A DISCUSSION OF THE RESEARCH PERFORMANCE EVALUATION IN BUILDING AND CONSTRUCTION MANAGEMENT DISCIPLINE: THE JOURNAL IMPACT FACTORS (JIF) AND 'SCI-INDEX JOURNALS'

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The trend of diminished funding, demands for greater efficiency and higher public accountability have led to a rapid expansion of interest in the bibliometric assessment of research performance of universities. A pilot research is conducted to provide a preliminary overview of the research performance of the building and construction schools or departments through the analysis of bibliometric indicators including the journal impact factor (JIF) published by Institute for Scientific Information (ISI). The suitability of bibliometric evaluation approaches as a measure of research quality in building and construction management research field is discussed.

Keywords: research performance, building and construction, journal impact factor, ISI, SCI.

INTRODUCTION

The ability to achieve research excellence and to maintain competitiveness in both the local and international arena has become a strategic goal and an explicit target of many universities and research institutes. Governments in many countries have adopted assessment mechanisms that relates university funding and grants to academic research performance. Assessment of research quality is regarded as one of the most complicated aspects of the process of academic evaluation, yet one of the most difficult aspects of scientific process. The methods for research quality evaluation are still a debatable issue in the research arena (Seglen 1997; Borbons *et al.* 2002). Research evaluation was traditionally conducted by peer review but it was criticized for not being able to provide 'specific insight to evaluate the ingenuity and originality of results generated within a scientific specialty' (Seglen 1997).

Over the last two decades, bibliometric evaluation approaches such as journal impact factors (JIF) and citation analysis have been initiated to provide an objective and quantitative research performance assessment with internal consistency and fairness. Data extracted from the Science Citation Index (SCI) produced by the Institute for Scientific information (ISI) were suggested to be one of the best indication for measuring research performance and this has been adopted in the analysis of research performance in various research disciplines, for example in business and economics (Taylor 1994; Johnes and Johnes 1995) and computer science (Guan and Ma 2004).

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The JIF are now widely used to evaluate individual scientists or research groups, and also for job application, academic promotion and funding allocation (Seglen 1997; Lowy 1997).

Construction and engineering research features as one of the growing research fields, and much scientific research is currently being undertaken (Betts and Lansley 1993; Brandon and Betts 1995). A number of studies have been conducted to investigate and evaluate the research performance in the discipline. Betts and Lansley (1993) analysed the pattern of publications in the 'Construction Management and Economic' journal and of their citations between 1983 and 1993, suggested research in the building field was rather inward-looking. Pietroforte and Stefani (2004) assessed the development of the contents of ASCE's Journal of Construction Engineering and Management (JCEM) by identifying changes in its subjects and related topics between 1983 and 2000, and also to identify the academic institutions or universities that have major contributors to the JCEM journal. Pietroforte and Aboulezz (2005) also conducted a similar review study for the ASCE's Journal of Management in Engineering publication between 1985 and 2002. As pointed out by Moed *et al.* (2002), there is an increasing demand for a clearer understanding of research strategy and quality in building and construction management discipline by faculties and research policymaker in a global context. However, to date relatively little has been done to investigate the suitability of different bibliometric evaluation approaches in evaluating the research performance in the building and construction management area. In this paper, a pilot research is conducted to develop a preliminary overview of the research performance across departments or faculties of building and construction in the USA, UK and Australia.

This paper aims to investigate the number and citation rates of the research papers appearing in ISI-indexed publications of different schools/ departments. The research will examine and compare the relative research universities' building and construction schools/departments through the application of proxy measures constructed by the JIF published by Thomson's ISI. Beyond this, another main purpose of this paper is to promote discussion in the suitability of bibliometric evaluation approaches as a measure of research quality in the building and construction management research field. The research findings, in particular the appropriateness of the use of JIF for research performance evaluation will be discussed.

DATA AND METHOD

This study focuses on assessing and comparing the research performance and quality of five construction schools/ departments respectively in the USA, UK and Australia over the period 2002-2008. The publication of interest in this study is limited to those relevant ISI-indexed publications. The use of SCI-covered journals is based on the assumption that the articles published in high impact journals should be of high quality, although it has been realized that the high impact factor of a journal may not result from citations of all the articles in the journal (Colquhoun 2003). This is also based on an assumption that the quality of research articles published in the high impact journals are examined by a strong peer-review system including industry experts and experienced editors/reviewers (Sombatsompop and Markpin 2005).

