

1 **Potential Bias in Peer Review of Grant Applications at**  
2 **the Swiss National Science Foundation**

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46 **Abstract**

47 **Background.** The Swiss National Science Foundation (SNSF) supports fundamental and use-  
48 inspired research in all academic disciplines. As part of the evaluation procedure, grant  
49 applications to the SNSF are reviewed by external reviewers. The legitimacy of funding decisions  
50 depends on its ability to base funding decisions solely on the scientific merit of grant applications.  
51

52 **Aim.** We examined whether the following factors influenced the scores given to grant applications  
53 submitted to the SNSF: (1) source of nomination of the reviewer, (2) the gender of the applicant  
54 and the reviewer, and (3) the country of affiliation of the reviewer.  
55

56 **Methods.** We gathered data on 38,250 external reviews of 12,294 unique grant applications across  
57 all disciplines between 2006 and 2016. Proposals were rated on a scale from 1 (=poor) to 6  
58 (=outstanding) by 26,836 reviewers. We used linear mixed effects regression models adjusted for  
59 research topic, applicant's age, nationality and affiliation.  
60

61 **Results.** We found that in univariable analysis applicant-nominated reviewers awarded higher  
62 evaluation scores than reviewers nominated by the SNSF. Further, reviewers affiliated with  
63 research institutions outside of Switzerland gave more favourable evaluation scores than reviewers  
64 affiliated with Swiss institutions. Finally, male reviewers awarded higher evaluation scores than  
65 female reviewers and male applicants received more favourable evaluation scores than female  
66 applicants. When we controlled for confounding factors, adjusted differences changed little for  
67 source of nomination and country of affiliation. In contrast, the gender differences nearly  
68 disappeared, which indicates that most of the gender effects observed in univariable analysis is  
69 explained by differences in scores between research topics and applicant affiliations.  
70

71 **Conclusions.** Our study showed that peer review of grant applications at SNSF may be prone to  
72 biases stemming from different applicant and reviewer characteristics. Based on this study the  
73 SNSF abandoned nomination of reviewers by applicants, and made members of panels aware of  
74 the other systematic differences in scores. We encourage other public funding bodies to conduct  
75 similar studies.  
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## 86 Introduction

87  
88 In public research funding, peer review of proposals by experts in each field is the accepted best  
89 practice for determining which projects are allocated funding. Peer review is an important  
90 element of quality assurance in the scientific community (Harman 1998). Against this  
91 background, a wealth of literature is concerned with the question of the legitimacy of peer review  
92 decisions. Generally speaking, the legitimacy of funding decisions relies on a funder's ability to  
93 minimize distortions in grant evaluations resulting from the influence of factors that are  
94 unrelated to the actual quality of the grant applications (Lutz Bornmann and Daniel 2007).  
95 Empirical studies usually examine whether and to what degree such factors influence funding  
96 decisions (Demicheli and Di Pietrantonj 2007). These studies suggest that the evaluation of  
97 applications is prone to biases that can stem from a number of sources that are related to both  
98 applicants' and reviewers' characteristics, including, but not limited to, age or institutional  
99 affiliation (Lutz Bornmann and Daniel 2007).

100  
101 Mandated by the Swiss Confederation, the Swiss National Science Foundation (SNSF) supports  
102 basic research and use-inspired basic research in all academic disciplines. With the aim of  
103 detecting and reducing potential biases in funding allocation, the SNSF started monitoring its  
104 evaluation processes in 2006. The main funding scheme of the SNSF is project funding, which  
105 provides support to independent researchers who propose research on self-chosen topics (Swiss  
106 National Science Foundation 2016). The final decision on funding is taken by the National  
107 Research Council (NRC), a body consisting of pre-eminent researchers based in Switzerland,  
108 which takes into account the reports of two or more external expert reviewers. Several factors are  
109 of concern in the context of external peer review of grant applications at the SNSF, including:

