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Centres of excellence: reward for gender or top-level research?

Women make up 30% of top researchers in Sweden. Thus, the fact that women receive less than 20% of funds for research at centres of excellence cannot be explained by a lack of top female researchers. It is more probable that notions of who are 'excellent' are coloured by gender prejudices. At the same time, half the recipients of excellence funding cannot be characterised as top researchers.

Today, 24% of professors in Sweden are women. The proportion is rising by less than one percentage point a year. It is twice as hard for women as for men to become professors in the 12 years after gaining their PhDs. In the past decade, Sweden has invested massively in excellent research environments: a total of some SEK 15 billion has been spent on such programmes. But women have received less than 20% of these 'excellence funds', whose distribution is, accordingly, more skewed in gender terms than that of the research funds from the research councils. There are two main possible explanations for this: 1) that women are less productive as researchers or 2) that they are discriminated against, especially in funding calls based on notions of 'excellent' and 'strategic' research.

Here, we have identified the best 10% of Swedish researchers, defined as those with the most citations in their fields in the period 2008–11. An analysis of the Web of Science shows that roughly 48,000 people had academic articles published in Sweden in these years, and the most cited 4,800 may be regarded as particularly skilled and productive researchers.

Of these top researchers, 30% prove to be women, i.e. a higher proportion than female professors and considerably higher than is reflected in the excellence funds awarded to women. Moreover, we have identified the people awarded funding for research at centres of excellence and investigated what proportion of them are among the top researchers.

Our questions

In a research system based on meritocracy, positions and grants are awarded on the basis of merit, in terms of qualifications and experience. Women and men have the same chances of getting grants and positions if they have produced equal amounts of, and equally good, scholarship. Meritocracy is not just fair but also the most economical way of distributing limited resources.

Data from Sweden show that men and women do not advance to the same extent in the academic system. As mentioned above, the proportion of women professors in this country today is less than one-fourth, although the share of girls completing upper secondary schooling overtook that of boys back in the mid-1960s. Everyone who is active in the research community today, then, was educated at a time when more women than men had the chance to pursue an academic career. Yet the female proportion of professors is rising by only between 0.5 and 1 percentage point a year: at this rate, it would take between 26 and 52 years to reach a point at which half of all professors are women. In 2004, using education statistics from Statistics Sweden, Agnes Wold and Cecilia Chrapkowska calculated how much further than women men had advanced in the Swedish academic system from first degrees to professorships, on the one hand, and from PhDs to professorships on the other.[1] The database states the gender of all those who take first degrees and doctorates in various academic disciplines every year, and reports the number of professors in various academic fields, with their age and gender. In 2002, there were 3,803 professors in Sweden. The women who, in that year, were professors of humanities, social sciences and medicine had, on average, had half the chance of becoming professors as the men who took their PhDs in the same period and the same academic areas. Men were thus at an advantage that, on average, doubled between PhD and professorship and quadrupled between first degree and professorship. This shows that there is no automatic connection between a high share

of women in university education and a high proportion of female professors, and also that women will not automatically become half of all professors now that they have become half of those who get PhDs.

Helene Dryler, a researcher at the Swedish Higher Education Authority, followed up broadly the same individuals who had taken PhDs in Sweden over the past few decades, and estimated their chances of becoming professors on the basis of their gender and social class.[2] The results show that women have roughly half as much of a chance of getting professorships as men in the same research field in a given period, such as 12 years. Parental educational level, on the other hand, does not affect people's chances of advancing to professorial positions if they have doctorates.

There are, as mentioned above, two diametrically different explanatory models for women's lack of advancement: that they are inferior researchers and that they suffer from discrimination. In fact, there is a third theory that is commonly used to avoid having to choose between these two: that the explanation lies outside academia. According to this hypothesis, women's relatively poor rate of academic advancement may be explained by the fact that they take, or are allocated, a greater share of responsibility for the family and children. However, the theory has no support in data, since women without families do not advance better than those who have families and children. Since grants and positions are the two indispensable factors for survival in the research world, a more immediate factor appears to be the distribution of these rewards between male and female applicants.

Christine Wennerås and Agnes Wold showed in 1997 that a female applicant needed to have 2.6 times better publication qualifications than a male applicant to receive the same competence rating in applications for junior research positions at the Swedish Medical Research Council in 1995.[3] Besides gender and productivity, it was possible to demonstrate the influence of only one other factor on competence ratings: whether a reviewer was involved in a conflict of interest in relation to the applicant: in such cases, the applicants were rated more highly than their scholarly productivity warranted.

