SWISS NATIONAL SCIENCE FOUNDATION

Gender Monitoring 2019
A Technical Report on Project Funding at the SNSF

1 Introduction

The Swiss National Science Foundation (SNSF) conducts a regular gender monitoring as requested by its Gender Equality Commission (GECo). The aim of this monitoring is to understand whether a systematic gender bias exists in the peer review process, and if it does, to determine possible explanations and decide if and which interventions are needed. In addition to inspecting the differences in success rates between female and male applicants, we try to disentangle the effect of the applicants' gender from the effects of other variables using flexible modelling techniques. We also look at how the gender effect has changed over time, and explore possible reasons for its existence. Finally, we investigate whether the funding level of approved projects is influenced by the gender of the applicant.

1.1 Review Process of the SNSF Project Funding

This report focuses on project funding, the SNSF's main funding instrument. Project funding enables qualified researchers to conduct self-chosen research projects independently. There are two calls for applications each year, on the 1st of April and the 1st of October. The projects can run for a maximum of four years. To determine acceptance, the scientific quality (scientific relevance, topicality and originality, suitable methods, and feasibility) of the project is evaluated together with the scientific qualifications of the applicants (scientific track record, ability to carry out the research project).

Each application is assigned to a referee and a co-referee (from the SNSF research council) who provide a recommended grade. To make an informed decision about this recommended grade, the responsible referees collect assessments from external reviewers. The referees then present their recommendation to the relevant evaluation body which decides on the overall grade of the project.

1.2 Data and Descriptive Statistics

This report will concentrate on the last ten years (from October 2008 to October 2018), and data will be presented for each of the three main research areas in project funding: Social Sciences and Humanities (SSH); Mathematics, Natural and Engineering Sciences (MINT); and Life Sciences (LS). In this report, the gender of the corresponding applicant of each application is used. Figure 1 shows the percentage of applications for each gender by call and research area. The percentage of applications from female applicants does indeed increase, but only very slowly. Especially for MINT, where the percentage of female applicants was 9% at the end of 2008, and is now 14%.

The trend of the unadjusted success rates for male and female applicants over time are provided in Figure 2. The evolution of these success rates is hard to interpret since the curves are fairly jagged. From the first subfigure with all research areas combined, we could conclude that the curves for male and female applicants are evolving together. However, the evolution of the success rates is very dependent on the research area. It also appears as if the success rates for male applicants decreased over time, while the success rates of female applicants is more constant, especially considering the data when all research areas are grouped together. In order to identify potential reasons or confounders of these differences in success rates for male and female applicants, we investigate gender differences in other variables.

Figure 3 tells us what percent of the researchers applying to project funding are international (researchers in Switzerland with non-Swiss citizenship), stratified by gender and research area. In general, it appears that applicants are becoming increasingly more international. Female applicants in particular are frequently non-Swiss, especially in MINT. As it is possible that Swiss researchers might have an implicit advantage over foreigners when applying at a Swiss organization, these non-Swiss women may have a disadvantage here.

Furthermore, the percentage of female applicants who apply to the SNSF for the first time is higher than the percentage of male first timers, and this holds true for (almost) all research areas and calls (see Figure 4). First time applicants might be judged as less experienced and consequently their applications get lower grades.

According to Figure 5, female and male applicants are similarly likely to submit continuation projects which are generally approved at a higher rate. A higher percentage of the male applicants for project funding are full professors compared to the female applicants (see Figure 6). Note that data about professorship status has only been recorded since October 2016. In the eyes of the referees and reviewers, full professors may be considered more experienced and therefore more capable of accomplishing the goals of their projects, putting them in a better position for funding.

Figure 7 shows the distribution of applications with respect to the type of institution where the applicant is employed. Most applications are submitted by researchers from universities. For MINT however, the highest percentage of applications come from the ETH domain. The percentage of male researchers is much higher than the percentage of female researchers at ETH domain institutions.