- 111 1. *Nomination of reviewers*: The SNSF previously allowed grant applicants to suggest  
112 reviewers to evaluate submissions via a “positive list”. A study of the Australian  
113 Research Council found that applicant-nominated reviewers tend to give better ratings  
114 than panel-nominated reviewers (Marsh, Bond, and Jayasinghe 2007). Similarly, a study  
115 of peer review in biomedical journals found that author-nominated reviewers made more  
116 favourable recommendations than editor-nominated reviewers (Schroter 2006).
- 117 2. *Country of affiliation of reviewers*: The SNSF frequently invites reviewers from abroad  
118 to review grant applications. The Australian study found that reviewers affiliated with an  
119 US research institution were more lenient than reviewers affiliated with institutions  
120 located in the United Kingdom, Germany and Australia (Wood and Australian Research  
121 Council 1997). In contrast, a study of the Austrian Science Fund suggested that reviewers  
122 affiliated with research institutions located in countries known for high scientific  
123 productivity were generally more stringent (Fischer and Reckling 2010).
- 124 3. *Gender of principle applicants and reviewers*: Potential discrimination against women is  
125 the most frequently investigated bias in the context of grant peer review (Mutz,

126 Bornmann, and Daniel 2012). A meta-analysis of gender bias studies showed small  
127 gender differences in grant awards where men were more likely to receive research  
128 funding than women. This meta-analysis also showed that gender differences in  
129 evaluation scores vary substantially between funding schemes and funding bodies and  
130 may be explained by other, confounding variables (L Bornmann, Mutz, and Daniel 2007).

131  
132 We analyzed the database of the SNSF to examine whether scores from applicant-nominated  
133 external reviewers differed from those from reviewers proposed by the SNSF, whether they  
134 differed between reviewers affiliated with a Swiss research institution and reviewers from  
135 foreign institutions, and whether they differed depending on the gender of the applicant or  
136 reviewer.

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## 138 **Materials & Methods**

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### 140 **Evaluation of Grant Applications at the SNSF**

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142 The evaluation of grant applications at the SNSF consists of four steps. After researchers have  
143 submitted their applications, the administrative office performs a formal verification in the first  
144 step and assign grant applications to two members of the NRC (referee and co-referee) based on  
145 their field of expertise. In a second step, eligible proposals are peer-reviewed by external experts  
146 according to the following criteria (Swiss National Science Foundation 2016): with regard to the  
147 applicant: 1) *Scientific track-record and ability to carry out the research project*; with regard to  
148 the project: 2) *Scientific relevance, originality and topicality* and 3) *Suitability of methods and*  
149 *feasibility*. Reviewers score each criteria on a scale from 1 to 6: (1) *poor*, (2) *fair*, (3) *average*,  
150 (4) *good*, (5) *excellent*, and (6) *outstanding*. In addition, reviewers submit an overall score of the  
151 proposal.

152

153 During the study period, expert reviewers were identified in several ways: (1) grant applicants  
154 suggested experts via a “positive list”, (2) NRC referees suggested reviewers, (3) the SNSF  
155 administrative offices proposed experts, and (4) experts may have declined to review but  
156 suggested other reviewers (Swiss National Science Foundation 2016). Applicants could also  
157 submit a “negative list” of reviewers who, because of possible conflicts of interest, should not be  
158 contacted. For each application, at least two external independent reviews were required.

159

160 In the third step of the evaluation, the two members of the NRC (referee and co-referee) assessed  
161 the usefulness of the peer review reports and took them into account when ranking the  
162 application relative to other proposals. In the fourth and final step, referee and co-referee present  
163 their assessment at the meeting of the corresponding section of the NRC. Each application is  
164 voted on and approved or rejected (Swiss National Science Foundation 2016).

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## 166 **Data and Variables**

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168 The outcome variable of interest was the overall evaluation score of a grant application ranging  
169 from 1 (=poor) to 6 (=outstanding). Explanatory variables included meta-data on applicants and  
170 external reviewers, including *source of reviewer nomination* (applicant-nominated vs. SNSF-  
171 nominated), *gender of the applicant and gender of the reviewer* (female vs. male) and *country of*  
172 *affiliation of the reviewer* (Switzerland vs. other). The category of SNSF-nominated experts  
173 includes reviewers who were proposed by the referee, the SNSF office or by experts who were  
174 initially contacted but declined to review. The latter three sources of reviewers were grouped  
175 together and categorized as “SNSF-nominated” in the analysis. We also considered meta-data  
176 regarding the *research topic* of a grant application, *type of affiliation* and *age of the applicant*.  
177 Last, because the SNSF introduced new guidelines for reviewers in October 2011, which had an  
178 effect on the distribution of evaluation scores, we introduced a dummy variable *application call*  
179 *deadline* that groups applications submitted before and after October 2011.

