# Allocation of Research Funds Using Bibliometric Indicators – Asset and Challenge to Swedish Higher Education Sector

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**Since 2009, the Swedish government has allocated a part of its direct funding to the Swedish universities based on a bibliometric indicator, which stems from the number of publications and citations found in the Web of Science bibliographic database. This paper discusses the creation and detailed structure of the new indicator, which has met criticism from both researchers and the Swedish Research Council, set to maintain the new system. The current focus on evaluation and quality assurance in the area of higher education, together with the introduction of the new indicator, has created an increased demand on the university administration and libraries for publication databases and bibliometric services**

The area of bibliometrics in Sweden has experienced strong growth for a number of years. The interest in assessments and quality revision has reached the higher education sector and publication analysis has been found to be specifically valuable in assessing general research performance. A new and contributing factor in this development is the recent introduction of a bibliometrics-based national allocation system for the direct research funding of the Swedish universities and university colleges. As of the 2009 financial year, a part of the funding from the national government to the universities depends on prior performance of the university researchers in terms of publications, citations and external funding. The structure, origin and consequences of this new system are investigated here.

## Bibliometrics for the Allocation of National Research Funding

The use of incentive structures has become more and more important in the desire to form a better and more productive society. This has also been true for researchers applying for research funding, which has been scrutinized by peers for decades. An area where this has not been implemented until recently is the direct financing of basic university research services, which have been funded by the public largely based on a percent increase from the previous year's levels. This has created uncertainty as to the validity of the system

and slowly eroded it in favor of the peer-review-based research councils, which have grown in size.

Several countries have made attempts to find solutions to this challenge. The United Kingdom unveiled its Research Assessment Exercise[1] (RAE) as far back as 1986 and set out to assess all institutions using peer-review panels. This cumbersome exercise has been repeated roughly every five years to give input to the British research councils in their work to fund research. Norway, on the contrary, chose a bibliometric system and allocates a part of its direct funding on a system built on publication counts and publication channel quality for publications reported by the Norwegian researchers.[2]

Sweden has been complacent to these developments for a long time. With a historically strong R&D sector, the political initiative was lacking. In 2004, the EU took a clear stance through its Lisbon Strategy to focus on reassuring the infrastructure of the knowledge-based community.[3] This, in part, was the reason that the Swedish Government in 2006 decided to widen an inquiry into improving the education funding model to also include the construction of a model for the research area.[4]

In November 2007, the inquiry (Resursutredningen) published its findings.[5] It suggested an extensive system for evaluation-based funding for both education and research. The new system would be governed by an intermediary agency, which would separate the universities from the funder, and determine allocation keys each year. The research system was built on a number of indicators, which had been found to have a high acceptance in the research community. The major part of the system was to be based on panel evaluation, much like the RAE system. In addition normalized citations in the international citation database Web of Science, external funding, number of teaching staff with a Ph.D. and number of female professors would make up the indicator. The choice of citation-based metrics was to some extent made because of its relative ease of startup as the system was to be functioning already in 2010 as stipulated by the Ministry. A system based on self-reported data, like the one in Norway, would require several years of preparations.

In the consultation following the inquiry, the universities and other stake holders expressed their opinions on the proposed systems. Many issues were raised, but a comparatively large number of respondents were relatively positive to the idea of citation bibliometrics as a part of a new allocation system. This was also the case for the external funding indicator. During the same period, the consultants responsible for the idea of citation analysis, headed by Dr. Ulf Sandström, in cooperation with the Swedish National Agency for Higher Education (HSV), published a more in-depth study of some concerns aired in the consultation regarding the bibliometric indicator.[6]

In October 2008, the final system was revealed through the government bill "Ett lyft för forskning och innovation".[7] Only the citation metrics and the external funding indicators remained. The idea of an intermediary

[1] http://www.rae.ac.uk
[2] http://dbh.nsd.uib.no/pub/hjelp.jsp?rapport=antall&
[3] http://ec.europa.eu/growthandjobs/pdf/kok_report_en.pdf
[4] http://www.sou.gov.se/kommittedirektiv/2006/Dir2006_29.pdf
[5] http://www.regeringen.se/sb/d/8439/a/91339
[6] http://www.hsv.se/download/18.8f0e4c9119e2b4a60c80006308/0818R.pdf
[7] http://www.regeringen.se/sb/d/10003/a/113957

had been removed and the Swedish Research Council (VR) had been put in charge of maintaining and calculating the indicator. The bill also introduced extensive funding to specific named strategic research areas, in which recipients were to be selected by the Ministry of Education. The suggested bill was signed into law by a decision of the Riksdag in January 2009.