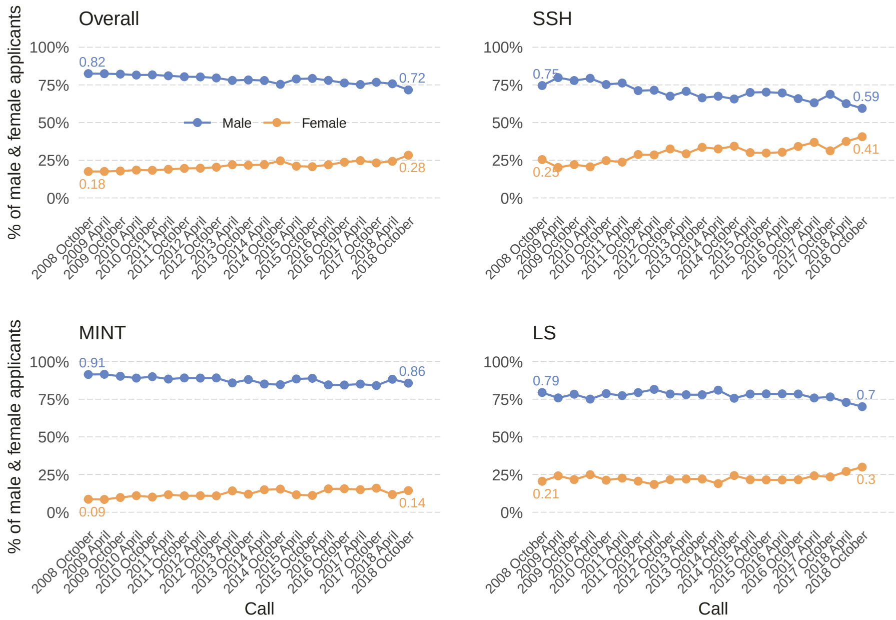

Figure 1: Percentage of applications from each gender over time, by research area.

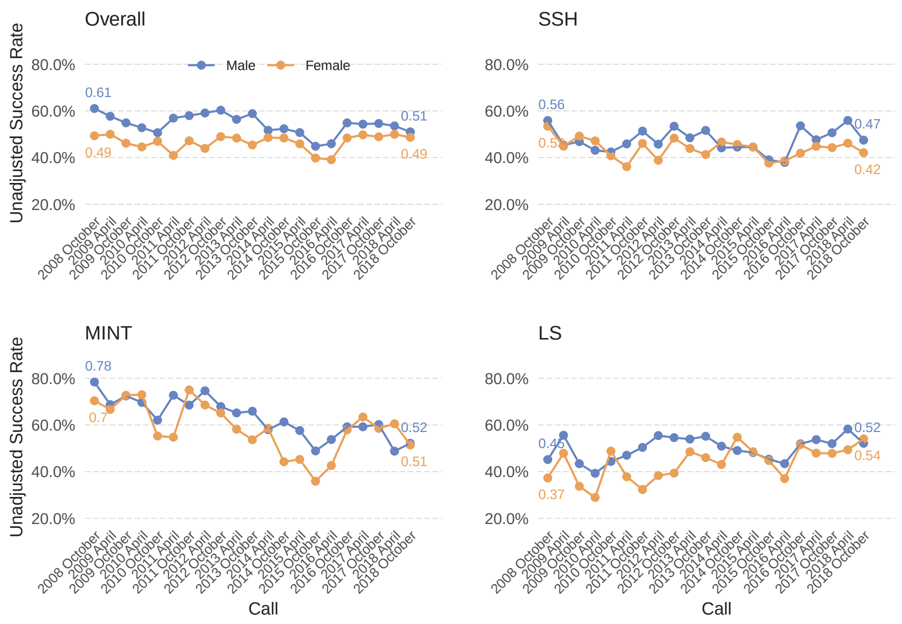

Figure 2: Unadjusted success rates over time, by gender and research area (no modelling involved here).

