aspects of gender bias and discrimination in science: "There are numerous forces working against the full participation of women in STEM which the authors themselves mention but do not include in their measurements of bias. These include sexual harassment, the collision of the tenure clock with the biological one, chilly climate, masculine heteronormativity, early socialization differences, and unequal distribution of family care-taking responsibilities, among others. Additionally, there are many remaining domains of potential bias in academic STEM which were not evaluated by Ceci et al., such as levels of grant funding, tenure and promotion, prestigious awards, etc."

This criticism is, however, more related to the working conditions in *universities and research organizations*, as well as to social processes in the *private sphere*, and rather than to the evaluation and funding allocation processes at *funding organizations*. These other gender differences may of course influence the possibilities of women to build up merit and therefore indirectly affect grant decisions. Without trying to be exhaustive, one could hypothesize that such factors may influence the career choices, self-presentation, performance, or application behavior. For example, if women would have on average lower academic performance because of more teaching obligations, less research resources, and more care responsibilities, this may reduce grant application success of women. However, this would not indicate gender bias in the evaluation of grant applications, but rather points to gender discrimination in the academic work environment and or unequal allocation of family responsibilities. These factors are important and may lead to *indirect gender bias* in grant allocation, but were not

[2] The first phase is also studied: see Möller 2023.

part of the studies reported here as these focus on *direct gender bias* in research funding organizations. In other words, it is important to distinguish between the places and processes where gender bias and discrimination occurs. Our focus is on potential bias in peer review process and funding decision making in funding agencies.

Within the evaluation processes, one may distinguish between the review/panel scores the applicants receive and the final decision about the application. In a previous study of the ERC starting grants, we found a systematic gender bias in favor of men in the panel scores, but a much more balanced picture in the grant decisions. Some panels showed an advantage for men, others were gender neutral and again others showed a preference for women, and these differences seem related to panel characteristics. On an aggregate level, however, the result was about equal as the average predicted probabilities were equal to the observed success rates (Van den Besselaar & Mom 2021). These results are also in line with the findings of Sato (2021), as specifically selected qualitative case studies at panel level would have shown gender bias against women, despite the overall equal picture we found. Bol et al. (2022) found similar results in a large-scale study of the Dutch career grants: The panel scores were biased but the final outcome wasn't. The case studies in this deliverable are aimed at a deeper understanding of this mixed picture.

Merit has various dimensions (Van Arensbergen et al. 2014; Van den Besselaar & Mom 2023) and "quality is much more than only bibliometric impact and productivity" (DORA, CoARA), but for our studies on mostly individual research grants, the contribution to science seems the most important merit dimension, and these are measured using bibliometric variables in the case studies in our project.

As previously mentioned, in observational studies, the analysis tries to find causes for observed effects, where gender could be a cause –residual- if we control for other plausible factors; in experimental studies, we move from causes to effects (Holland 1986) by manipulating gender and measuring the effects in the outcomes of interest.

Case studies

The eight case studies cover nine different cases. One case (SRC 2020) has been analyzed twice: on the funding instrument level and separately on the disciplinary *panel level*. This is an important difference, as grant evaluation and decision-making generally happens at the level of (disciplinary) panels, and the more aggregated studies may suffer from too much disciplinary heterogeneity. Six of the cases studied are examples of individual (early) career grants, and three others are thematic grant programs where the content of the project is the core interest. The deployed methods are varied. In the design of the project, a main consideration was that only correlational studies would be not enough to identify gender bias: the causal effect of gender on the evaluation outcomes. These correlational studies should be complemented with other approaches that are better suited to identify *causal relations* (Cruz-Castro & Sanz Menendez 2019). We used experiments (Study 1), mediation analysis using Process (Studies 4-6), and longitudinal studies (6-7), next to pure correlational approaches (studies 2, 3, 8). The following cases are included, and due to space limitations, only for a few we give some more details.

Study 1 (Cruz-Castro & Sanz-Menéndez 2023a) implemented a randomized controlled field experiment in a Spanish Regional Funding Organization. The causal analysis revealed no significant gender effect in grant evaluation using reviewers scores of applicants, nor was there an interaction effect between the gender of the applicant and the gender of the reviewer.