### The Nuts and Bolts

Because of its relatively quick processing, the new system was taken into production already for the 2009 financial year. As a part of the increased focus on research, and because of the new added reliability in the funding model, new fresh funding was made available. This new funding was allocated in its entirety with the new system. From 2010 a part of the old funding will also be reallocated. This is done by the removal of 10 percentage of the funding of each university and redistribution is based on the new system of the withheld amount. This mode of action will ensure a gentle transition to a more and more indicator-based allocation at the same time as the new funding limits the chance of anyone losing out in the system. A base funding of SEK 8 000 per student also insured the level of funding for the small colleges.

The exact construction of the bibliometric indicator is of interest for purely bibliometric reasons, but has also been discussed by researchers trying to understand the system. Therefore I will make an attempt to present it in some detail. The data for the indicator is collected from Web of Science (WoS), which is a database indexing over 10 000 (recently 6 500) scientific journals in all areas of science. Based on publication addresses, the individual contributions are contributed to the different Swedish universities. Publications that are authored by researchers with affiliation to the university hospitals must include the corresponding university name to be counted. Only first authors and corresponding authors are considered and the publications are split if these researchers come from different institutions. It should be noted that address information is not always easy to interpret and a considerable effort is therefore put into this work. The number of publications, and citations to these publications, are counted. As the base for the 2010 allocation, data from 2005-2008 is used.

Methodologically, the raw number of publications and citations are somewhat misleading, mainly due to differences in publication rate, citation rate and database coverage for different areas of research. This leads up to a need for normalization. Several years back, a method for normalizing citations, creating what is called field-normalized citation counts, was proposed and has won some acceptance.[8] The system for normalizing publications is new with this proposal.

Citations are normalized based on three different conditions: the field of research, the document type (article, review or letter) and publication year. It is done by collecting all papers worldwide in the WoS database that share the same field, document type and publication year with the analyzed article. Field is determined by the journal and can be one of several of the 255 journal fields in WoS. From the reference body of papers, an average number of citations per publication can be calculated and the field-normalized citation is constructed by dividing the number of citations for the analyzed article by the average citation of the reference publications. The resulting indicator is practical in that it is 1 for publications with world-average citation numbers. A score of 1.22 would indicate that the article or a group of articles are cited 22 percentage more than

[8] Moed, H. F.; De Bruin, E.; Van Leeuwen, T. N. *Scientometrics,* 1995, 33, 381-422

the world average. It should be mentioned that the citation distribution per publication is skewed, which has led to a debate questioning the value of the average as an indicator.

Publications were also in need of normalization. The main reason for this is the fact that a large part of research is conducted in areas, where the quality research is presented in non-journal publication channels (books, anthology chapters or conferences). Since these forms of publication are outside the WoS coverage, an apparent lower publication rate can be found in large parts of the humanities and the social and applied sciences. In the new bibliometric system, the publications are normalized by comparing the publication rate of other Nordic researchers in a number of rather broad fields of science.[9]The number of fields was first 23 in the inquiry report, though in the HSV report and the bill they had increased to 34. To generate the normalization data, the average number of publications is calculated. The database itself shows all publications with authors that have published at least one publication. By the use of the Waring distribution, the number of authors which has not published anything can be approximated and together the average production per researcher can be determined.[9] Using the average production the publications of the analyzed university can be converted to the number of average productive researchers, which is used as the normalized value for publications in the evaluation. Because less than 10 percentage of the publications from the Humanities and Social Sciences are visible in WoS, an average researcher only publishes a small fraction of a WoS publication each four-year period. This leads to the fact that a publication in the HS fields count nearly 15 times higher than a publication in a more proliferate WoS area such as chemistry.