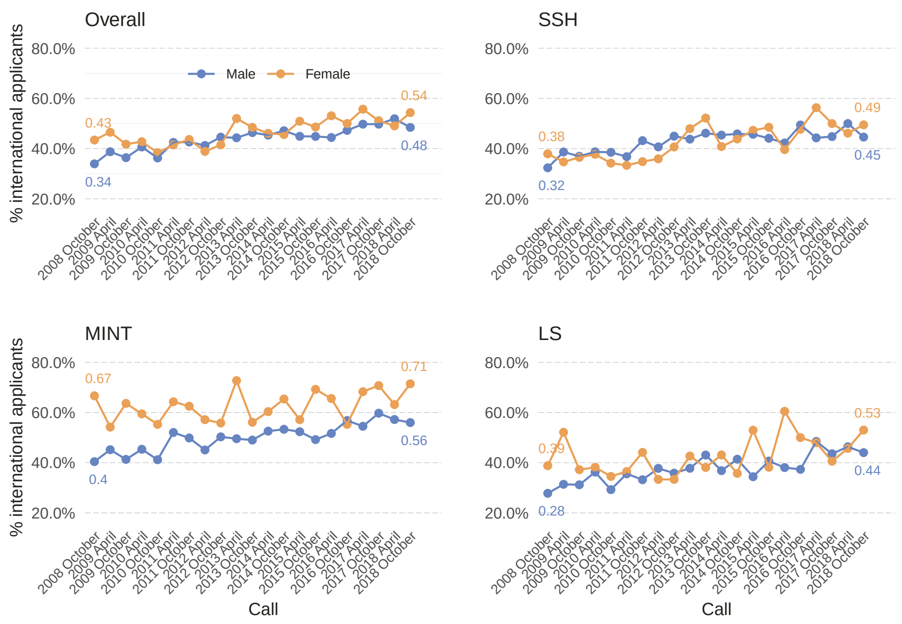

Figure 3: Percentage of non-Swiss applicants over time, by gender and research area.

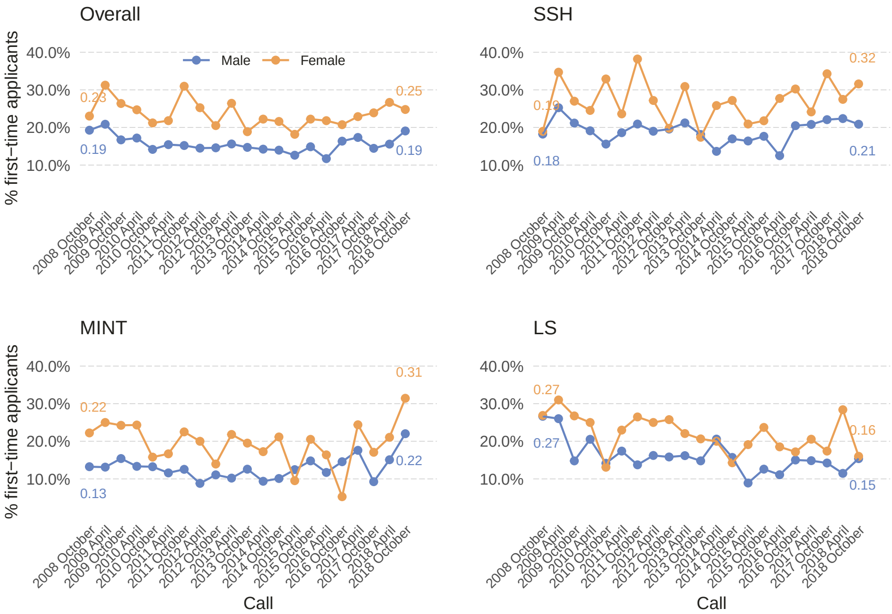

Figure 4: Percentage of first-time applicants over time, by gender and research area.

Figure 5: Percentage of continuation applications over time, by gender and research area.