This article triggered a major debate since it showed unequivocally, for the first time, that women's and men's qualifications were judged differently. The Medical Research Council (MFR) also carried out its own study in 1996. This study, published in *MFR informerar* in 1997, showed

that applicants with the same overall ratings for their applications were awarded grants of different sizes depending on their age and gender. Older men received most money, while younger people and women were given smaller sums.[4]

The Medical Research Council reformed its assessment process and carried out continuous analyses of women's and men's chances of being awarded funding. Ulf Sandström and Martin Hällsten were able to show that seven years later, in 2004, the Council had a policy of treating women more fairly, although conflict of interest still stood out as a dominant problem in the assessment process.[5]

In the early 2000s, however, a development took place that was to sweep aside all previous efforts to make men's and women's chances more equal. Centres of excellence were launched under Thomas Östros's leadership as minister of education. Generous funding was now to be allocated to the most 'strategic' research and to 'strong' or 'excellent' research environments. While a research grant of one or two million Swedish kronor had traditionally been regarded as large, tens of millions were now awarded to individual researchers or research groups. By 2009, decisions to award some SEK 10 billion in 'excellence funding' (excluding 'strategic research areas') had been taken, and of this money women in medical, scientific and technical fields received only 13%. By comparison, roughly 30% of grants from the research councils went to women.[6]

The evidence of low female shares of funding for centres of excellence gave rise to some critical debate, after which the funders appear to have made a certain effort to boost women's share of funding in the new centres of excellence. Today, women receive some 19% of the excellence funds, which is still considerably lower than their share of the research funding from the research councils. In the Government's strategic research areas, female grantees made up just over 20% of the total. The model of large grants to researchers assumed to be excellent has persisted since 2009, and is an important part of several research funders' activities. These funders include the Swedish Foundation for Strategic Research (SSF), the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas), the Swedish Research Council for Health, Working Life and Welfare (Forte) and the Knut and Alice Wallenberg Foundation (KAW). It therefore remains important to investigate whether this form of allocation of research funds favours men more than women.

In this study, we pose two questions:

- Does the share of excellence funding that goes to women correspond to the proportion of women among the most successful researchers in Sweden?
- Are the researchers awarded excellence funding among the most successful ones (in terms of publications)?

As material, we have used bibliometric data from the Web of Science database, comprising all articles from Swedish researchers in 2008–11 with citations up to and including August 2014. By identifying the most productive and highly cited researchers systematically, we can investigate 1) the proportion of women among them and 2) the proportion of all 'excellence grantees' in the period 2005–12 who are included in the category of the 10% most productive and highly cited researchers in Sweden.

Methods

Our purpose was to identify the most highly cited researchers during the four-year period 2008–11. In small groups, as at individual universities, CVs and publication lists are of course obtainable from all the researchers. But for a study on this scale we had to use databases. To answer our two questions, all the authors of an article had to be identified, and for the first question their gender also had to be ascertained. We used the Web of Science citation database. Using its contents, algorithms and considerable manual work, we have succeeded in identifying and stating the gender of a great majority of virtually all the Swedish researchers whose work was published academically in 2008–11.

The Web of Science is a database that contains information about citations among academic articles. The database is classified according to articles, not individuals, and it is no easy task to keep unique people separate. Grouping the articles found in the Web of Science and attributing them to specific individual authors are a process that involves several stages.

The task of identifying authors and keeping them separate is known as 'disambiguation'. With a combination of automatic and manual methods, this task can be performed satisfactorily. An algorithm for disambiguating unique individuals was developed by Ulf Sandström and Erik Sandström[7], based on research by the Spanish physicist José M.

Soler[8], and found to be more effective than the corresponding algorithm proposed by Thomas Gurney at the Dutch Rathenau Institute and colleagues.[9] The method takes into account surnames and first-name initials, the words that occur in article headings, and the journals, addresses, references and journal categories used by each researcher. There is also weighting for the importance of the various fields. This strategy is used to give every researcher a unique identifier. Thus, the 'Hedlund, A(rne)' engaged in mycology research at the Swedish University of Agricultural Sciences in Uppsala can be distinguished from the 'Hedlund, A(nnika)' who does neurochemistry research at Lund University. The algorithm uses the surname and one first-name initial, and since the number of first-name initials varies among authors and complete first names are not available for all of them, information on more than one initial is not usable for automatic methods. Until very recently, The Web of Science and similar databases have been relatively unusable for identifying individuals, while they have been highly suitable for breaking down the data by research field, country or author. Before 2008, the Web of Science contained only information about the first author's name and that of the 'corresponding author', from whom reprints could be requested. Since 2008 there has, in most cases, been an address linked to most authors' names, and this substantially facilitates the disambiguation process.