The data collection starts with the search for a list of papers in ISI-indexed journals in the building and construction discipline via ISI's Web of Knowledge Database. Thomson's ISI contains bibliographic information on all articles published in over 7,500 international scientific journals (ISI Web of Knowledge 2008). University

information (for example, location or name) and publication year were used as the search strategy for the articles in the ISI database. In the present studies, the investigation is limited to seven key ISI-indexed journals in category of the 'construction and building technology', which includes Building and Environment (B&E), Energy and Buildings (E&B), Automation in Construction (AiC), Building Research and Information (BRI), Journal of Construction Engineering and Management (JCEM), the Journal of Management in Engineering (JME), and the Journal of Professional Issues in Engineering Education and Practice (JPIEEP). As a result, information including the author affiliation, address and citation data of sixteen universities for the time period from 2002 to 2008 was abstracted, and the lists were downloaded from the search engines. Then, the articles on the database list were downloaded via various publication search engines including ScienceDirect, ProQuest, EBSCOhost, etc. The purpose of this step was to confirm the bibliometric details, including authors' affiliations were accurate, by checking the information on the articles. In this study, it should be noted that items like correspondence, letters, commentaries, perspectives, new stories, editorial, obituaries, and tributes in SCI-covered journals were not considered as part of research output.

In the present study, citation analysis was adopted in order to understand the level of citation within building and construction research, and the citation pattern as well as the most cited individual papers during the study period. According to Seglen (1997), the use of citation as a quality measure is based on the assumption that the authors select their references on the basis of quality. In this study, citation numbers were counted for the year of publication between January 2002 and May 2008, and analysis of citations was confined to the ISI-indexed journals covered in this study. In addition, the JIF produced by ISI and published in the annual SCI Journal Citation Reports (JCR) was also employed as the bibliometric indicator to assess the scientific output and impact. The latest JIF in 2007 was downloaded from the ISI web site (i.e. Thomson Reuter). The research performance of a given university in the international context could be analysed both from a quantitative and qualitative point of view. First, the number of ISI-indexed publications of a school/ department and its contribution to the total publication are obtained. Then, the impact of its research production, preferably by scientific disciplines, will be measured and analysed through impact factor measures (Bordens *et al.* 2002).

RESULTS

Share of ISI-indexed publication

Some studies suggested that the most direct and general approach of evaluating research output is the number of articles published in SCI-covered journals (Guan and Ma 2004). In this study, an analysis of the total output and the trends of publication shares of SCI-covered journals by different university building and construction departments in the period 2002-2008 were conducted and are tabulated in Table 1.

An analysis of the total publication output indicates that the construction department in Loughborough University (N = 58) occupies the highest ranking in the number of publication in the UK, for it is roughly equal to that of the engineering school in the University of California in the US (N = 63). Table 1 reflects that, surprisingly, building and construction schools in Australia have a low level of publication in ISI-indexed journals over the years 2002-2008(May). Only the Queensland University of Technology (QUT) (N = 19) has a SCI-covered journal publication output level which is comparable to the construction and engineering schools in UK and US. However, as

Table 1: Output of the universities' building and construction departments in ISI-index journals during 2002-2008 (May)

Institutes	Year							
	2002	2003	2004	2005	2006	2007	2008(May)	Total
Reading	2	0	2	2	5	4	3	18
Salford	1	1	0	5	5	5	0	17
Imperial	0	1	1	1	2	6	0	11
Loughborough	8	7	7	8	14	6	8	58
UCL	0	0	2	0	7	1	4	14
Florida	2	3	0	2	3	1	0	11
Michigan	0	1	0	0	1	4	2	8
Stanford	2	1	1	3	2	4	1	14
California	6	5	10	20	7	10	5	63
MIT	8	4	2	2	2	6	3	27
UNSW	1	0	2	1	0	3	1	8
QUT	2	4	2	2	4	3	2	19
UTS	0	0	1	0	0	2	0	3
Melbourne U	1	1	0	0	1	2	0	5
RMIT	0	1	0	1	0	3	0	5
World	920	926	922	928	933	943	950	6522

argued by Guan and Ma (2004), counts of published journal papers is limited in revealing anything about the impact of the research as publications differ considerably in importance, quality, and influence.

