Springboard or Stumbling Block – Can Research Councils Promote Scientific Excellence without Gender Bias?

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Whether research councils tend to conform to discriminatory procedures, or not, is a crucial question in determining strategies for policies on scientific excellence in Europe. The complex problem of gender bias is a cornerstone in that discussion. The proposed European Research Council is but one illustration of the importance of this question. Indeed, a better understanding of the procedures used in the peer review processes should be developed. Yet, very little research has focused on research councils. Although several important studies were conducted during the 1970s and 1980s, few have been carried out with new empirical material covering what has happened during the last 10-15 years. Recent studies often report on cross-sectional investigations based on small samples. Investigations that cover longer periods and larger data sets are needed.

This paper draws on data from more than 20,000 research grant applications submitted to four different Swedish research councils. Success rates were markedly lower for women during the first half of the period. However, a change in policy could be observed after 1995, probably due to the debate over discrimination. Hence, an initial hypothesis is that gender should be distinguishable as a determining factor in the research grant process even after controlling for other social and institutional variables.

Research Councils and Peer Review

An essential principle of the classical model for research councils is that scientists, unrestricted by and unaffiliated with external factors, should govern research. In Sweden, active researchers constitute a majority on the council's board, i.e. in all bodies where applications are assessed and evaluated and grants decided upon. Committee members are chosen through an electoral process involving all members of the research community in the university system. Peer review is used to guarantee the quality and diversity of basic research. A specific feature of the Swedish councils is that scientific committees are in command of the work. Consequently, and in comparison to the situation at NSF and NIH (in the USA), programme officers in Sweden have little or no influence over granting procedures, initiatives and priorities (see Sandström 2000).

Peer review is a documented, critical review performed by peers (persons having technical expertise in the subject matter to be reviewed) who are independent of the work to be reviewed. It is a tool that funding agencies (and programme managers) can use to obtain high-quality technical and scientific input for decisions on allocating resources. Peer review is

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intended to improve both the technical quality of projects in R&D and the credibility of the decision-making process. The independence of peers should make them more effective than internal reviewers.

Generally, the procedures among the councils in Sweden were similar during the 1990s. Each applicant (principal investigator) submitted a CV, bibliography and a research proposal. A dozen of scientific committees, each covering a specified research field or discipline, reviewed the applications. Each proposal was rated by three to five reviewers in the committee to which it was assigned. Reviewers graded the proposals and "track records" with a score, and that score formed the basis for the ranking used in funding decisions.

The Gender Gap

During the first half of 1990s, success rates for applicants to the research councils (MFR, NFR, TFR and SJFR, see abbreviations below) in Sweden were marked by a significant gender gap. Women often had 10% lower rates than men did. A study in 1995 by Wennerås and Wold (published in *Nature* 1997) disclosed a gender bias in the evaluation of merits for postdoctoral fellowships at the MFR. Thereafter, a shift in policy was imposed by the Ministry and soon implemented. Practices among most research councils changed, and the gap narrowed significantly during the second half of the 1990s (Figure 1). This indicates a positive effect on female funding chances[2]. In a sense, we have identified "the Wold Effect".

Wennerås and Wold showed that female productivity was credited lower than male productivity in the evaluation of applications for postdoctoral fellowships (N = 114) submitted to the Swedish MFR. The conclusion was clear: "Our study", they said, "strongly suggests that peer reviewers cannot judge scientific merit independent of gender." (*Nature* p.341). Affiliation with a committee member further increased the chances of being funded. The disclosure of discriminating procedures and nepotism resulted in an intensive debate, and the MFR council board was replaced.

A detailed examination of male and female success rates within the research councils from 1989 to 2000 shows that success rates for males were generally 5 to 10 percentage points higher than the success rates for females. This difference decreased already in 1993 for three of the four councils under study and the fourth had equal rates all over (Figure 1). However, the success rates for male applicants remained higher even after 1995. Obviously, the differences are partially explained by male domination in upper academic positions. Hence, a positive difference in success rates between males and females is not in itself an indication of discriminating procedures. Success rates are affected by a number of factors, includi9ng number of applications, growth of budget, granting policy and so on.

[2] It should be emphasised that the first findings were discussed early in 1995 and after that the Ministry of Education financed the study by Wennerås & Wold, and the results were known to the Ministry from mid of 1996. Consequently, the Ministry had time to give recommendations to the councils at least from 1996