Even if researchers always write their names in the same way, they are not always identifiable since there may be thousands of Swedes with exactly the same name. Since the ID numbers assigned to the researchers are commonly based on the surname and one first-name initial, the problem is even greater. At Lund University alone, there are eight people whose publications may have the author name 'Andersson, K.', and in Uppsala (including the Swedish University of Agricultural Sciences, SLU) there are seven individuals whose names can be written 'Andersson, A.' Using the algorithm method, different people called 'Andersson, A.' are distinguishable if they work in different fields, but a number of people still remain that cannot be identified for certain. These are researchers whose names (surname and one first-name initial) may be found in at least six university locations.

Combinations of surnames and first-name initials that are common have thus been excluded from our analysis. Altogether, just over 1,000 people have been excluded.

All methods entail errors. Researchers have studied how a single researcher's name can vary in the Web of Science database.[10] The variations can be divided into 'legitimate' ones, generated by the researchers themselves, and 'illegitimate' ones that are incorrect owing to errors (such as spelling mistakes). Errors in entering the data are, however, few and do not constitute a great problem, while 'legitimate' variations can cause problems when they must be attributed to a single researcher. Broadly, four types of variation occur: direct misspellings, those that arise when names are transcribed from other alphabets; variations caused by people changing their names, as a result of marriage or divorce, for example; and variations in the use of initials. We have tested the method several times with randomly selected lists of references from researchers, compared them with the lists generated for the same researchers by the Web of Science, and examined our disambiguation method and manual adjustment procedures. As a result, agreement of more than 98% is achieved.

Since 2008, the author's first name (which is necessary for gender to be assigned) is usually included in the Web of Science database. However, there are still journals that traditionally state authors' first names using initials only, which means that the articles lack information about first names when they are listed in the Web of Science. When the disambiguation procedure is complete, the next stage is to assign gender to each unique author. To do this, we have applied a combination of methods. In some cases, the last two letters of the first name state the gender: this is true, for example, of names ending in '-na' or '-va', which are usually women's names (Lena, Irina, Kristina, Eva), while those ending in '-an', '-av', '-rs' or '-lf' (Håkan, Gustav, Anders, Rolf, Ingolf) are men's names. In this way, with simultaneous manual checks, it has been possible to assign gender to the majority of names in the Swedish dataset.

Further information is available in name databases, such as the US Census, Wikiname and Wikipedia. The method has been used previously by the Canadian bibliometrist Vincent Larivière and colleagues, to assign gender throughout the Web of Science database in 2008–12, i.e. for more than five million articles.[11] In this global material, the researchers have been able to assign gender for roughly 65% of the shares relating to authors. For the sake of clarity, it should be emphasised that their method focuses solely on those shares containing full authors' names, since they have not used methods of identifying unique authors. With our combination of methods, we can thus reduce dropout considerably.

To reach further in the work of assigning gender in the Swedish researcher material, we have also applied manual matching, using staff databases from the major universities and also SwePub (swepub.kb.se), which contains publications from these universities with full authors' names. In addition, we have manually sought Asian authors on the Internet, especially the names of Chinese, Japanese, Iranian and Arabic authors. In many cases photographs of the authors are available, and this has made gender recognition possible.

With this method, we have succeeded in assigning gender to 94% of the authors in our material, and to more than 98% of the article shares. The cases where identification has not been feasible relate to articles in which the authors are not listed with their complete first names and only their initials are given, and also authors with Asian names where it is mostly impossible to recognise gender on the basis of names in western transcription.

In the Swedish database, covering 2008–11, there are 74,000 articles and 195,000 author shares that have been judged to belong to Swedish organisations. In a few cases, articles from people who have worked both in Sweden and in one or more Nordic countries have been kept together, and articles have thus been included even if they came into being outside Sweden (the process of distinguishing names is thus carried out at Nordic level).

Bibliometric method

Every researcher's impact has been calculated on the basis of articles written in 2008–11, with citations in the period from 2008 to August 2014. We count fractions of articles: if five researchers have written an article, each co-author is credited with 0.2 of the article.