Figure 6: Percentage of applications from full professors over time, by gender and research area.

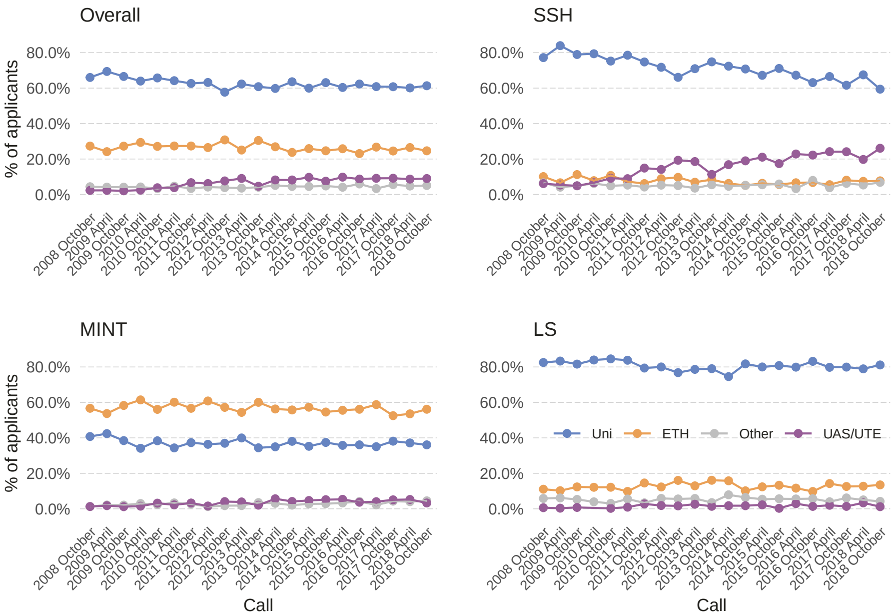

Figure 7: Percentage of applications from each institution type over time, by research area.

2 Multivariate Analysis

To analyse a possible gender effect in the peer review process in project funding, we will start modelling the binary outcome 'approval vs. rejection' using logistic regression models in Section 2.1. Then, since the models in 2.1 only inform us about the final decision and less about the steps throughout the process, in Section 2.2 we discuss models that investigate gender effects in the external reviewers' evaluations. As a final modelling step, we apply normal linear models to understand if and how the funding level for approved projects is influenced by the gender of the applicant in Section 2.3.

2.1 Success (Odds Ratios)

Table 1: Odds Ratio Female vs Male of binary regression models, stratified by research area, for the three most recent calls.

Research Area	Unadjusted OR (95% CI)
SSH	0.75 (0.55 to 1.01)
MINT	1.17 (0.78 to 1.74)
LS	0.87 (0.65 to 1.16)

The female vs male odds ratios (OR) from an unadjusted fixed effect logistic regression model, stratified by research area, can be found in Table 1, for the three most recent calls in our data (October 2017, April 2018 and October 2018). This OR measures how much more or less likely female applicants are to get funding compared to male applicants.

The OR for SSH and LS are smaller than 1, meaning that on average male applicants have higher odds of getting funding for their project than female applicants. Both 95% confidence intervals include 1, but for SSH just barely. The opposite is true for MINT, which has a very large confidence interval.

We would like to investigate how these ORs have changed over time. To study the gender OR trends, we will use all the available data on all the calls since October 2008 and apply restricted cubic splines on this time/call variable. Hence, the models become time-dependent. Further, since over this long time span some researchers have applied to project funding more than once, we also include a random intercept for the main applicant using a mixed regression model.