Study 2 (Sandström 2023) is a correlational analysis of gender bias in the Swedish Research Council SRC. Study 3 (Sandstrom and Sandstrom 2023) is a correlational study of gender bias in a specific funding instrument of the SRC, of the Science Foundation of Ireland (SFI) and of the Austrian FWF.

Study 4 (Mom & van den Besselaar 2023b) analyses the same SRC funding instrument, but now at the panel level, in order to reduce the heterogeneity which exists at the instrument level. Only in the natural sciences panel, systematic bias in favor of men was found and the other two panels were neutral. At the instrument level (study 3), scientific impact had a non-significant positive effect on the scores and on the probability to receive a grant, but this effect disappeared at the panel level. Interestingly, age has a significant effect and the younger the applicant is, the higher the probability to get funded.

Study 5 (Van den Besselaar & Mom2023a) is an experiment comparing different models of peer review within a German research funding organization: traditional reviews versus team-based reviews. At the instrument level, no gender effects were found, but at the panel level is was. Six panels show a male advantage in scores and two are in favor of women. Grant decisions however, show more balanced results and an overall gender neutrality – which is in line with other studies (Van den Besselaar & Mom 2021; Bol et al 2022).

Study 6 (Mom & van den Besselaar 2023a) tested whether gender bias occurred in the scores and the grant decision. And in the latter, men had in all the three panels a (non-significant) advantage. The effect of gender was not mediated by performance, suggesting the absence of indirect bias. In this study, we also looked at *predictive validity*: do the granted applicants outperform the others in the later career? In two of the three panels this was not the case, and with hindsight several very good female applicants should have been funded. So the lack of predictive validity does have a gender effect.

Study 7 (Möller 2024) examines the German Emmy Noether Fellowship, showing among others that gender had no significant effect on the grant decision, but age clearly had. In the longitudinal perspective, gender only has a significant effect on career success (appointment to a professorship) in one of four research fields (biology). In the other three fields (chemistry, medicine, physics), early career grant success is the decisive factor.

Study 8 (Van den Besselaar & Mom 2023b) replicates the Wenneras and Wold (1997) study that played a central role the discussions about gender bias in grant allocation. The study claimed that women, to get a similar score for scientific competence, needed to have an additional three *Science* or *Nature* papers. This finding attracted a lot of attention and critique (Williams et al. 2011; Ceci et al. 2023), and in our replication we still find a significant gender effect on the competence score, but it is an order of magnitude *smaller* than in the original study. Analyzing gender bias in the funding decisions – something Wenneras and Wold did not do – we found a *non-significant* advantage for men in getting grants.

Most studies include *bibliometric performance variables* to account for applicants' merit. The only exception is the experiment in study 1, as the random assignment of the gender of the

principal investigators in the experimental conditions is assumed to measure the direct effect of gender and no further control variables were needed. The different studies do include a series of *covariates*, but not the same in every study. This is partly because data were not available, and partly because in many cases the relatively low N makes the use of many covariates impossible. The following variables appear in the case studies, albeit in different combinations: gender, age, academic age, academic position, institutional affiliation and ranking, cognitive proximity, organizational proximity, linguistic characteristics of the review reports, independence, recommendation letter.

Findings

As the case studies cover three decades, the findings show trends in gender bias in panel scores and in grant decisions. In the more recent observational studies, we found less cases of gender bias in favor of men and more mixed and neutral results as well as cases of gender bias in favor of men compared to the older studies. This result holds for the evaluation scores as well as for the grant decisions. In the experimental study included in the project (a stratified randomized control trial) we found that the gender of the Principal Investigator did not cause bias in the reviewers' assessment, and no significant differences were found between the scores given by male and female evaluators. in the observational studies. We added some large other recent case studies (Van den Besselaar & Mom 2021; Bol et al. 2022) which fit in the pattern found in our project. Table 1 summarizes the findings.

Table 1: Share of cases with bias in favor of men and in favor of women*,**

	Panel score			Grant decision		
	N	Male advantage	Female advantage	N	Male advantage	Female advantage
1990s	1	100%	0%	5	100%	0%
2000s	3	67%	33%	9	77%	11%
2010s	3	67%	0%	4	25%	25%
2020s	8	25%	38%	8	37%	50%

* The GRANteD project, plus the cases from van den Besselaar & Mom 2021 and Bol et al. 2022.
** When percentages do not add up to 100%, some of the cases were neutral and did not bias.