All the articles in each disciplinary area are then ranked, based on these citations. The field is defined according to their subject categories (some 260 in number) specified in the Web of Science, and the articles are divided into percentile classes (the top 1%, 5%, 10% etc.). Measures based on percentiles have the advantage of not being affected by causes of bias in citation distributions.[12] In certain disciplinary areas, a few publications with very numerous citations otherwise boost the mean[13], which can result in 70% of the articles in the area being below this mean.

We have 'translated' the percentile indicator into a number of points

Table 1. Distribution of points among percentile classes

Percentile (%)	Points
0.01	100
0.05	20
0.10	10
0.25	4
0.50	2
1.00	1

for each article, with an article that is among the most highly cited percentage of the articles being assigned 100 points, ranking in the top 5% being given 20 points and so forth (see Table 1). An article that is among the 50% least cited is given 1 point, which means that a researcher can never lose from getting an article published.

The points thus received by each article are adjusted by means of the field-adjusted production (FAP) method[14] to compensate for differences among research areas in the rate of scholarly production. All the journals in the Web of Science have been classified according to five categories (applied sciences, natural sciences, health sciences, economic & social sciences, and art & humanities).[15] On this basis, analyses using the Waring method have served as the foundation of an FAP factor.[16] The measure we use is thus a composite one that, in a single value, expresses productivity (the number of articles) and citation level (quality). The advantage compared with other, similar measures, such as the h-index, is that this measure was designed to be used across and among all disciplinary areas.

A researcher identified by means of the above method gets a total number of points based on article shares and their citation-based points. Accordingly, all Swedish researchers can be ranked.

Results

We have thus, using various methods, attempted to identify how individuals in the Swedish research community who had academic articles published in the period 2008–11 are cited according to the Web of Science database in the years 2008–14. The first question is how many researchers are active in Swedish research. Using our methods of identifying

unique researchers by means of their Swedish addresses, we have found some 48,000 unique authors. People whose common surnames and initials made them unidentifiable number about 1,200, i.e. less than 3%. A number of people are included who, in fact, work outside Sweden or are temporary guests at Swedish research institutions, and this means that we cannot immediately define the population of 'Swedish researchers' with any precision.

We can approach the problem by dividing the corps of authors in the publication database into various categories: 1) recurring Swedish researchers ('continuants'), 2) 'novices' (such as doctoral students), 3) 'transients' (who come and go) and 4) 'terminators'. Since the database we have analysed holds only four years' data, we cannot be sure of the category to which an individual author belongs. However, we have opted to assume that people who produce three or four articles during the period are continuants.

Our database of 'Swedish' articles in the Web of Science in 2008–11 comprises some 74,000 articles with an average of six authors each (a total of some 410,000 author shares), of whom 2.7 count as 'Swedish' by our definition (some 195,000 author shares). The 48,000 researchers thus produced an average of four article units, shared among the authors concerned, over the four-year period. This makes one article unit a year: for example, six articles with six authors of each article or three articles with three authors per article. Each article share is assigned to its field-normalised percentile class and receives points based on the author fraction and percentile class, after which this is summarised at individual level, at a value that then forms the basis for the 'national' ranking of all researchers.

If we look at how the various disciplines are represented in the top decile, we find that 40% are categorised as science & engineering, 40% as medicine and health sciences, and 20% humanities and social sciences. The same distribution applies to the top percentile. The entire ranking is composed of 40% natural sciences and engineering, 45% medicine and health sciences, and 15% humanities and social sciences. The divergent proportions in the top decile may be regarded as an effect of the FAP weighting factor.

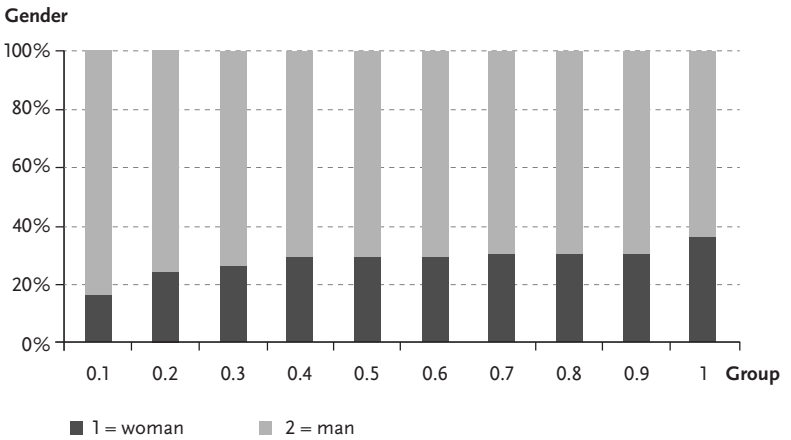

Figure 1. Gender distribution of percentiles in the top decile, with each bar (percentile) representing 474 researchers.