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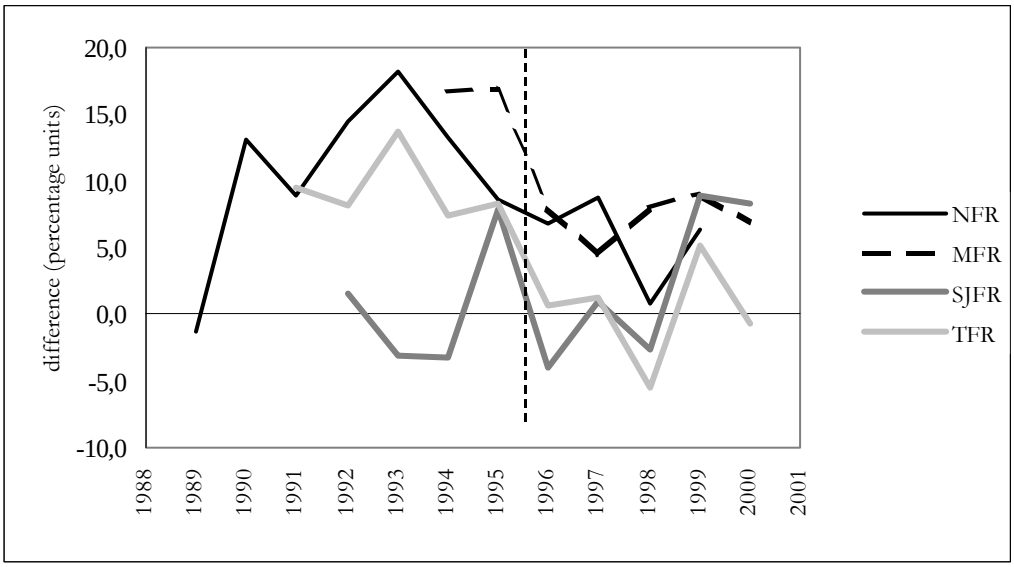
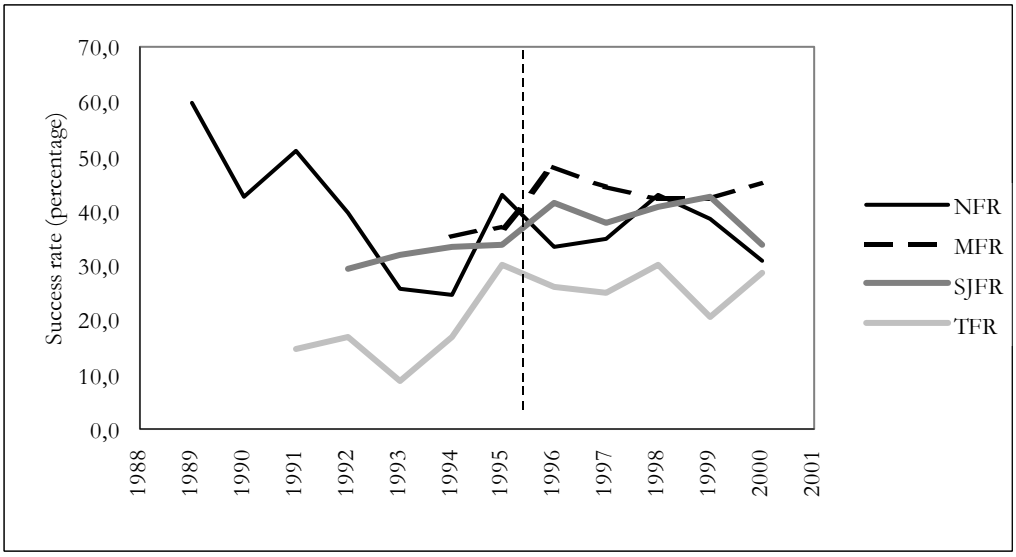
Figure 1. Differences in male and female success rates in four research councils (1988/89 – 2000).



Sources: NFR based on database and from 1997 annual reports; SJFR on database; TFR on annual reports from 1998; MFR on annual reports from 1998.

This paper investigates the gender issue by using a large set of data generated by the research councils in the process of handling applications and grants. To our knowledge, these Swedish data have not been used previously for scientific study. The first part of the analysis shows that the gender difference fluctuates over time. Funding levels change from year to year and policy conditions are unstable. A closer look at success rates for women indicates that structural factors favour higher success rates, which leads toward closing the gender gap (Figure 2). The process of convergence started long before the Wold intervention. Nevertheless, we will need a more comprehensive approach to understand the gender gap phenomena.

Figure 2. Success rates for women in four research councils (1989 –2000).



Notes, see Figure 1.

Research on Gender and Research Councils

The paper by Wennerås and Wold (1997) is one of the most frequently cited articles in this area of research. Searching the Web of Science Online yielded more than 2000 hits for "peer review". Among these articles on peer review and related subjects, Wennerås and Wold had the eleventh highest number of citations (94 citations in March 2004). Unfortunately, virtually none of the papers citing the *Nature* article from 1997 attempted to replicate or critically discuss the findings. Since publication of the article, there appears to be a lack of further investigation. There are, however, a few exceptions to this observation: reports from funding agencies in the Netherlands and the UK have discussed fairness and funding in gender research from the perspective of modernising peer review (see the EU 2000). Other research projects have presented results from Denmark and the Netherlands. We will briefly review this research before examining the Swedish data in greater detail.

It is essential that the academic community has confidence in the peer review system. The legitimacy of funding procedures is based largely on trust. Therefore, conclusions about the functions and performance of research councils should be scrutinised and well researched. The problem with several of the studies on gender bias in research councils is that they cover only small samples and short periods of time i.e. mostly cross-sectional studies. Although most of the work to date is careful and methodologically sound science, the lack of data is a general concern, as summarised in Table 1.

Table 1. Quantitative studies on Gender Bias in Research Councils

Author	Published in…	No. of cases	…of which women	Data from year
Wennerås&Wold	1997	114 cases	52	1995
Brouns	2000	357 cases	52	1993-94
Wellcome Trust	1997	354 cases	105	1993-96
MRC (UK)	1997	276 cases	107	1993-96

Richness and quality of data is necessary if this area of research is to be developed further. Generally, investigations on this subject have had problems in finding relevant data on the applicants and their research areas. Due to restrictions and economy of the research process, many of the studies have used only simple descriptors, e.g. age, time lapse since dissertation, affiliation, publications, review grade, etc. as explanatory factors in relation to decisions taken by the councils.

The first two papers in Table 1 support the hypothesis that research councils tend to discriminate against applications submitted by women. The other two support the reversed hypothesis. Discrimination is a strong proposition and has to be taken seriously. It is contrary to earlier research findings reported e.g. by Zuckerman (1991, p. 43) on U.S. data from NIH and NSF. Later studies by Cole (1992) and McCullogh (1989), both on NSF populations, found no gender differences regarding awards and grants. Likewise Emery et al (1992), in a study of NIH First award applicants, concluded that none of the identified predictors (including gender) determined whether an application would be funded.