To see the evolution of the gender odds from one call to the next, we let the gender variable interact with a spline on the call. This enables us to calculate odds ratios for different points in time. A difficulty in using splines is that they depend on "knots" to determine where to divide up the curve in space, and we have to define how many knots should be used and where to fix these knots. We are analysing data on eleven years with two calls each year, resulting in 21 different calls (in 2008 we only use the information from the call in October). The knot arrangement we choose should be able to handle the fact that the SNSF started its gender monitoring at the end of 2013, and introduced regulation reforms at the end of 2016, both of which potentially influenced application and evaluation practices. We tested several arrangements of knots, and in our final model we use four knots, which produces results consistent with other values without over-fitting the model.

The unadjusted model (with gender interacting with the call-spline as the sole fixed variable) stratified by research area is summarized in Figure 8. This figure shows the evolution of the gender odds ratio over the different calls together with their 95% Wald confidence intervals for the three research areas separately. For SSH, the gender OR is significantly below 1 between the 2011 October and 2013 April calls, favoring men over women, and the same is true in October 2017. In MINT, the gender OR is significantly smaller than 1 between April 2014 and April 2016. In LS, a significant gender bias can be observed before 2014 (before the introduction of the gender monitoring). Hence, depending on the research area and call we can detect some periods where, without considering confounding factors, men had higher odds of being approved.

In Section 1.2 we discussed some other variables that might be acting as confounders, meaning that they may influence the final decision, but may also influence the gender distribution. Therefore Figure 9 shows again the evolution of the OR, but using a model adjusted for institution type, age (in decades) and external reviewer grade. Note that we explored other confounders (first-time applicants, continuation projects, etc.) using state-of-the-art variable selection methods, but with the goal of working with a simple model, we retain only the first three.

After adjustment for these confounders, significant gender effects only remain in MINT in 2015 and in LS from the end of 2010 to the beginning of 2013. We observe that most gender differences can be explained by the external reviewer grades. For the same external reviewer grade, male and female applicants have, on average, the same chance of getting approval (for SSH, and most calls in MINT and LS).