The final step in the calculation of the bibliometric indicator is to determine the product of the field-normalized citation and the number of average productive researchers. This score is then used together with the indicator for external funding. The system was quickly found to favor the specialized universities and especially the external funding gave the Humanities and Social Sciences a disadvantage. To weaken this effect a factor was introduced where institutions with large Humanities and Social Sciences (HS) activities were given a higher indicator. Based on the old funding scheme, institutions were given twice the points equivalent to the ratio of old funding for HS research, 1.5 times for the Science section and 1.0 for Medicine and Engineering. The other areas were denoted 1.1. The final collected indicator was made up of 50-50 of bibliometrics (publications and citations) and external funding multiplied by the correction factor.

## Criticism and Fine-tuning

During the preparatory work of the new system and especially after its final form, criticism has been heard from several directions. Independent researchers have aired concerns to whether research can be evaluated with bibliometric tools or whether it improves the quality of research in Sweden.[10] The limited coverage of the humanities and social sciences has led to a debate whether these areas are overseen by the Ministry.[11]

The Swedish Research Council was in the bill given the responsibility for maintenance

[9] Sandström, U.; Sandström E. *Res. Eval.* 2009, 18, 243-250

[10] http://www.fekis.se/debatt/2008/11/konstgjord-konkurrens-fungerar-inte-i-hogskolan-heller
http://www.sulf.se/templates/CopyrightPage.aspx?id=9902

[11] http://www.dn.se/kultur-noje/debatt-essa/sverker-lenas-utraknad-humaniora-1.888122

and development of the bibliometric indicator. They were also given the task to produce the yearly statistical material for the Ministry.[12] To allow for improvements already the first year, the Department of Research Policy Analysis of the Research Council embarked on an in-depth study of the new system. The sector was invited to act as a reference group for the process. The work came to focus on a number of obstacles. The Waring method for publication normalization was studied in depth and determined to be too unstable. The coverage of the data for the Humanities and Social Sciences was also a major point of weakness.

To aid the process, SUHF concurrently gathered a number of problems and tried to find solutions for these. The list was submitted for consultation to all Swedish universities and colleges. These are summarized in Table 1.

In May 2009, the Research Council presented a first report in their new task to oversee the new system.[14] The suggestion included a suggestion for substantial revision of the system. The Ministry was urged to suspend the current system for a year to allow for the system to be completely revised. The HS section was to be removed from the system permanently until more reliable data was made available. The Waring method was suggested to be replaced by a system based on incoming funding and the normalized productive re-

**Table 1. Problems of the bibliometric indicator in the new Swedish allocation system for direct funding (freely after SUHF)**[13]

| Problem | Possible solution |
|---|---|
| Humanities and Social Science researchers have limited possibility to affect the system. | Other sources than WoS, mainly self-reported data, must be employed. |
| The system is geared towards and encourages journal publishing. | Other sources than WoS, mainly self-reported data, must be employed. |
| The system is not transparent enough for the researchers. | Data must be made available for the universities, so they can understand their outcome. |
| External funding yields more publications, so it is counted double. | Only the part of publications that counts for the ratio of direct funding should be used for the indicator. |
| The applied correction factor is arbitrary | Also the indicator for external funding should be normalized prior to use. |
| The borderline to the university hospitals is unclear | This needs to be considered in a further study. |
| The technique of identifying all Nordic researchers to give data for the Waring process is too uncertain | Other sources than WoS, mainly self-reported data, must be employed. |
| The Waring system is too uncertain | Other sources than WoS, mainly self-reported data, must be employed. |
| The use of only first and corresponding author is unfair. | Also the other researchers should be allowed to share the publication. |

[12] http://www.regeringen.se/sb/d/10692/a/120853

[13] http://www.suhf.se/web/Problemstallningar_kring_den_nya_nationella_fordelningsindikatorn_for_direkta_medel_till_forskning_-_skrivelse_till_VR_april_2009.aspx

[14] http://www.vr.se/download/18.72e6b52e1211cdobba8800010145/bibliometrisk_indikator.pdf

searcher was to be replaced by a normalized cost of each publication. This would also allow for better comparisons with institutions with large propositions external funding. The university hospitals were to be included in the data in their entirety.

Upon submission of the report, it was quickly clear that the Ministry had not expected to be handed a suggestion with such longed-going revisions in a first report. It was made public through a renewed task in the summer, when the Ministry requested VR to calculate the indicator for the 2010 financial year as it was constructed before VR's report. This task was later completed by the Research Council.[15]

## Need for Institutional Support

When it comes to the consequences of the new system for Swedish university researchers, the change has only just begun. Even if criticism is still strong, several universities are looking for ways to encourage their faculty to publish in ways that would benefit their funding. This has especially been clear at smaller institutions, where each publication has a larger weight for the overall outcome for the university.