In 1996, a governmental investigation collected information on sectoral funding agencies in Sweden regarding the number of awarded grants to men and women in relation to the number of applications in fiscal year 1994/95 (SOU 1995:110, p.46). Comparing observed and expected levels of awards for these agencies leads to the conclusion that there seem to be no significant gender discrepancies in the material. Although the result is interesting, it should

be underlined that these data have low relevance to the overall question posed in this paper as the agencies do not work according to normal council procedures. The academic community do have influence in some of the agencies, but this is not the case generally.

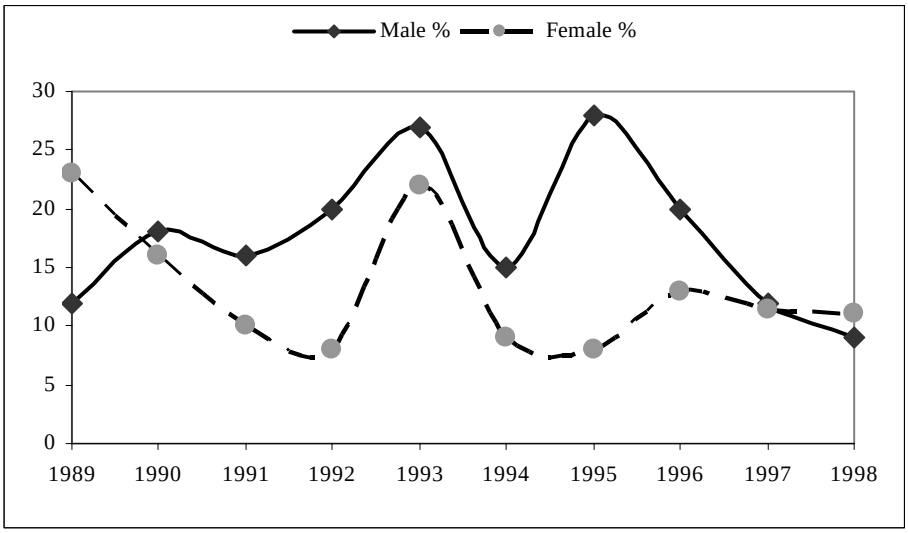
More to the point are two investigations recently published by an undergraduate student in Gothenburg (Ekström 2003 & 2004). The first paper investigates the Bank of Sweden Tercentenary Foundation (RJ), which is very similar to a normal research council, during the period of 1990-2002. Valid data cover the period of 1995-2001 and include almost 2 000 cases with a high portion of applications sent in by female researchers (Table 2). Ekström found no gender differences, and concluded that there are no signs of discrimination within the RJ Foundation. Instead, women researchers seem to have an advantage compared to men. The same author has also investigated the Agency for Working Life Studies (RALF) during the same period (Ekström 2004). This agency is a hybrid between an academic council and a sectoral agency. Many of the committees are steered by academics. Interestingly, the result also from this investigation is negative to the hypothesis on gender discrimination. Her conclusion is very much in line with what she found in the first investigation.

Table 2. Recent Swedish studies on Gender Bias in Research Agencies

Author	Published in…	No. of cases	…of which women	Data from year
Ekström I	2003	1 987 cases	623	1996-2001
Ekström II	2004	2 431 cases	684	1996-2000

In this paper we attempt to go a bit further into the effect of different factors related to gender aspects, but we also include new aspects and new variables that should be considered when studying granting procedures. The 1990s were dynamic years as regards research policy. Many new policy aspects were introduced, e.g. gender, the need to support young researchers, interdisciplinarity, strategic research. During this period research councils had to learn how to adjust to a changing environment. This is illustrated by the fluctuations in success rates for postdoctoral fellowships awarded by the Swedish Medical Research Council (MFR) during the first half of the 1990s. In 1989, female applicants had a much higher success rate than males, but figures were changing as the number of applicants from women increased. For a couple of years during the middle of the period, rates were more or less even between the sexes. A substantial difference appeared in 1995, the year that Wennerås and Wold used for their study. Clearly, the year-to-year variations make it necessary to use data from longer periods if we want to gain a complete understanding of the outcome of procedures.

Figure 3. Success rates by gender for MFR postdoctoral fellowships 1989-1998.



Source: Annual Reports and *MFR Contact* 1997.

Data and Methodology

First, a distinction can be made between subjective and non-subjective information about application and applicant. Evaluation of applications is a subjective process, and hence information on the matter is subjective. The applicant's sex, academic position and age are examples of non-subjective information. Our data also includes institutional factors such as affiliation, sub-discipline and year of application. The latter data is important because, as we know from other studies, the total budget and number of applications submitted fluctuates over time. Before we use variables in regression models, we need to understand the associations and the interdependencies involved. Our final aim is to detect all potential interactions involving gender. However, prior to that it is interesting to discuss each variable and investigate the variables individually. The effect of gender is largely explained by structural differences between the groups. These differences are discussed and illustrated below.

For the empirical analysis, we mainly utilise the project databases from two Swedish research councils – NFR and MFR. These databases include granted and rejected applications, but also information on the applicants, e.g. sex, age, academic position and institutional affiliation (there are a few specific discrepancies in this formula). Table 3 describes the variables available in the different data sets. In addition, it should be noted that the project database has been cleaned and includes only regular research projects. No postdoctoral fellowships, travel grants, institutional grants or other types of grants are analysed. This was motivated by our ambition to create a database for the study of the political economy of research funding (see Sandström 2000).