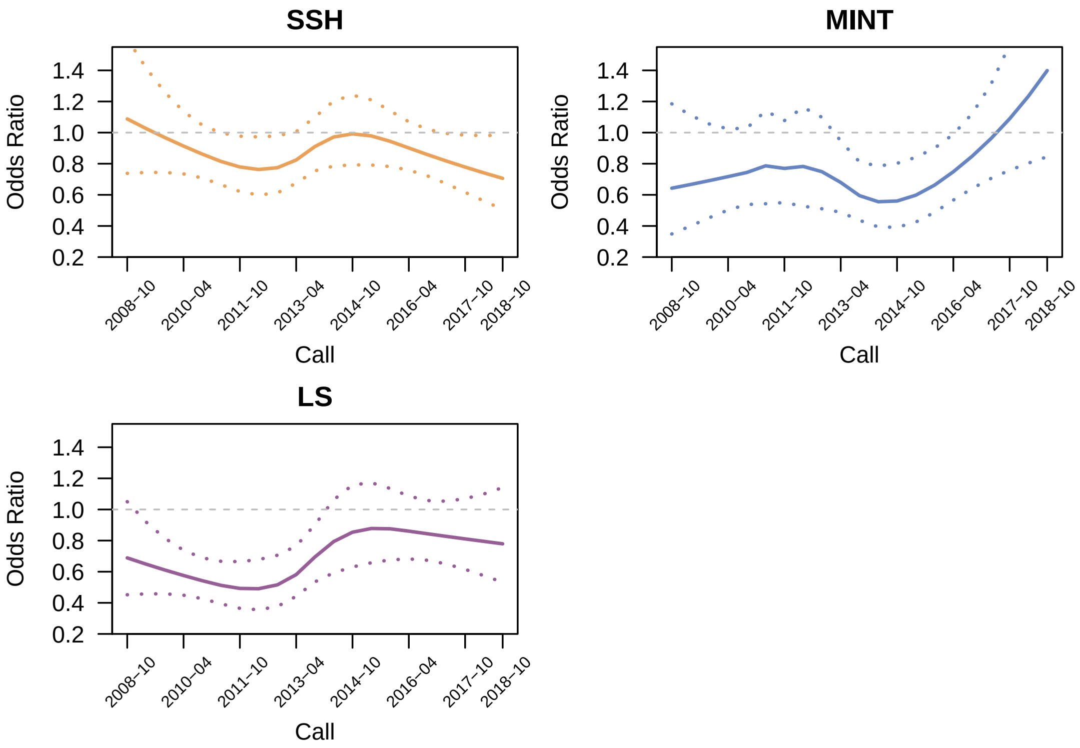

Figure 8: Female vs male odds ratio trends for the unadjusted mixed model, together with their 95%-Wald confidence intervals.

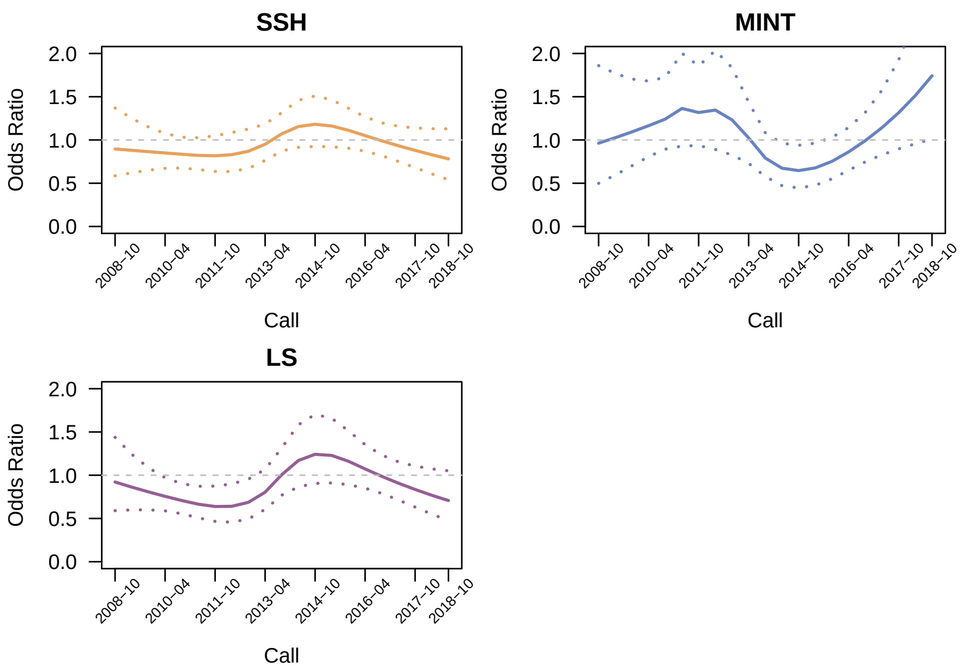

Figure 9: Gender odds ratio trends for the mixed model adjusted for institution type, age and external grade, together with its 95%-Wald confidence interval.

2.2 External reviewer score

The external reviewer grades turned out to explain an important part of the gender effect in the decisions. A possible gender bias in the evaluation by the external reviewers is further explored in a separate article. As elaborated in this article, applications from female applicants are on average graded less favorably than applications from their male peers. In addition, gender differences increased after new evaluation forms were introduced. It has been found in previous studies that women are at a disadvantage when track records are taken into account, where equivalent track records are ranked lower for women than for men. The new evaluation forms may have placed more emphasis on the applicant's track record, which might potentially explain some of the observed difference.

2.3 Funding level

Even if there seems to be no considerable and unexplained gender biases remaining in the evaluation process, there might still be differences in the amount of resources allocated to women compared to men in order to complete their research projects. To address whether there is a gender difference in the amounts requested, the amounts granted, or the funding levels (the amount of funding awarded divided by the amount requested for funded grants), we first look at the density plots of these quantities in Figure 10.