## 180 181 **Statistical Analysis**

182  
183 We used a linear mixed effects model to examine the effect of explanatory variables on the  
184 overall peer-review scores (Bates et al. 2015). This model was chosen because our data are  
185 clustered and hierarchical (Jayasinghe, Marsh, and Bond 2003). Grant applications received two  
186 or more independent reviews, some reviewers had reviewed more than one application and many  
187 applicants had submitted more than one grant application over the study period, causing  
188 evaluation scores to be clustered at the levels of research projects, reviewers and applicants. We  
189 therefore introduced random effects on the IDs of the reviewer, the applicants and the project in  
190 the model, thus taking into account the non-independence between clustered scores (Harrison et  
191 al. 2018).<sup>1</sup> We present regression coefficients, which reflect differences in peer review scores,  
192 and coefficients adjusted for research topic, applicant's age, nationality and affiliation, with their  
193 95% confidence interval (CI).

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<sup>1</sup> The notebook of the analysis, including a summary of the different statistical models, is available online at [www.git.io/fhaJx](http://www.git.io/fhaJx).

## 202 Results

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### 204 Descriptive Analysis

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206 We analyzed the overall assessment scores of 38,250 external peer review reports on 12,294  
207 project grant applications across all disciplines that were submitted 2006 to 2016 by 26,836  
208 external experts from Switzerland and abroad. The average number of reviews per grant  
209 application was 3.1, applicants submitted an average of 2.1 grant applications and reviewers  
210 reviewed an average of 1.4 applications.

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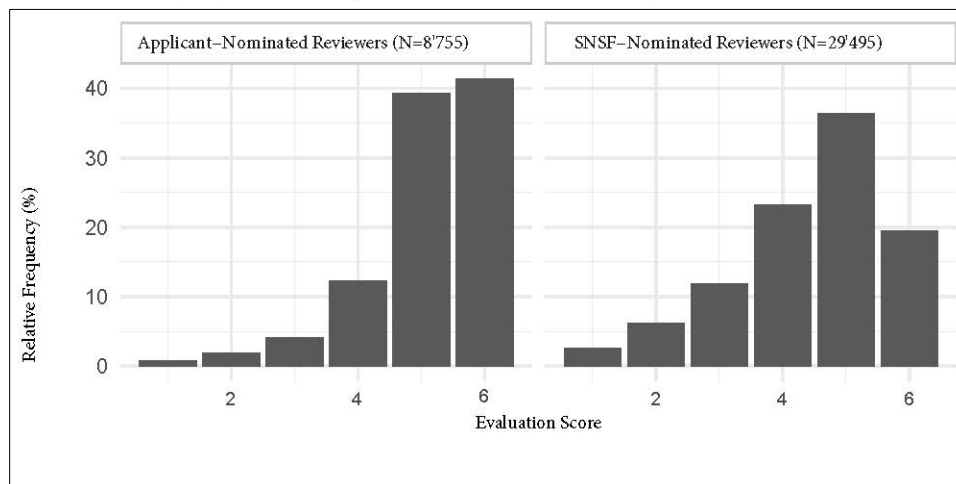
212 In a first step, we examined overall score distributions for the different reviewer and applicant  
213 characteristics that represent potential sources of bias in the external evaluation of grant  
214 applications at the SNSF. Frequency distributions of external evaluation scores are shown in  
215 Figures 1, 2, 3 and 4. Distributions were skewed for all variables, with grant applications more  
216 frequently being awarded high evaluation scores than low scores.

217

218 Applicant-nominated reviewers awarded higher scores than SNSF-nominated reviewers. The  
219 *source of external reviewer nomination* thus influenced evaluation scores (Fig. 1).