Conclusions and discussion

Some of the studies found a significant direct gender bias in favor of men in the panel scores: Only in one SRC panel (study 3) and in the Wenneras & Wold replication (study 8) this was found, as well as in the two added studies (Van den Besselaar & Mom 2021; Bol et al 2022;). In one panel we found significant bias in favor of women (study 5). We found even less occasions of gender significantly affecting the grant decision, of which two were in favor of women and one was in favor of men. In line with the added studies, our project found that bias in scores does not necessarily leads to bias in grants. Over time the studies show a shift from male advantage to some female advantage. We also inspected the non-significant regression coefficients for gender, and that does not change the overall picture. These

observational findings suggest a tendency towards at least an overall more neutral grant allocation, or even a somewhat advantage for women.

As the case studies are rather different, this result does not seem to be an artifact of the methods deployed. Sato et al. (2021) claimed that *large-size quantitative* studies generally don't find gender bias in grant allocation, but *small-scale qualitative* studies do. Our *small-scale quantitative* case studies fill the gap and lean towards the conclusion that the male dominance in terms of direct gender bias in grant allocation is disappearing. Looking at the panel level, one finds panels with a male and panels with a female advantage. The question to answer may be less whether there is overall bias against women in grant allocation and why, but under which conditions bias at panel level is in favor of men or in favor of women.

The findings presented here are about direct gender bias, and that does not preclude the existence of *indirect gender bias* in grant evaluation. Women may score systematically lower on accepted evaluation criteria like publication impact and output, due to e.g., inequal working conditions, or inequal division of labor in private life. In some of the cases we tested mediation (Hayes 2018): Is the effect of gender on grant allocation mediated by academic performance? Explaining the underlying mediation mechanism is outside the scope of this paper. However, hardly any mediation effects were found in those case studies where the test was done.

We also tested in one case for predicted validity (are grant decisions still justified if one takes into account the later performance of the applicants), and the answer here is 'partly'. In several panels we found that with hindsight other selections of grantees would have been better, and these would have had a positive effect for women.

One may overall conclude that the decision-making process either corrects (at least to a large extent) gender bias in the peer and panel review scores, or at least does not introduce additional gender bias. How that works is an interesting question for further research.

Finally, the research also raises methodological questions, which could improve further research: (i) Some of the funding instruments – especially the thematic grants – have teams of applicants where the 'gender' of the applicant is difficult to determine, unless we take the gender of the Principal Investigator (PI). Different 'gender-mixes' occur and one needs a method to take that into account. (Sandstrom & van den Besselaar 2021) (ii) Several of the analyses are probably suffering from heterogeneity, especially where the analyses are done at the level of a funding scheme that includes all fields (or in case of thematic grants many themes). (iii) As the samples in most of the cases are relatively small (even when cases are at the funding scheme level), the power of statistical tests are low and that implies that one can only detect large effects, and small gender effects may have been missed. (iv) Large-scale studies are relevant, especially if multi-level designs can be applied to include panel characteristics in the analyses. Data requirements for studies on gender bias in grant allocation have to become stronger: bigger and richer data are required and do exist, especially the research funding organizations may have a task here to make those data accessible to the scientific community. (v) The methodological lesson is that one should avoid small scale studies, as they suffer too much from heterogeneity and lack of power.

Finally, it is needed to extend the set of variables measuring merit, quality, and performance, and especially trying to define and operationalize those criteria that implicitly or explicitly play a role in grant evaluation. One could think of variables as independence (Van den

Besselaar & Sandstrom 2019; Möller et al 2022), but also more personal characteristics as academic leadership. These variables should be properly defined and operationalized, as without valid and reliable indicators, human and small group decision-making becomes easily subjective and this leads to noise and bias (Kahneman et al 2021; Van den Besselaar and Sandstrom 2019b). In this context, the experimental approach with strong internal validity has generated robust evidence, that should be replicated in other contexts and funding agencies to enhance its external validity. And where experiments are impossible, causal methods for observational data should be used more.

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