Citation index

Table 2 suggested that construction and engineering schools including QUT (Australia) (N =11; 57%), University of Reading (UK) (N= 33%), University of Florida (US) (N =4; 36%) and the University of California (US) (N =21; 33%) have a higher number of internationally co-authored articles than other schools. This suggests that collaborative or co-authored publications in ISI-indexed journal were common in building and construction research. Table 2 also summarized the total number of citations and average citation rates per paper of the ISI-indexed journals for different construction schools in this study. The finding suggested that, universities'

Table 2: Summary of citation and international collaboration of different building and construction schools

Institutes	Researcher's Rank in SCI Articles				Citations	International Collaborative Papers
	1st author [N]	2nd author [N]	3rd author [N]	4th author [N]	[No of citations; citations per article]	[No of paper; % in institutes' total SCI publication]
Reading	12	4	0	0	41; 2.28	6; 33%
Salford	12	0	2	3	34; 2.00	2; 11%
Imperial	8	2	0	0	30; 2.73	1; 9%
Loughborough	35	15	7	5	120; 2.07	12; 20%
UCL	14	1	0	1	6; 0.43	0; 0%
Florida	6	3	2	0	99; 9.00	4; 36%
Michigan	7	2	0	0	21; 2.63	2; 25%
Stanford	5	8	0	1	21; 1.50	3; 21%
California	27	15	3	1	30; 0.48	21; 33%
MIT	20	3	1	0	94; 3.48	7; 25%
UNSW	8	1	0	0	10; 1.25	2; 25%
QUT	8	6	3	0	23; 1.21	11; 57%
UTS	3	1	0	0	4; 1.33	0; 0%
Melbourne Uni	5	2	1	0	1; 0.20	1; 25%
RMIT	4	0	1	0	1; 0.20	1; 25%

Table 3: Research impact analysis of universities' building and construction departments in the relevant SCI-covered journals

Institutes	ISI-indexed Journals (RII)							
	B&E (0.852)*	E&B (0.834)*	BRI (0.659)**	AIC (0.609)*	JCEM (0.493)*	JME (0.415)*	JPIEEP (0.181)*	Aggregate RII SCORE
Reading -	3.15	1.25	0.26	0.24	0	0	0	4.91
Salford	0	0	0.59	2.25	0.20	0.21	0	3.25
Imperial	1.96	0	0.26	0	0	0	0.13	2.35
Loughborough	1.11	1.58	0.26	5.79	1.08	0.95	0.18	10.96
UCL	0.68	1.33	1.52	0	0	0	0.14	3.68
Florida	0	0	0	0.30	0	1.00	0.14	1.45
Michigan	0.26	0.58	0.26	0.73	0.20	0	0.07	2.10
Stanford	0	0	0	0.61	1.73	0	0	2.33
California	1.53	2.42	0	0.30	3.25	0.66	0.43	8.61
MIT	2.22	1.00	0	1.46	1.08	0.17	0	5.93
UNSW	0	0.33	0.46	0.24	0.39	0.17	0.14	1.74
QUT	1.70	0.33	0	0.12	0.99	0.12	0.13	3.40
UTS	0	0	0.53	0.18	0	0	0.07	0.78
Melbourne Uni	0	0	0.26	0.12	0.74	0.12	0	1.25
RMIT	0	0	0	0.73	0.20	0.08	0	1.01

*Note: 1: TPW = Total output score of an university construction department/school in a SCI-covered publication (0.4 for 1st author; 0.3 for 2nd author; 0.2 for 3rd author; 0.1 for 4th author); RII =TPW x impact factor of a SCI publication; *The impact factors is based on the SCI 2007 index; ** 2006 SCI Impact Factor figure*

construction and engineering departments in the US, including University of Florida (9.00); University of Michigan (2.63) and Massachusetts Institute of Technology (3.48) had a higher impact and average citation rate of ISI-indexed journals. This shows that many of the American researcher' works achieve international recognition. Despite that, it should be noted that the downside of citation analysis is the problem of time-lagging (Johnes and Johnes 1995).