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221 **Figure 1: Frequency distributions of external evaluation scores by source of nomination of the  
222 reviewer, ranging from 1 (=poor) to 6 (=outstanding).**



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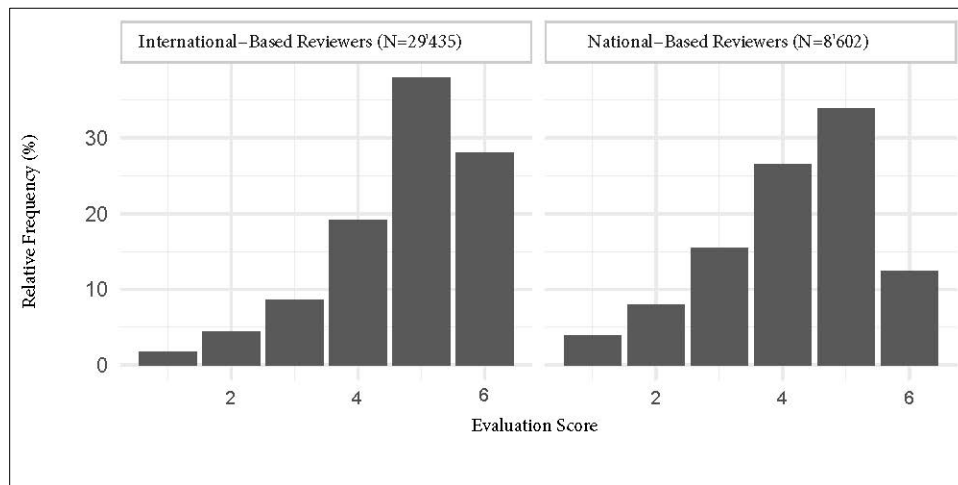
225 Similarly, reviewers affiliated with foreign research institutions awarded higher evaluation  
226 scores than reviewers affiliated with Swiss research institutions: *country of reviewer affiliation*  
227 could thus also influence the evaluation (Fig. 2).

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231 **Figure 2: Frequency distributions of external evaluation scores by country of affiliation of the**  
 232 **reviewer.**

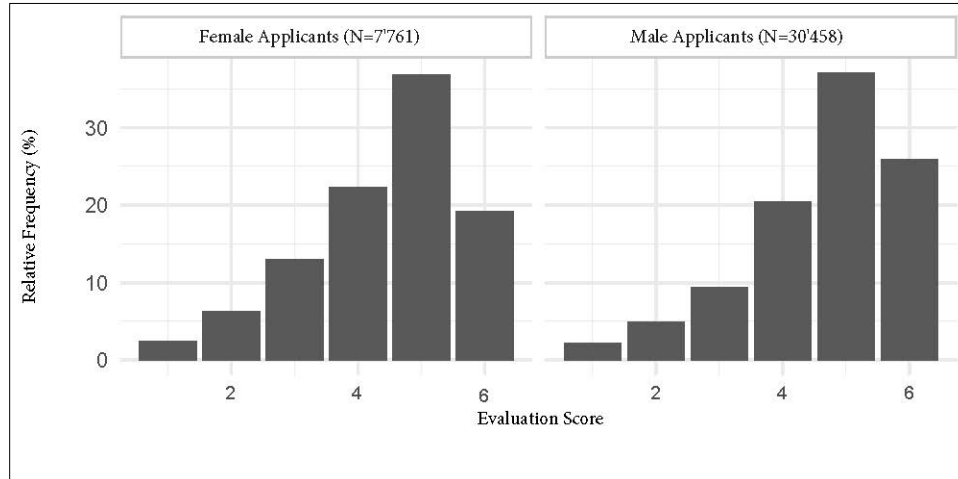


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235 The distribution of evaluation scores by *gender of the principle applicant* (Fig. 3) shows that  
 236 male principle applicants received higher evaluation scores than female principle applicants.  
 237 Similarly, analysis of evaluation scores by *gender of the reviewer* showed that male reviewers  
 238 tended to award higher scores than female reviewers (Fig. 4).