It should be underlined that we use applications as the population of interest. An alternative strategy would be to aggregate applications to individuals, but this has proven to be difficult due to problems with identifying individuals in the databases. Data are extracted from the project databases, and the analysis is conducted at the population level.

The NFR database, in particular, shows considerable gender differences. Hence, it was chosen for our purposes to describe and investigate the factors that might explain the

variations. We have access to NFR data from 1989 to 1995, entirely from the pre-1995 period. It is also the richest of the four databases, as evident from Table 3. The share of female applicants in the NFR project database increased from a low 9 % in 1989 to 13 % in 1995. During that period, the numbers of applications grew rapidly – from 1,000 to 1,500 – and the population of applications submitted by female principal investigators doubled from 100 to 200 per year.

Table 3. Available data from the council's project databases.

Variables	MFR	NFR	TFR	SJFR
Granted	x	x	x	x
Sex	x	x	x	x
Age		x		x
Academic status	x	x		
Institutional affiliation	x	x	x	x
Sub-discipline	x	x	x	x
Year of application	x	x	x	x
Renewal or new project		x		
Rookie or senior		x		
Evaluation score (grade)	x			
Period of data	1994 - 1997	1989 - 1995	1991 - 1996	1992 - 2000
N=	3 057	7 675	4 724	7 510
Number of women	534	927	248	1 873

The Problem of Self-Selection

Earlier studies on careers of men and women scientists have shown that smaller proportions of women apply for research funding, smaller than their numbers in the pool of scientists. The studies on the Wellcome Trust and the British MRC (Grant et al 1997) proposed that self selection was a dominant problem. In this paper we have considered applications to a council as our population. Another approach is to view applications to a research council as a sample of a population of scientists. Then the sampling probability (the probability to apply) for each element is unknown and may not be equal for males and females. These selection effects are yet unknown, but we have made a rough approximation by comparing the share of specific academic positions within applications to the council and within the Swedish research community (i.e. medicine and natural sciences). Table 4 presents ratios of these shares.

In the MFR, the relationship for a full-time professor is almost 1:1 indicating no selection bias. For the other positions, significantly fewer females apply. For senior lecturers and researchers within NFR the pattern is notably the same. For full-time professors and research assistants, however, actually larger parts of the female population are represented.

Table 4. Ratios between a) female share of applications and b) female share of research community.

Academic position	MFR (1997)	NFR (1993)
Full professor	0.952	1.438
Senior lecturer (associate professor)	0.714	0.768
Assistant professor (postdoc.)	0.884	1.582
Researcher, others	0.675	0.698

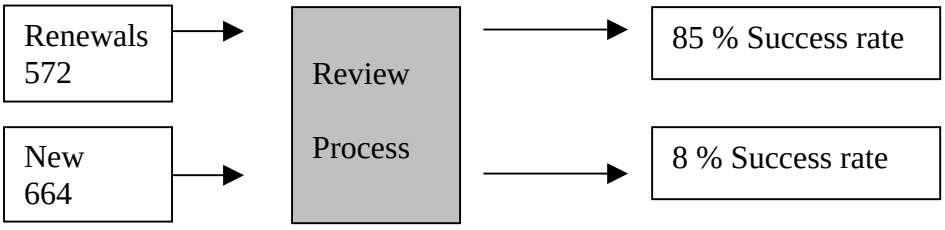
Source: Project databases and Statistics Sweden.

Renewals and Rookies

An important characteristic of the NFR database is that it includes two different types of projects that should be kept separate in most analyses: new projects and prolonged projects (called renewals). The first category normally includes no more than 10% of the total annual granted project stock. Therefore, it should take about ten years before the full project stock is renewed completely. Prolonged projects are the applications that can be identified as resulting from grants that have received funding during the last two to three years. This indicates a tendency towards "conservativeness" in council procedures. If an applicant receives funding, the chances are much higher to receive funding in the next round. This mechanism makes it more difficult for the female population to receive funding since they are largely newcomers in the funding system.

Nilsson (1999) investigated applications sent to the NFR in 1999 from this perspective. His data reveal that proposals resulting from ongoing projects granted by the council had a much higher success rate than other applications (Illustration 1). Another interesting feature of the study is that Nilsson points out that of the other half of the population of proposals consists of two different categories. First, the council knows many of the applicants because they have received grants or have sent in applications before. Smaller shares of proposals come from applicants that are completely new to the NFR.

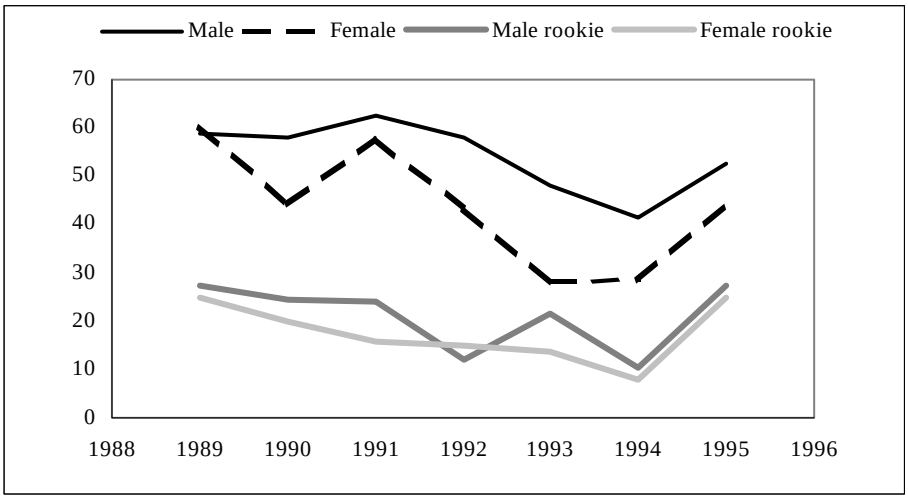
Illustration 1. The review process in 1999 (NFR)



Source: Presentation by Dr. Lars M Nilsson.