Gender and publications

Are any differences in citation performance between men and women discernible? 'No' is the answer. Women and men, in various author positions (as first or last author) have equivalent citation rates.

We identified the 10% best researchers (numbering 4,800) based on total field-normalised citation rates. The American health-policy researcher John P. A. Ioannidis and colleagues showed that a core group of researchers engage in continuous production and account for the lion's share of highly cited publications.[17] This core represents roughly 1–2% of the total.[18] Of the 4,800 'best researchers' identified in our material, the majority work in the natural sciences, technology/engineering and medicine, while slightly over 800 work in social sciences and some 60 in humanities. The majority, 3,500, are continuants, i.e. had at least three or four article units (composed of article shares, for example four articles a year with four authors on average per article) in the four-year period, while just over 300 researchers had only one article unit published during the period. The gender of those in the top decile (10%) was identifiable in all cases. With these results, we have identified the Swedish researchers in the best decile, which enables us to ascertain the proportion of women in this group: 30% (some 1,300 women, against 3,400 men).

If we investigate how these roughly 1,300 women belonging to the top

decile are distributed in terms of the percentage points comprising this tenth, we see only marginal variation around 30% and above in the lowest percentiles, while the incidence of women in the highest percentiles range from 18% to 28% (see Figure 1).

Grants for centres of excellence, 2005–12

The findings consist of identified grants for centres of excellence, defined as follows: 'Grants consisting of research funding of SEK 10–100 million, awarded according to grantees' characteristics or performance, denoted as "strategic", "strong", "leading", "potential", "high-achieving" etc.'

In recent years, initiatives in this form have been undertaken by virtually all research-funding organisations in Sweden (see Table 2). The purpose has often been defined as being 'attainment of such concentrated or concerted resources in university research that it can deliver a strong impact on industry'. This quotation is from SSF and the Swedish Governmental Agency for Innovation Systems (VINNOVA), but similar wording may be found in several other excellence programmes.[19] In the present analysis, we have included research funders' initiatives that have been implemented in such a way as to result in decisions to award large amounts of research funding per individual grantee or group of grantees. It should also be pointed out that this survey does not take into account grants from the EU and other funders.

Altogether, some SEK 15 billion was distributed in 2005–12. The table shows amounts decided upon, not what was subsequently in fact awarded. We have identified 165 projects for each of which there is one main applicant (the principal investigator) and some co-applicants (mean: seven). Where the application specifies a long list of researchers, we have registered only the researchers with professorial titles.

The category of researchers identified as excellent by virtue of receiving one or more excellence grants contains some 1,500 people. Just under 20% of these are women, this being a considerably lower female proportion than that of recipients of research funding from VR (about 30%). The population falls, in fact, into two parts: the principal investigators, responsible for the projects, and the co-applicants. The responsibilities of the latter are not always clarified, but we assume that being listed as a co-applicant entails a certain responsibility and, above all, some influence on decisions.

Table 2. Excellence programmes, 2005–12, included in the survey

Programme name	Total grant, SEK million
Berzelius Centres	400
Swedish Council for Working Life and Social Research (FAS) Centres	500
Formas Strong Research Environments	525
Formas X	150
Linnaeus Centres, 2006 and 2008	2 500
Mistra programmes	500
Nano Vinnova	70
RJ programmes + Golden Jubilee Initiative*	300
Swedish Environmental Protection Agency	150
SSF Research Centres II	750
SSF Framework Programmes	2 200
Swedish Research Council (VR) Strong Research Environments	220
Strategic Research Environments	3 000
Wallenberg Scholars 2009–2012	675
Wallenberg High Potential	2 000
VINNOVA VINN Excellence Centres	500
VR Leading Researchers	60
TOTAL	15 000

* RJ's initiative comprises a number of foreign researchers in the humanities who have not, however, been included in the grant survey.