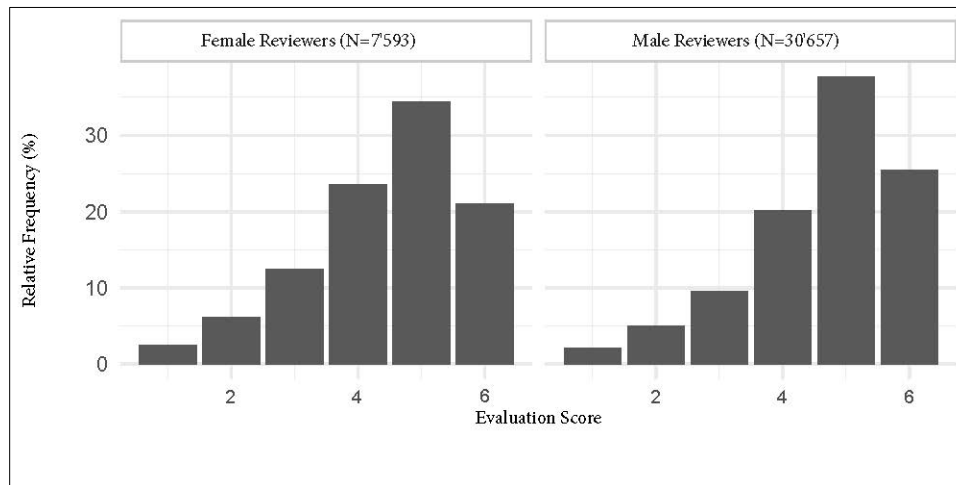
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**Figure 3: Frequency distributions of external evaluation scores by gender of the applicant.**



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250 **Figure 4: Frequency distributions of external evaluation scores by gender of the reviewer.**



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253 To further explore gender differences in applicant scores, we stratified analyses by *research*  
254 *topic* (Fig. 5, supplementary files), *applicant age* (Fig. 6, supplementary files) and *applicant*  
255 *affiliation* (Fig. 7, supplementary files).

256

257 There were important differences in evaluation scores across *research topics*. For example, grant  
258 applications in the natural and technical sciences or in linguistics and history received higher  
259 evaluation scores than applications covering other topics. Gender differences in evaluation scores  
260 were more pronounced for some research topics (for example mathematics and physics and  
261 engineering, biology and medicine, sociology) than others (for example geology, history,  
262 psychology). Female applicants were underrepresented (below 50 percent) in all research topics  
263 (lower panel of Fig. 5, supplementary files).

264

265 Regarding *applicant age*, applicants aged 60 years or older received the highest evaluation  
266 scores, independent of their gender. For the younger age groups, female applicants consistently  
267 received lower evaluation scores than male applicants. For groups aged 65 or older, female  
268 applicants received higher evaluation scores than male applicants. Female applicants were  
269 underrepresented across all age groups, except for the youngest age group, and representation  
270 was particularly low in older age groups (lower panel of Fig. 6, supplementary files).

271

272 Regarding *applicant affiliation*, applications submitted by applicants who are affiliated with the  
273 Swiss Federal Institutes of Technology and associated research institutions (“ETH Domain”)  
274 received higher evaluation scores than applications from Cantonal universities or from other  
275 research institutions. Gender differences in scores were evident for all three affiliations, and  
276 women were underrepresented for all affiliations (lower panel of Fig. 7, supplementary files).

277

278 Analysis of the *nationality of the applicant* showed that grant applications submitted by  
279 applicants with a Swiss nationality received slightly lower scores than those submitted by



280 applicants with other nationalities, with a similar gap between genders (Fig. 8, supplementary  
 281 files). Finally, Figure 9 (supplementary files) shows the effect of the *new evaluation guidelines*  
 282 *for reviewers* that were introduced in October 2011. Grant applications submitted before October  
 283 2011 received higher average scores than applications evaluated under the new guidelines.

284

## 285 Linear Modeling of the Effects

286

287 Table 1 presents the final, adjusted model and Table 2 (supplementary files) compared crude and  
 288 adjusted differences in average scores.