The category "New projects" include an interesting smaller group consisting of "rookies", i.e. proposals submitted by persons applying to the NFR for the first time. In the database we are able to identify these applications. During the period studied (1989-1996), the share of rookies among female applicants varied between 15% and 19%, while the share among the male population was between 5% and 10%. Success rates for rookies and non-rookies differed considerably during the period, but both categories show a downward trend in this respect (Figure 4). As females have a larger proportion of rookies, there is an important structural difference between the populations. Rookies of both genders seem to be treated by the same standards, but there is a considerable difference between men and women among those who are non-rookies. To some extent this difference is explained already by the fact that the female population is growing more rapidly than the male population. Consequently, there are differences that are reproduced and extended each year. Up to the time when the male population of principal investigators has been renewed these differences will remain as a structural feature of the council population.

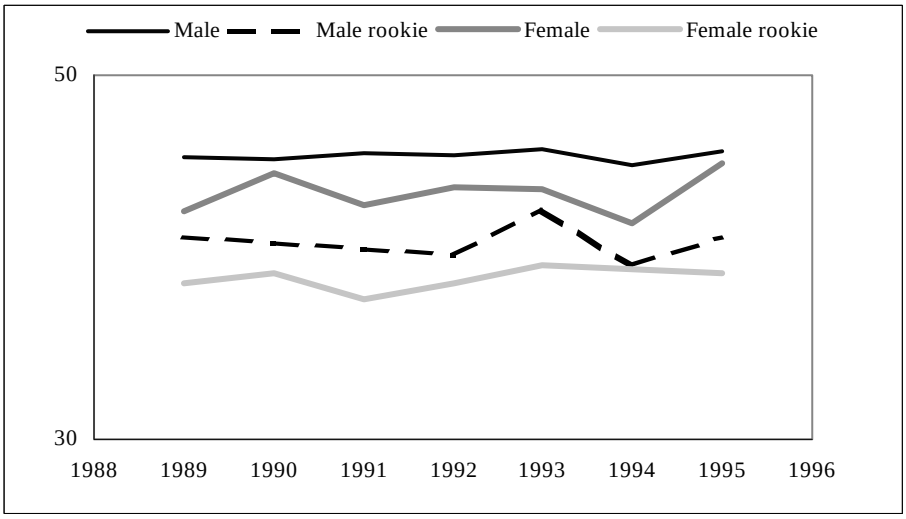
Figure 4. Success rates for rookies and non-rookies by gender 1989-1995



Source: NFR database

An effect of the process described in the last paragraph is that the female population is generally younger than their male counterparts are. This is illustrated in Figure 5 where it is apparent that female applicants are younger than male applicants irrespective of whether or not they are rookies.

Figure 5. Age (mean) at the time of application for rookies and non-rookies by gender



Source: NFR database 1989-1996

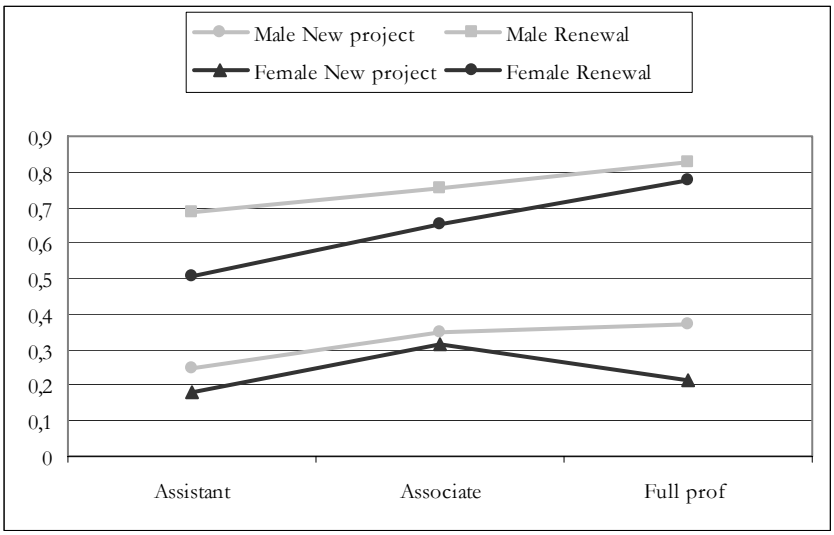
New projects and Renewals

The above figure 4 indicates that gender differences are small and of marginal importance for rookies, but that, there are disparities for other groups of applicants. In this paragraph, we will put the rookies aside and concentrate on proposals sent in by applicants with a record of former applications. For the analysis we will distinguish between new projects and renewals, a distinction indicated by the applicants themselves and noted in the application form.

Looking at success rates the difference between these types of projects is obvious. Renewals have high rates of success while new projects are markedly lower. Gender

differences are about the same for the two groups of applications with 77 and 32 per cent for men and 66 and 24 per cent for women.