Research impact analysis of the schools

To develop a better understanding of the performance, research output of different building and construction schools/ departments need to be assessed with the impact factor of the ISI-indexed publications. This enables us to judge the relative impact and quality of their research output. Prior to the research impact analysis, publications were first fractionated and assigned with a rating on the basis of the impact factor of the journal. The first author listed on a publication was allocated a score of 0.4, where the second author was allocated 0.3; a score of 0.2 and 0.1 was allocated to the third and fourth authors of the publication respectively. In the present study, only the first four authors of the publication were taken into account in the analysis. The product of research output/performance assessed with the JIF of the ISI-indexed publications was named as research impact index (RII). The calculation commenced with multiplying the publication counts in each co-authorship (i.e. single author, two authors, three authors and mutli-authors) by the relevant allocated score (i.e. 0.4, 0.3, 0.2 and 0.1) for an ISI-indexed journal of an individual school/department. Then, the product was multiplied by the JIF (for example, 0.852 for the 'Building and Environment' Journal) in order to obtain the RII of that particular journal. The same calculation method was then recurred to compute the RII values of other ISI-indexed journals. All journals' RII scores were then summed up to form an aggregate RII score of each department/school.

The aggregate RII score shown in Table 3 reflects that Loughborough University (RII = 10.96) and University of California (RII = 8.61) have the strongest position in UK and US respectively. This reflects that these universities are being approximated to the

mainstream discipline and have become more recognized by the mainstream readership in the building and construction area aspect.

DISCUSSION AND CONCLUSION

In this study, ISI's journal impact factor was adopted as part of the measures to evaluate capacity, efficiency and quality of researchers and research works. The question here is: 'Do the universities have high number of publications, counting citations and RII in SCI-indexed journals are considered as best performers in terms of research quality?' In recent years, research outputs of many universities have tended to focus on the number of referred or high impact-factored publications and competitive research grants. University's presence in the journals indexed in the SCI has increased (Butler 2003). Governments, such as in Finland, are increasingly using impact factors as a criterion to consider and measure the quality of researchers and research institutions, and most importantly, to determine institutional research funding levels. Appropriateness of articles submitted has become a critical research strategic issue concerned by many university faculties, particularly in the countries where strong competition amongst university's research performance exists. Departments in many universities have started to re-assess and adapt publication strategies that avoid low impact or non-ISI-indexed journals; and maximize high impact or ISI-indexed journals whereever possible. As a result, great reliance on SCI-covered publications stimulates researchers focus on submitting their 'masterpieces' to high impact-factor publications (Luwel *et al.* 1999).

The use of the JIF as an indication of performance and quality of individual researchers or research institutions is still a highly controversial issue which has been debated amongst scholars. For example, Sombatsompop and Markpin (2005) argued that good researchers and their work could be considered as substandard if their product were published in a journal with a low impact factor, instead of SCI-covered journals. Seglen (1997) also maintained that the use of JIF in research performance and quality evaluation will alter the researchers' publication habits that shun journals or inferior impact regardless of their quality. Although books are another key publication by the researcher, they are not contributed to the JIF values (Seglen 1997). In addition, impact factors of journals in different subject fields are difficult to compare due to unfairness in the assessment of quality when impact factors are employed in the assessment (Guan and Ma 2004; Sombatsompop and Markpin 2005). Despite these arguments, Hoeffel (1998) argued that JIF still has 'the advantage of already being in existence and is, therefore a good technique for scientific evaluation…and it fits well with the opinion we (the researchers) have in each field of the best journals in researchers' specialty'. Previous studies argued that there is no perfect tool in measuring the quality of articles (Hoeffel 1998; and Sombatsompop and Markpin, 2005).

Another concern is raised in the prevailing research setting with reference to an inverse relationship between publication outputs (i.e., the number of publications) and esteem (Traynor *et al.* 2001). As argued by Geuna and Martin (2003), the funding policy based on research performance and output would discourage diversity and experimentation of research, and encourage a shift towards the research 'homogenization' (Geuna and Martin 2003). In many cases, departments or individual researchers would tend to focus on the 'production' of articles aligned with the research areas or interests of the ISI-indexed journals. Thomson (1999; cited in Geuna and Martin 2003) argued that academics would be inclined to reward 'safe' research,