289

290 **Table 1: Differences in external peer review evaluation scores between characteristics of reviewers,**  
 291 **applicants and research proposals.**

292

Variable	Difference in score (95% CI)	P-Value
Source of nomination of reviewer		<0.001
Applicant	0.49 (0.46 – 0.51)	
Office	0	
Country of affiliation of the reviewer		<0.001
Outside Switzerland	0.47 (0.44 – 0.50)	
Switzerland	0	
Gender of the applicant		<0.001
Male	0.08 (0.04 – 0.13)	
Female	0	
Gender of the reviewer		<0.001
Male	0.08 (0.05 – 0.11)	
Female	0	
Age of the applicant		<0.001
Per 10 year increase	0.05 (0.03 – 0.07)	
Affiliation of the applicant		<0.001
ETH Domain	0.11 (0.07 – 0.16)	
Other Universities	-0.19 (-0.25 – -0.14)	
Universities	0	
Nationality of the applicant		0.218
Other than Swiss	-0.02 (-0.05 – 0.01)	
Swiss	0	
Field of research		<0.001
Medicine	0	
Architecture	0.14 (0.05 – 0.24)	
Biology	0.27 (0.21 – 0.33)	
Chemistry	0.24 (0.17 – 0.31)	
Economics	-0.01 (-0.09 – 0.06)	
Engineering	0.07 (0.00 – 0.13)	
Geology	0.25 (0.14 – 0.35)	
History	0.32 (0.24 – 0.40)	
Linguistics	0.26 (0.18 – 0.34)	
Mathematics / Physics	0.45 (0.39 – 0.52)	
Psychology	-0.08 (-0.15 – 0.00)	
Sociology	0.01(-0.07 – 0.08)	
Call-cut		<0.001
Before introduction of guidelines	0.43 (0.40 – 0.46)	
After introduction of guidelines	0	

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295

Notes. Results from linear mixed effects models. Marginal R<sup>2</sup>: 0.13, Conditional R<sup>2</sup>: 0.526, Intercept 4.45 (95% CI 4.34-4.57). Random effect variances: Between reviewers: 0.37, Between applicants: 0.15, Between projects: 0.08, Residual: 0.72.

296 In the adjusted model, substantial differences of about 0.5 points are observed for *source of*  
297 *reviewer nomination* and *country of affiliation of the reviewer*. Small differences (less than 0.1  
298 point) are evident for *gender of the principle applicant* and *gender of the reviewer*. Substantial  
299 differences are also observed across disciplines. For example, scores are on average 0.45 points  
300 higher in mathematics and physics than in medicine, but about 0.1 point lower in psychology  
301 (Table 1).

302

303 Compared to crude differences, adjusted differences tended to be attenuated. For example, the  
304 crude difference between male and female applicants was 0.19 points, compared to 0.09 points in  
305 the adjusted analysis (Table 2, supplementary files).

306

## 307 Discussion

308

309 We retrospectively examined whether the scores given by external reviewers to grant  
310 applications submitted to the SNSF were influenced by the following factors: (1) *the source of*  
311 *nomination of the reviewer*; (2) *the country of affiliation of the reviewer*; (3) *the gender of the*  
312 *principle applicant* and *the gender of the reviewer*. We analysed data on 38,250 reviews of  
313 12,294 unique grant applications across all disciplines between 2006 and 2016 using linear  
314 mixed effects regression.

315

316 Our analyses showed that the source of nomination of a reviewer has a statistically significant  
317 effect upon evaluation scores in the external peer review of grant applications at the SNSF.  
318 Reviewers who were nominated by applicants via the “positive list” on average tended to award  
319 higher evaluation scores than reviewers nominated by SNSF administrative offices, referees or  
320 other reviewers. This effect can be interpreted in several ways. First, applicant-nominated  
321 reviewers may award more favorable evaluation scores because they know the applicants  
322 personally and/or have received positive evaluations from the applicant in the past (Schroter  
323 2006). This would mean a conflict of interest. Second, applicants may nominate reviewers who  
324 are experts within their field and therefore might be particularly familiar with their research and  
325 will recognize the impact and importance of their grant application. The SNSF decided to  
326 discontinue the use of the “positive list”, thereby abolishing the possibility for grant applicants to  
327 suggest their own reviewers. Of note, applicants can still submit negative lists of reviewers that  
328 should not be used because of conflicts of interest.