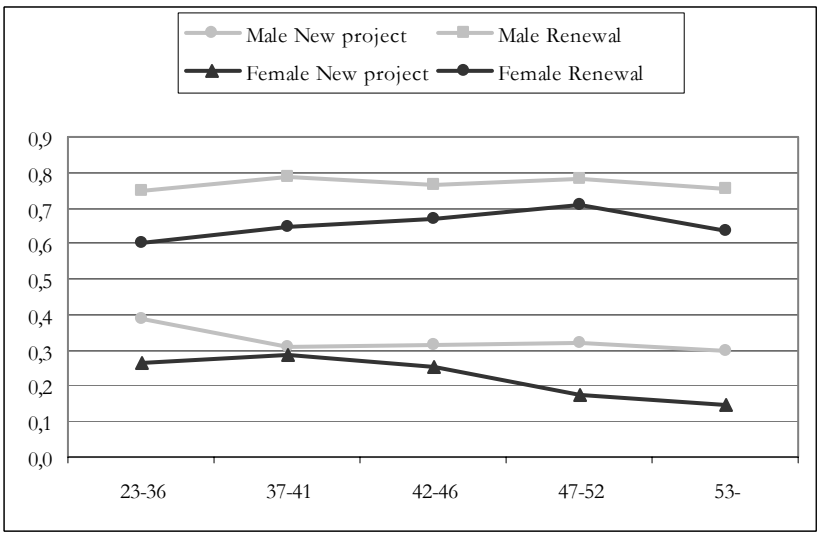
Figure 6. Success rates for status groups and type of project by gender (per cent)



Notes: NFR 1989-1996 (rookies excluded) N= 6828

The dynamics of the structures described above affect the distribution of grants. For reasons of simplification, all status categories were re-coded into four groups: assistant professor, associate professor, full professor and others. Controlling for academic status (figure 6) does not fully explain the differences between men and women. Success rates are lower in all status groups, but there is a tendency for a reduced gap with higher status at least when it comes to renewals. The disadvantage for women is lower for new projects in the ranks of assistant professor and associate professor, but these ranks find a hard time funding renewed projects. Even if there are signs of convergence this trend is not supported by the data on age groups displayed in figure 7. Irrespective of age, female disadvantages seem to persist.

Figure 7. Success rates for age groups and type of project by gender (per cent)

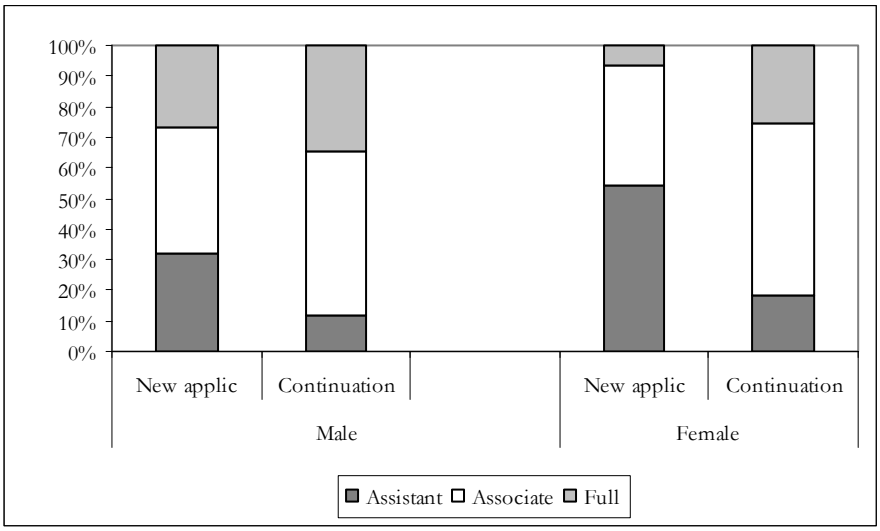


Notes: NFR database 1989-1996, (rookies excluded), N= 6878

Academic Status and Territorial Segregation

The differences between men and women in the NFR population become obvious if they are compared according to the distribution of academic status among new applications and renewals. Since female applications come from younger academics, a large share of new proposals come from assistant professors (Figure 8).

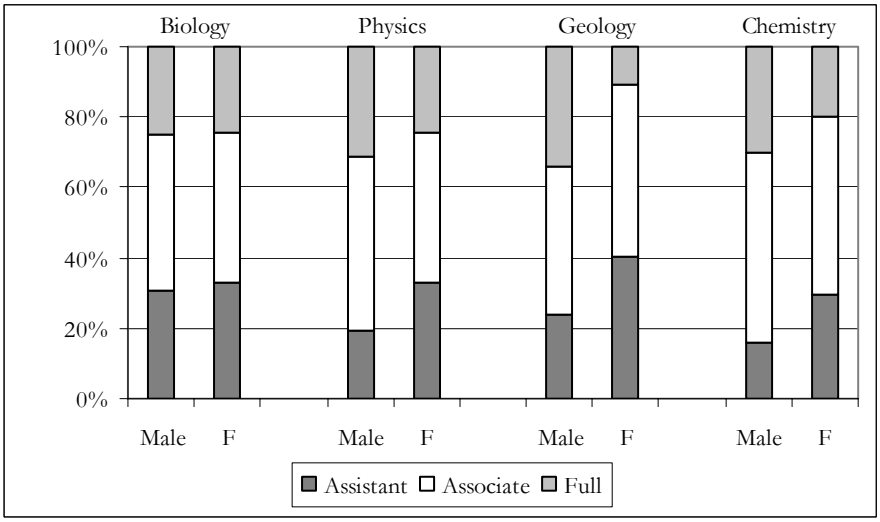
Figure 8. Distribution of gender and status by new and renewed applications



Source: NFR database 1989-1996

Female researchers that applied for funding during the 1990s were younger than their male competitors, and they also had lower academic status. This is illustrated in figure 9 where status is displayed by gender and discipline or programme committees within the NFR. In three of four committees there are marked differences between men and women. Only the biology committee has an equal structure.