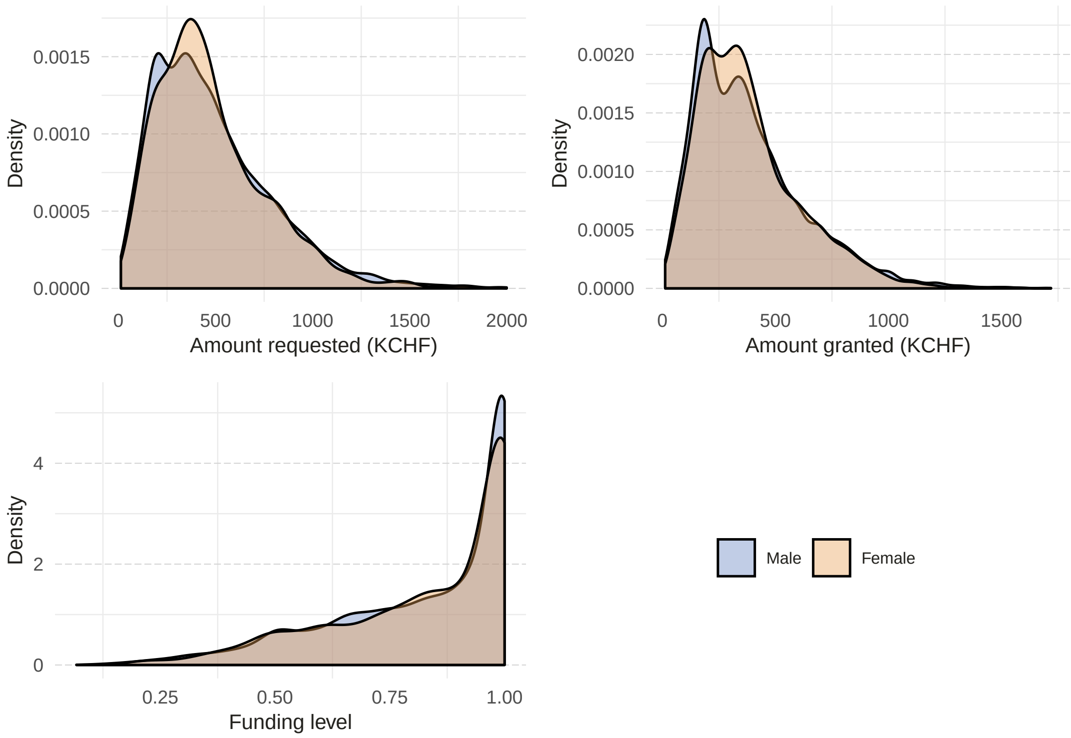

Figure 10: Density plots for the amount requested, amount granted, and funding level, depending on the gender of the applicant (outlier requested amounts of more than to two million have been removed for clarity).

To further study a possible gender effect, we now analyse the change in requested and approved amounts by modelling the approved amount (in 100KCHF) using gender as the main variable and the requested amount (in 100KCHF) as a reference. For this analysis we only use the approved applications and add a random intercept for the distinct applicants as some might have applied to project funding more than once in the range of years considered. The model is summarised in Table 2, stratified by research area. We see that an approved application in SSH on average gets a base amount of 34'000CHF plus 0.77 times the amount requested. Female applicants in this research area get on average 9'000CHF more per project funded than their male peers, for the same amount requested. In MINT and LS however, this gender effect goes in the opposite direction, and is even stronger. In these research areas, female applicants get, for the same amount requested, 15'000CHF and 17'000CHF less when compared to male applicants.

Table 3 shows the same model, but with coefficients adjusted for call, age (in decades) and institution type. The gender effect favoring males over females remains significant, and increases in MINT and LS, while it vanishes in SSH. However, if we only consider the three most recent calls (October 2017, April 2018 and October 2018, without random intercept), the significance of the gender effect disappears. Consequently, we can conclude that at least in recent years, there is no evidence that funded female and male applicants are allocated a different level of funding (see Tables 4 and 5).