329

330 Our analyses further showed that the country of affiliation of the reviewer affects evaluation  
331 scores. Reviewers affiliated with a research institution outside of Switzerland tend to give higher  
332 evaluation scores than reviewers affiliated with a Swiss institution. It is possible that reviewers  
333 affiliated with institutions in countries known for high scientific productivity generally are less  
334 favorable in their evaluation of grant applications than reviewers from countries lagging behind  
335 in terms of their scientific productivity (Fischer and Reckling 2010). Switzerland consistently

336 has been shown to belong to the most productive countries in terms of its research outputs  
337 (Bonaccorsi and Cinzia Daraio 2007) and this might explain why we found that reviewers  
338 affiliated with Swiss research institutions award lower evaluation scores than reviewers affiliated  
339 with foreign universities. It should be noted, however, that this interpretation is based on the  
340 assumption that a country's scientific productivity is influenced by standards of scientific quality  
341 and excellence of its national research system. A further interpretation for this bias is that Swiss-  
342 based reviewers might be downgrading their competitors, in order for there to be more funds for  
343 their own projects to be funded. As the Swiss research community is small, it is basically  
344 impossible to rule out conflicts of interest as a potential reason for biases stemming from country  
345 of affiliation of the reviewer. Another possible explanation for the effect we observed is that  
346 there are other factors that contribute to the stringency of reviewers affiliated with Swiss  
347 institutions. For example, it could be that Swiss reviewers are commonly asked to review on  
348 topics related to the social sciences, law and humanities as the focus of topics within these fields  
349 is often more national than international, which would require domestic experts. As we have seen  
350 in our analyses, reviewers within these fields award lower evaluation scores than reviewers in the  
351 natural and technical sciences.

352  
353 Finally, our study has shown that both the reviewer's gender and the applicant's gender influence  
354 evaluation scores. In the external evaluation of grant applications submitted to the SNSF, male  
355 reviewers tend to award higher evaluation scores than female reviewers and male applicants tend  
356 to receive higher evaluation scores than female applicants. Both of these effects were small.  
357 These findings are in line with previous research that found robust evidence of small gender  
358 differences in grant award procedures (Bornmann, Mutz, and Daniel 2007). It should be  
359 mentioned that when we adjusted for research topic, applicant's age, nationality and affiliation in  
360 the regression model, the effects related to gender decreased significantly. This indicates that  
361 observed gender differences in the external evaluation of grant applications at the SNSF can, in a  
362 large part, be explained by other, confounding factors. The SNSF started to monitor gender  
363 differences on a regular basis in 2013, overseen by an independent commission on gender and  
364 equality. The annual analyses provide the opportunity to detect and address gender effects in a  
365 timely manner and to take precautionary measures. Remaining gender effects could be explained  
366 by factors that we could not include in our model, or by the fact that external reviewers indeed  
367 might have a small bias against female applicants.

368  
369 Our study has several limitations. First, this is an observational study and our inferences are from  
370 data retrospectively gathered on evaluation scores as the outcome variable and reviewer and  
371 applicant characteristics as the independent variables. The latter were not under our control and it  
372 is difficult to infer causality. Chance, bias, and confounding variables must always be considered  
373 as possible explanations for associations between reviewer and applicant characteristics on the  
374 one hand and evaluation scores on the other hand. We tried to mitigate the influence of  
375 confounding variables by adjusting for these in our regression model. Second, there were low

376 proportions of female reviewers and applicants, which reduces the resolution power of our  
377 observational study in terms of gender effects. From a more general point of view, it should be  
378 noted that our study covers SNSF project funding only, and does not relate to other SNSF  
379 research funding schemes including career funding for early career researchers, programme  
380 funding, awards and prizes as well as infrastructure and science communication funding. In  
381 addition to this, our results pertain to the external review of grant applications submitted to the  
382 SNSF. Our study does not cover evaluation scores awarded by members of the NRC, who serve  
383 as (co-)referees, or the final funding decisions of the evaluation body. This restricts the  
384 generalizability of our results concerning SNSF evaluation procedures as a whole.

385

386 We encourage funding bodies to monitor their evaluation processes in order to detect and  
387 adequately address potential biases in evaluation scores and final funding decisions. Further  
388 research is needed that aims to disentangle the underlying mechanisms of biases in grant  
389 funding.

390

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392

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