Figure 9. Distribution of status by programme committee and gender 1989-1996.



Source: NFR database 1989-1996

Hidden in the last figure is the uneven distribution of men and women by scientific field. Programme committee is an aggregated level that consists of sub-committees in the first place and scientific fields (64) in the second place. Disaggregating the material gives more marked discrepancies between men and women. While men tend to be equally distributed over areas of research, women seem to be concentrated to specific areas. This has been noted in earlier research and Rossiter (1982) called the phenomena the "territorial segregation" between the sexes. Figure 10 illustrate this concept with Swedish empirical material. In this figure, the areas of research are presented according to the share of female applicants. To the left are the areas that consist of a large share of females. Displayed in the figure are the relative frequencies of applicants.

Figure 10. Territorial distribution by gender (Natural Sci. Res. Council 1989-1996)

Note: N= 6898. Only the 32 largest fields are displayed.

Publications and Citations

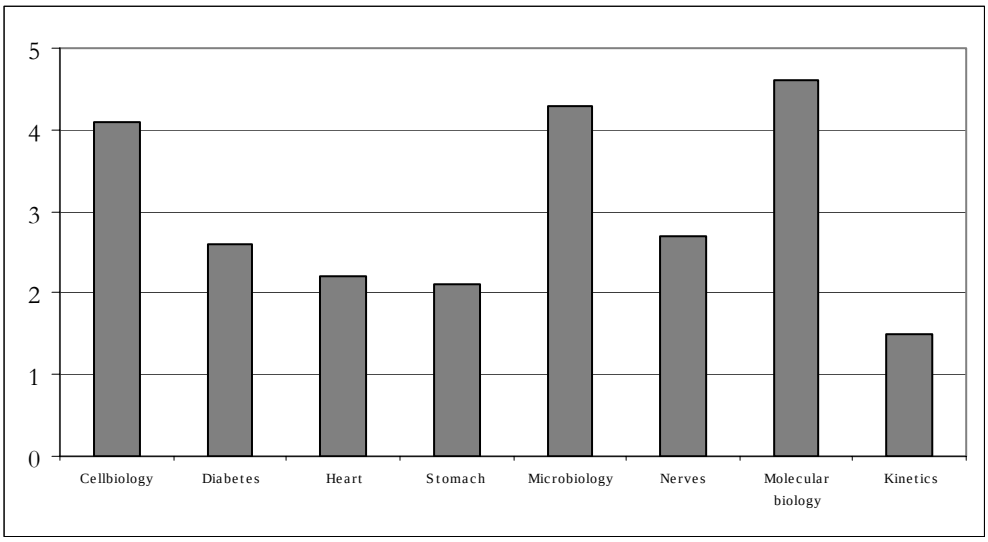
It is commonly assumed that differences in quality among researchers can be measured by publications and citations. A strength of the Wennerås and Wold paper is that they could use data of that type. Scientific productivity and impact measured by bibliometric indicators are two dominant factors that constitute much of the "track record". Studies by (Grant et al 1997 and MFR 1997) have done this using data from applications while also considering gender. Neither of these studies reveals any systematic differences between men and women. The number of articles during a fixed period, impact factor and citations were similar between the two groups of men and women (Table 5).

Table 5. Number of articles and citations by gender (MFR 1997)

	Men	Women
Number of articles per year	5,7	6,0
Impact factor per year	15,0	16,1
Impact factor per article	2,8	2,8

The MFR 1997 study will be presented in detail here, as it is one of the few larger studies on research council applicants that have collected data on publications and citations. Scientific reports submitted together with application for grants formed the basis for the analysis. In May 1996, 320 reports were collected, of which 40 came from female principal investigators. In the reports, each applicant lists the articles published as a result of earlier research. No significant gender differences in productivity could be detected. On the contrary, the impression from this investigation is that female researchers are slightly more productive than their male counterparts are, and this corresponds to earlier research on this subject (e.g. Long 1992, Levin & Stephan 1998, Black & Holden 1998, Bourdons 2003). In the article from 1997, Nilsson underlined that the MFR regarded the publications and citations as an unrealistic measure of scientific quality, but thought it could help in analysis on higher aggregate levels (research groups).

Figure 11. Mean impact factor per scientific field

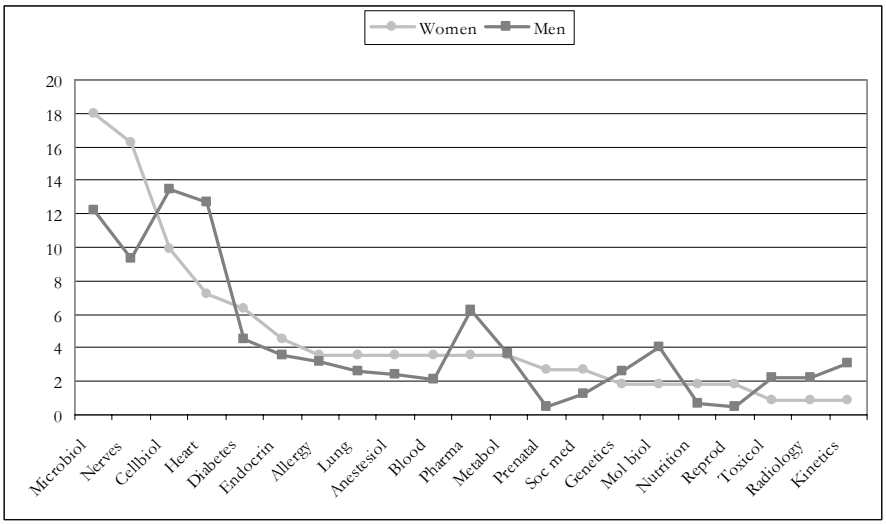


Source: Nilsson (1997)

At the same time, it became obvious for the MFR that there are noticeable differences between different areas of research when it comes to research productivity. While the number of articles per year is stable across areas, the mean impact varies according to the journals active in the fields. This creates large variation between scientific fields. Consequently, this can have profound effects for different categories of applicants. For example, when controlling for impact by age groups, the MFR investigation found that the youngest researchers had the highest mean impact. The study did not care to analyse this aspect any further, but discussed the possible explanation that young researchers either were selected in harsh competition or were concentrated to competitive areas such as molecular biology microbiology.