In 86% of cases the principal investigator is a man, and 85% of the research funds are awarded to male principal investigators. Of the 20 researchers who received the largest amounts altogether (several excellence grants may be received, and this is even common), 18 are men. Women thus make up a remarkably small proportion of those who, as main applicants (prospective principal investigators), have been awarded excellence funding.

Among co-applicants, too, the proportion of men is very high: 81%. Evidently, the largest share of women among main applicants and co-applicants may be found among the projects awarded SEK 7.5–9 million. Moreover, the projects that receive more money than the median appear

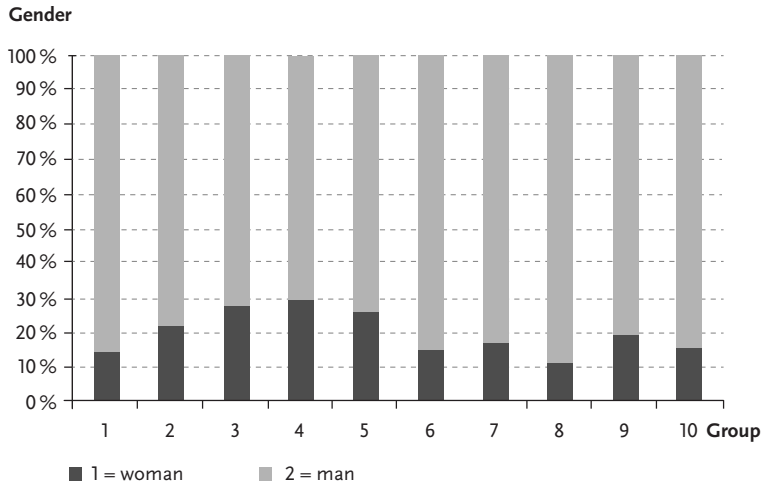

Figure 2. Proportion of women per tenth of excellence grants distributed when grantees are sorted by grants received, divided equally among project members. Decile 1 received the largest amount and Decile 10 the smallest.

to involve a higher proportion of men than those that have received less money than the median project.

When we analyse the productivity and/or quality of researchers who received excellence grants, those who were unidentifiable in the publication database because of their very common names — a total of 14% of the principal investigators and co-applicants — drop out. This dropout shows no crucial differences with respect to mean grant size and gender distribution. The remainder for analysis comprises 1,326 recipients of excellence funds who received a total of 1,890 grants.

One explicit purpose of the very large excellence grants was that top researchers would escape the constant toil of applications and have time to do their research. But the outcome has been different: among a group of mainly male researchers, applying for and collecting excellence grants has become common (see Table 3). Thus, a group of researchers have been able to accumulate substantial funds and, since there is no superior authority to assess the reasonableness of distributing the total amount of funding awarded to particular researchers or research groups, no one has considered whether this procedure is appropriate. Overall, it may be said that Swedish research funders have shown scant interest in following up and evaluating the results of the grant-allocation policy pursued.

Table 3. Number of grants received, by gender

Number of grants	Men	Women	Total	Funding, SEK m
1	817	201	1 018	1 018
2	166	41	207	414
3	58	9	67	201
4	23	4	27	108
5	12		12	60
6	6		6	36
7	4		4	28
>7	3		3	25
Total	1 089	255	1 344	1 890

Table 4. Distribution of excellence researchers by decile of research quality

Decile	Number	Per cent
1	724	55%
2	229	17%
3	130	10%
4	46	3%
5	34	3%
6	33	3%
7	13	1%
8	16	1%
9		1%
10	11	1%
(11) Missing or no publications	96	7%
Total	1 326	100%

Each decile represents some 4,800 individual researchers.

Do the top researchers include excellence grantees?

We have estimated how many of the recipients of excellent grants are among the 10% best Swedish researchers, based on the percentile model with field-normalised citation as described in the method section above.

With this definition, only 55% (724/1 326) of the 'excellence grantees' count as 'top researchers' (Table 4). Altogether, 14% of these 'excellence researchers', i.e. nearly one in six, belong to the lower half of their research area in terms of quality, measured by citations, and many of these researchers had no international journal publications at all during the period.

Looking more closely at the group of people who have received four or more excellence grants, we find that 70% of them are in the top 10% of Swedish researchers. Conversely, 30% of those who together received more than SEK 600 million in excellence grants after 2005 do not belong to the 'research elite', if this is defined as the 10% most highly cited researchers in their respective fields.