irrespective of its benefits to the society and the real world. As a result, this would discourage research with innovative natures, and experiments with new risky approaches. In addition, Seglen (1997) clearly pointed out the problem of research evaluation in the existing practice and criticized that the journal should not be taken as representative of the article. Seglen argued that the citation impact is primarily a measure of scientific utility rather than of scientific quality. Author's selection of references is also subject to strong biases unrelated to quality (Seglen 1995). For the evaluation of scientific quality, Seglen (1997) pointed out that the evaluation of research or scientific quality should involve the qualified experts reading the publications and peer evaluation. In the UK, the Research Evaluation Framework consultation process of the last few years, specifically HEFCE started out from the view that peer review was clumsy, expensive and unreliable, and wanted a test based primarily on citation counts. After several lurches in policy during the consultation period about how the next evaluation will be done, they have all but dropped the idea of citation analysis because it is clumsy and uninformative and reveals nothing about quality. They have now moved to a process based on peer evaluation as the most appropriate.

In recent years, some new forms of bibliometric evaluation have been developed. For example, Hirsch (2005) has proposed the 'h-index' as a single-number criterion to measure the productivity and the apparent scientific impact of the scholars. This new measure of academic research impact has generated a widespread discussion and interest. The 'h-index' is measured based on the number of a scholar's publications, and their impact on the peers – that is a scholar with an index of 'h' has published 'h' papers each of which has been cited by others at least 'h' times. The 'h-index' can be calculated using Internet databases such as Google Scholar and subscription-based databases such as Scopus and the Web of Knowledge. However, not everyone is in favour of the new approach. Lehmann *et al.* (2005) argued that the 'h-index' lacks the necessary accuracy and precision to be useful. Bornmann and Daniel (2007) also pointed out that there has been a lack of cross-discipline validation on the basis of broad statistical data for various areas of application of the 'h-index'. Another problem with the 'h-index', as pointed out by Bornmann and Daniel (2007) and Harzing (2008), relates to the appropriateness of the measures for senior and junior academics. Bornmann and Daniel (2007) argued that 'h-index' favours academics that publish a continuous stream of papers with lasting and above-average impact. The 'h-index' however is a less appropriate measure of academic achievement for early career researchers (ECR) as their papers have not yet had the time to accumulate citations and it might take more than five years before a paper acquires a significant number of citations (Harzing, 2008). For ECR, the impact factor of the journal they publish in might be a more realistic measure of eventual impact. In addition, the h-index is based on the set of the researchers' most cited papers, and the number of citations that they have received in the publications of other researchers and this creates a problem. This removes any academic judgement from the question of academic quality, and turns the whole question into an administrative process that rewards citation in particular places, regardless of whether research is being cited with approval or cited as an example of poor research. Based on these problems, Sidiropoulos *et al.* (2006) proposed the contemporary h-index, which adds an age-related weighting to each cited article, giving less weight to older articles. This contemporary h-index is regarded as a slightly fairer comparison between junior and senior academics than the regular h-index.

In this article, a pilot bibliometric study was conducted to provide an initial review of the research performance of universities building and construction schools and departments on the basis of ISI database. A major limitation is the categorization of much of the research in the building and construction field. ISI does not have a specific category for the 'construction management and economics' discipline, and a better classification is needed in the future study when making claims about the scientific utility and application of ISI counts as compared to other disciplines. In addition, a more comprehensive study is needed to include additional journal publications, to compare the results from other bibliometric measures such as h-index, peer evaluation, etc. This study generally discusses the existing administrative approaches to the evaluation of research quality. This is an example of illustrating how numerical and systematic assessments of research quality have unintended consequences that are highly damaging as they reward people for focusing on what is counted, rather than for focusing on what counts. As argued by Rey-Rocha (2001), bibliometric measures such as citation and impact measures are only parts of many possible research performance measures but they have been over-emphasized in many evaluation processes in many countries. Other possible research evaluation approaches such as research utility and societal quality, scientific quality, researchers' training, and international scientific or industry collaboration are still under-considered. It is hoped that this paper opens up a debate, and makes some contribution to stimulate a wider discussion on this important area of study. Further investigation and discussion is recommended to be undertaken in this area.

REFERENCES

Altbach, P G (1995) Problems and possibilities: the US academic profession. *Studies in Higher Education*, **20**(1), 27-44

Brandon, P and Betts, M (1995) *Integrated Construction Information*, London: Spon.