An area where the developments have already had a major impact is in the area of bibliometrics itself. Bibliometric research has been present at the Swedish universities for a considerable time. It was pioneered on a larger scale by Olle Persson at Umeå University already in the 1970's.[16] It was also earlier used as a more professional tool at a number of institutions, where the university libraries often were the settings because of their knowledge in related areas.

The professional work was intensified as the schools sensed an increased need for an internal understanding of their activities and as the Ministry's reporting requirements had already increased prior to the new financing system. The reporting requirements also put a focus on the need for an internal publication reporting system at the universities and publication databases were implemented first at Uppsala university and then at more and more universities. A study made a few years ago identified publication databases at 26 of 41 Swedish universities and colleges; more or less all were maintained or coordinated by the university libraries.[17]

The surge in interest also yielded a need for further cooperation in Sweden. In 2007 SUHF created a working group for bibliometrics under its subsidiary for library directors.[18] The group's major responsibilities have been in networking, staff development and knowledge exchanged. In 2007 a list of 10 persons with library connections were indentified as bibliometric staff. This list has now grown to over 80. In 2008, the group commissioned an inventory study of the area and identified 13 universities with organized bibliometric activities.[19] A year later this group has grown to 19 institutions and now covers all large universities and half of all Swedish institutions of higher education.[20]

Most of the bibliometric activities are still concentrated in the libraries. The presence of

[15] http://www.vr.se/download/18.2dc104631220c7154e180002895/Missiv_Redovisning+Bibliometriuppdrag.pdf
[16] http://www.issi-society.info/ollepersson60/
[17] http://tinyurl.com/epubse
[18] http://www.suhf.se/web/Arbetsgrupper_inom_Forum_for_bibliotekschefer.aspx
[19] http://hdl.handle.net/2077/18182
[20] http://publications.lib.chalmers.se/cpl/record/index.xsql?pubid=101049

high-quality data sources such as the publication databases paired with the bibliometric competences have together defined a new library service. This is also apparent in the increase of bibliometrics-related diploma theses from the Swedish library schools. The bibliometric staff today aids in the identification of researchers for upcoming research funding opportunities, finding suitable internal and external collaborators and later in enriching the contents of the application itself.

Another common task for the local bibliometric staff is the production of indicators for the local allocation of funds for research. The university and faculty administrations have discovered the use of bibliometric indicators from the national system and would like to develop similar systems locally. Unfortunately, this is a complicated undertaking. It first includes identifying the local organizational structure in the data. This can often be done by coupling external data to the publication database data. Next field-normalized data must be acquired, if that type of data is desired in the indicator. This data is not readily available since it requires reference data from the whole world and can not easily be calculated from the normal library resouces. A final obstacle is to engineer the indicator. The national indicators are very broad in their scope and the statistical downside of bibliometrics becomes clear as the aggregations of publications get smaller and the statistical uncertainty increases. These and other issues often give rise to heated discussions at the biannual metrics seminars for bibliometric professionals organized by the SUHF working group.

## Databases for Self-reporting and the Next Steps

What can be said about the immediate future of this still quickly developing area? SUHF has recently published recommendations for quality improvements to the publication databases. The lacking or uneven quality of these databases forced the Ministry in 2007 to base the national system on the Web of Science. The quality has since then become better and with the development this fall of a national aggregating service, Swepub, accessibility will also increase. This may make it possible to shift data sources to the local publication databases.

The bill and the resent annual budget have indicated a new government inquiry related to the area. The prediction is that this inquiry will be given the task of looking into the area of panels as an evaluative means for financial allocations, but it is also possible that the task of incorporating the current system with panel data will still need to be addressed. This may shed some new light on the problems of the current system addressed in the VR report.

## Conclusions

The introduction of a performance-based evaluation and allocation systems is not problem free in any organization and especially not so in the academic realm. The process takes many years and affects the academic sector in the process. It also leads to a healthy discussion. The new opportunities for university libraries are also inspiring and utilize classical library knowledge in a new way. I personally look forward to the direct funding to education as the next area of reform and to a whole new set of inspiring controversies.

[21] http://www.suhf.se/web/REK2009-3.aspx
[22] http://www.swepub.se