Table 2: Model coefficients of an unadjusted mixed model stratified by research area.

	Coef. estimate (SSH)	p-value	Coef. estimate (MINT)	p-value	Coef. estimate (LS)	p-value
Baseline/Intercept	0.34		0.31		0.91	
Amount requested (in 100K)	0.77	<0.001	0.68	<0.001	0.66	<0.001
Gender=Female	0.09	0.014	-0.15	0.037	-0.17	0.003

Table 3: Gender coefficients in a mixed model adjusted for call, institution type and age, stratified by research area.

Coef. estimate (SSH)	p-value	Coef. estimate (MINT)	p-value	Coef. estimate (LS)	p-value
0.07	0.066	-0.19	0.006	-0.22	<0.001

Table 4: Model coefficients of an unadjusted fixed effects model stratified by research area on the three most recent calls (Oct 2017 - Oct 2018).

	Coef. estimate (SSH)	p-value	Coef. estimate (MINT)	p-value	Coef. estimate (LS)	p-value
Baseline/Intercept	0.69		1.39		1.82	
Amount requested (in 100K)	0.78	<0.001	0.66	<0.001	0.59	<0.001
Gender=Female	0.13	0.269	-0.05	0.81	-0.25	0.071

Table 5: Gender coefficients in a fixed effects model, adjusted for institution type and age, stratified by research area on the three most recent calls (Oct 2017 - Oct 2018).

Coef. estimate (SSH)	p-value	Coef. estimate (MINT)	p-value	Coef. estimate (LS)	p-value
0.18	0.128	-0.04	0.854	-0.24	0.088

3 Conclusion, limitations and further research

In this report, the SNSF analysed data on project funding from a ten year period (October 2008 to October 2018) to understand whether its review process differentiates between female and male applicants: do female applicants have, on average, lower odds of acquiring funding from the SNSF compared to their male peers? To give a detailed answer to this question, this report presents a set of descriptive statistics together with the results of more complex regression models. This is the first gender monitoring report to be publicly released by the SNSF, but gender monitoring has been performed internally every year since 2013.

We are always examining new ways to analyse this topic, and this report still has limitations. For example this report does not provide information about any funding schemes other than project funding (*e.g.* career funding). Also, due to the non-availability of the data, the models in this report do not account for certain variables that might have had a strong confounding influence on the results (*e.g* professorship type). This monitoring report concentrates on the final decision of whether or not to fund an application. This decision is based on a thorough peer review procedure, which involves many steps where gender bias might appear. Furthermore, the report did not discuss effect sizes nor causality. The SNSF plans to follow up on these limitations in future gender monitoring.

The main results of the report are the following:

- Our analysis showed that female researchers submit fewer applications to project funding than do their male counterparts. However, the proportion of women applying to the SNSF is similar to the overall proportion of women among potentially eligible researchers in Switzerland. This proportion is dependent on the research area; in October 2018 41% of the main applicants to project funding in SSH were women, while only 14% of the MINT applications were submitted by women.
- In project funding, we can observe, on average, lower approval odds for female researchers, especially in MINT and LS. Female applicants are on average younger than their male peers, and they are also less likely to be affiliated to an ETH institution. The largest part of the gender effect can however be explained

by the grades given by the external reviewers. A bias was observed in these grades, and this point was investigated further in the article mentioned in Section 2.2. After adjustement for more confounding variables the differences between male and female researchers in approval odds decrease, but do not disappear completely in the whole observation period, especially for MINT in 2015 and LS from october 2010 to april 2013. In further research, the SNSF would like to better understand why and how the external reviewer scores are biased against female researchers and will contemplate possible interventions to diminish this bias.

- Gender differences in the funding level of approved projects were observed. If we analyse all calls from the last 10 years, female researchers in MINT and LS receive on average less funding for their projects compared to male researchers for a same amount of funding requested. However, when only considering the most recent three calls in our data, these effects were no longer significant. This observation should also be further investigated.