Discussion

We found no difference in scholarly activity or quality, measured in terms of field-normalised citations, between men and women. This finding is in contrast with the results presented by Larivière's team.[21] Our Swedish database is considerably more complete than the international one, which succeeded in ascertaining the gender of only two out of three researchers.

We have shown that women make up 30% of the top researchers, defined as the 10% most highly cited researchers in their fields. This is not reflected in the allocation of excellence grants, of which less than 20% have been awarded to women. The reason why there are so few women among the recipients of excellence funds is thus not that women are lacking among the most high-achieving researchers but probably that allocation of the large sums characterising the strategic programmes, the centres of excellence and the 'strong research environments' has not been gender-blind.

One may also, perhaps, wonder whether the use of language itself does not prompt grant providers to choose men. Who is 'strongest' on average, a woman or a man? Why are the environments described as 'strong' and not 'wise' or 'proficient'? After all, research has nothing to do with strength; what counts are intelligence, creativity and tenacity. The word 'strategic' is connected with 'strategy', which has connotations of a general's worth and the use of military and other instruments of power. Why has the terminology been taken from warfare, when researchers are probably one of the most peaceful and globally oriented of all occupational

groups? Why are the metaphors not taken from farming or gardening instead? These would be much more suitable for research work: we sow and harvest, cull among ideas and projects, fertilise with new and expensive equipment, and so forth. 'Excellent' means that someone is raised above all others; might this be an image that is not readily attached to women? In round figures, as we have seen, SEK 15 billion has been allocated to centres of excellence of various kinds, without any thoroughgoing analysis being carried out before the programmes were launched. Nor have any genuine evaluations taken place afterwards, unless one counts those carried out by the people who are themselves responsible for the programmes. The sum of SEK 15bn may come to be raised, since the strategic research environments in the grant survey were estimated as using funds for only four years but, according to the plan, these environments are to persist for ten years or more. It should also be pointed out that nearly half of the strategic research environments in the Government's initiative were allocated to researchers who had already received excellence grants.

Women have, as we have shown, received a considerably lower proportion of these funds than would have corresponded to the share of professors (24%) or top researchers (30%) who are women. The immense size of the excellence initiatives have meant that other researchers — those not defined as excellent — have received a smaller sum to share for their research than if Sweden had not chosen to implement this policy. Women have thus lost out twice: by getting less money than they would have done if the excellence policy had not been launched and by being excluded from the definition of 'excellent' researchers, which has also fed prejudices that women are not among the best.

A high proportion of the Swedish researchers who have been awarded excellence funding are not among the research elite who can be identified through analysis of citations in the Web of Science. Half of all these 'excellence researchers' are outside the limit we have assessed as reasonable. Up to 30% of those who have been awarded funding for more than one centre of excellence have come to benefit from more than SEK 70 million each without belonging to the tenth of researchers in their subject area who produce most articles and are cited most in international academic journals.

If it were possible to turn back the clock to before the funding went to the latter group of researchers, who do not fulfil the conditions for the top 10%, we would have at our disposal more than SEK 5 billion, corresponding to far more than SEK 1bn a year for four years.

We can perform a thought experiment. Supposing that this money were allocated according to the percentile model, researchers would then be rewarded for what they have attained, not for what they claim to be capable of doing.[22] One objection might be that only senior individuals were then rewarded, while young researchers would be left out in the cold. But the same may, of course, be said of the funding for centres of excellence that, in principle, goes only to researchers who are strongly established in the academic community, and often to them who already have very large grants.

Nicklas Lundblad, Google's director of public policy and government relations for Europe and the EU, has proposed just such a model.[23] Rewards instead of grants are one of his prescriptions, and the percentile model is a proposal that can easily be reshaped into a reward system. This is independent of factors that constitute strong limitations for many researchers today. Reviewer selection is a factor that, with another model,

will cover all the peers that each researcher has to take into account. What will emerge is thus bibliometric peer review instead of a selection of unclear criteria from a handful of peers for assessing proposals for future research. Several researchers[24] have presented results indicating that research systems based on peer review underpin conformity and avoid supporting innovative research. At the same time, other researchers show that atypical combinations of results from different research fields are what yield the most cited articles.[25] This may be difficult for reviewers to grasp, but it provides results that are clearly reflected in bibliometric peer review.

And women, who thus make up 30% of the top researchers, would receive 30% of the grant funds. This would be fairer and more efficient than any system for distributing funds today. The excellence initiatives have, with no reasonable basis, given less than 20% of the funding to women.

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