Bornmann, L and Daniel, H D (2007) What do we know about the h-index. *Journal of the American Society for Information Science and Technology*, **58**(9), 1381-1385.

Bordons, M, Fernández, M T, and Gómez, I (2002) Advantages and limitations in the use of impact factor measures for the assessment of research performance in a peripheral country. *Scientometrics*, **53**(2), 185-206.

Colquhoun, D (2003) Challenging the tyranny of impact factors. *Nature*, **423**, 479.

Drennan, L T (2001) Quality assessment and the tension between teaching and research. *Quality in Higher Education*, **7**(1), 167-178.

Fox, M F (1992) Research, teaching, and publication productivity: mutuality versus competition in academic. *Society of Education*, **65**(4), 293-305.

Garfield, E (2006) The history and meaning of the journal impact factor. *The Journal of the American Medical Association*, **295**(1), 90-93.

Garfield, E and Welljams-Dorof, A (1992) Citation data: their use a quantitative indicators for science and technology evaluation and policy-making. *Science and Public Policy*, **19**(5), 321-327.

Geuna, A and Martin, B R (2003) University research evaluation and funding: an international comparison. *Minerva*, **41**, 277-304.

Guan, J and Ma, N (2004) A comparative study of research performance in computer science. *Scientometrics*, **61**(3), 339-359.

Harzing, A-W (2008), *Reflections on the h-index*. http://www.harzing.com/pop_hindex.htm, accessed on 18 May 2010.

Hirsch, J E (2005) An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences*, USA, **102**(46), 16569-16572.

Hoeffel, C (1998) Journal impact factors. *Allergy*, **53**, 1225.

Johnes, G and Johnes, J (1993) Measuring the research performance of UK economics departments: an application of data envelopment analysis. *Oxford Economic Papers*, **45**, 332-347.

Johnes, J and Johnes, G (1995) Research funding and performance in U.K. university departments of economics: a frontier analysis. *Economics of Education Review*, **14**(3), 301-314.

Johnes, J, Taylor, J and Francis, B (1993) The research performance of UK universities: a statistical analysis of the results of the 1989 research selectivity exercise. *Journal of the Royal Statistical Society* **156**(2), 271-286.

Johnson, R (1994) Effects of resource concentration on research performance. *Higher Education*, **28**, 25-37.

Luwel, M, Noyons, C M and Moed, H F (1999) Biblipmetric assessment of research performance in Flanders: policy background and implications. *R&D Management*, **29**(2), 133-141.

Lehmann, S., Jackson, A.D., and Lautrup, B.E. (2005). Measures and mismeasures of scientific quality, http://arxiv.org/abs/physics/0512238, accessed on 18 May 2010.

Massy, W F (1996) *Research Allocation in Higher Education*, Ann Arbor: University of Michigan Press.

Moed, H F (2002) Measuring China's research performance using the Science Citation Index. *Scientometrics*, **53**(3), 281-296.

Moed, H F, Luwel, M and Nederhof, A J (2002) Towards research performance in the humanities. *Library Trends*, **50**(3), 498-520.

Price, D.De.S. (1981) The analysis of scientometric metrics for policy implications. *Scientometrics*, **3**, 47-54.

Rey-Rocha, J, Martin-Sempere, M J, Martinez-Frias, J, and Lopez-Vera, F (2001) Some misuses of journal impact factor in research evaluation. *Cortex*, **37**, 595-7.

Seglen, P O (1997) Citations and journal impact factors: questionable indicators of research quality. *Allergy* **52**, 1050-1056.

Sombatsompop, N and Markpin, T (2005) Making an equality of ISI impact factors for different subject fields. *Journal of the American Society for Information Science and Technology*, **56**(7), 676-683.

Taylor, J (1994) Measuring research performance in business and management studies in the United Kingdom: The 1992 research assessment exercise. *British Journal of Management*, **5**, 275-288.

Tijssen, R J W, Visser, M S and Van Leeuwen, T N (2002) Benchmarking international scientific excellence: Are highly cited research papers an appropriate frame of reference? *Scientometrics*, **54**(3), 381-397.

Van Leeuwen, T N, Moed, H F, Tijssen, R J W, Visser, M S, and van Raan, A F J (2001) Language biases in the coverage of the Science Citation Index and its consequences for international comparisons of national research performance. *Scientometrics*, **51**(1), 335-346.