Inspired by Asmar (1999) we have studied the territorial distribution of the MFR applicants in 1997. From this we can illustrate that some areas with high impact also have high concentrations of female applicants (Figure 12).

Figure 12. Territorial distribution by gender and field of research (MFR 1997)

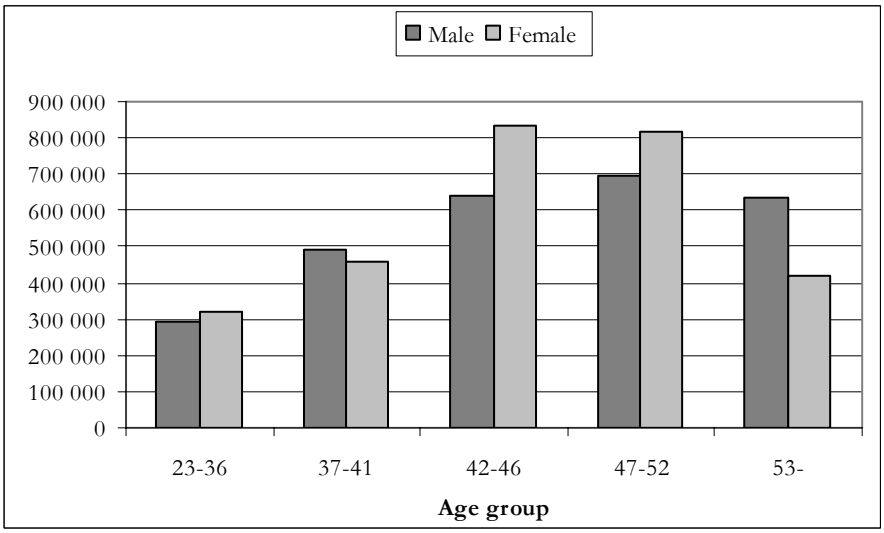


Source: Database.

The Outcome – Distribution of Grants

Are there dissimilarities when it comes to the size of grants? We finish the empirical part with a small section on outcomes for those applicants that were successful. There are small differences in the size of awards granted by the NFR during the period in focus. Overall there is an identical sum allocated per research project irrespective of gender, but differences exist on the level of age group as illustrated in Figure 13. Looking closer at project sum awarded per year reveals that younger female rookies are much more successful in receiving large awards, and that older female rookies seem to experience the opposite. Regarding the length of projects, there are no differences.

Figure 13. Project grants (SEK) by age group and gender



Source: NFR database 1989-1996.

Summary and discussion

The research reported in this paper describes and analyses the gender gap in success rates during the first half of the 1990s. Empirically, the material used is from the Swedish Natural Science Research Council (NFR) and the project database called NAS. This database includes 8000 applications for research grants and is comparably rich in variables with descriptors for the application and the applicant. Together with other research council databases this gives us a unique opportunity to analyse and scrutinise the council procedures in detail. The present paper provides a background and initial analysis using these databases from a gender perspective.

What may first appear to be an external policy effect – the Wold effect, i.e. the closing of the gender gap – can also be explained by structural trends during the period. Most of the councils in our study started to close the gap already in 1993-1994 and continued to do so until rates were stabilised at a lower level.

However, descriptive statistics reveal a gap in success rates, and the aim of the report is to look further for different structural aspects that can explain the difference. Our first contribution is the distinction between new projects and renewals (prolonged projects). Another aspect concerns new applicants or “rookies” to the council system. The number of rookies has grown during the period, and the category is of importance for a gender analysis as the proportion of female rookies is comparably high. Also, the analysis shows that there are significant differences in age structure and status (interacting variables) between the groups. Taking this into consideration some, but not all, of the differences between men and women in this material can be explained.

A major drawback in this type of analysis is the lack of information on publication productivity and citations. The strength of the Wennerås and Wold paper was related to this. To discuss this aspect, we use an investigation performed in 1997 on applicants to the MFR (the Medical Research Council). Supporting earlier research, this study concluded that there are no gender differences in productivity, and women appeared to receive more citations than men do. Noticing this, we go on to the phenomena of territorial segregation. The distribution of female applicants appears to be skewed across the scientific fields. In the MFR study, a possible hypothesis is that they were concentrated in fields with high impact. The conclusion following from this is that the territorial segregation in the NFR should have been a counter-acting factor that would have given female applicants higher success rates. But this is not the case in our material. A gender gap still exists and should be further analysed with more sophisticated statistics.

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Abbreviations:

MFR	The Swedish Medical Research Council (MFR in Swedish)
NFR	The Natural Science Research Council (NFR)
TFR	The Engineering Science Research Council (TFR)
SJFR	The Forestry and Agricultural Science Research Council (SJFR)
RALF	The Agency for Working Life Studies
RJ	The Bank of Sweden tercentenary Foundation