Bibliometric Modelling And Policy Making

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Abstract: Bibliometric methods for analysing and describing research output have been in existence and usage for over half a century. This has been supported internationally by the establishment and operations of organisations such as the Institute for Scientific Information (ISI) and the continual release and calculations of journal lists, bibliometric indicators and rankings. More recently bibliometric analyses have responded to the changes posed by the growing field of Internet publishing by incorporating some electronic versions of journals. Policy makers in Australia have been relying on such bibliometric information and analyses in making funding decisions and encouraging the development of research potential and strengths. This raises a number of concerns. Does bibliometric modelling of research productivity reflect the real impact research has for Australia's future? Is the electronic word in all its varieties overpowering the printed word? Is the grey literature as important as the officially recognised prestigious publications? Are the expectations policy makers, policy executives and managers draw from bibliometric modelling justified? The paper attempts to provide some answers to these questions based on a study of three Australian research centres in the field of the geosciences. The analysis reveals a number of anomalies in the generalisations made when ISI models are used for policy decisions.

Keywords: *bibliometric modelling; policy setting; research performance.*

1. INTRODUCTION

Bibliometric analyses are the main way in which the research performance of Australian researchers is traditionally recognised. This is evident in the quests for academic and/or research promotion, recognition by peers, research grant applications, and job applications. The research performance measures of the Department of Education, Science and Training (DEST) which funds higher education in Australia, also include refereed publications.

There has been concern amongst some Australian academic and research communities regarding the reliance on the bibliometric measure of citation analysis as a useful indicator of true research performance and impact. A study of the research performance of geoscientists in three Australian research centres, a Key Centre for Teaching and Research (KCTR), a Special Research Centre (SRC) and a Cooperative Research Centre (CRC), was undertaken to establish the validity of this concern. The KCTR and SRC were university based while the CRC was located at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and had a number of participating partners as core parties. The results of this work are used to discuss whether the reliance on bibliometric measures is a reasonable indicator for Australian research performance and whether other trends are being missed.

2. BIBLIOMETRIC MODELS AND RESEARCH

The advent of computerisation in the 1970s has assisted the Institute for Scientific Information (ISI) in its bibliometric modelling resulting in a wide range of bibliometric products now available. Many of them, especially those revealing citation counts, are widely used for the performance measurement of Australian researchers. For example, a series of projects carried out by Bourke et al.[1] in the 1990s to assist the Australian government in its science funding policy decisions was based on the citation products.

Bourke et al. (1996) admit that the use of bibliometric methods to measure research performance only provide indications of what is involved. They state that there is "little argument" for pursuing a more elaborate count of the research activities undertaken (1996: 58). However, others caution against the use of bibliometrics to provide these indicators (e.g. Blair, 1992; Klimley, 1993; Narin et al., 1994; Gibbs, 1995).

3. WHAT DOES A RESEARCHER DO?

Accepting that refereed publication and in the case of the university academic, external grant successes and research student supervision and

[1] See the References section of this paper.

completions, are considered important in the Australian government policy environment, what other functions does a researcher perform? The analysis of research for the participants in the study included a range of activities which were not scaled in any order of importance. The perusal of the researchers' CVs and publication lists which provided the main data source for the analysis highlighted the following categories as relevant:

- professional activity, i.e. number and type of professional association memberships, type of professional engagement and visiting positions;
- education, i.e. participation in under- and postgraduate teaching, research student supervision, industry courses and seminars;
- research activity, i.e. research grant successes and research management;
- publication, i.e. formal publication and grey literature.

Formal publications were books – authored; books edited; book chapter(s); and detailed journal article information. The following categories were used: (1) *Indexed international journals*, i.e. ISI recognised journals; given ISI's criteria for journal selection, these articles are fully refereed. (2) *Non-indexed international journals*, i.e. non-ISI indexed journal titles; these articles might be refereed, but are not considered important by the ISI. (3) *Indexed Australian journals*, i.e ISI-indexed Australian journal titles; the separation between international and Australian titles allowed analysis of publishing preferences. (4) *Non-indexed Australian journals*, i.e. as above for non-ISI indexed Australian journal titles. The analysis also covered whether the researcher was the sole and the senior (i.e. first) author of a journal article.

Grey literature is a category used in the library world to describe publications which cannot be readily acquired through normal bookselling channels and are difficult to identify and obtain (*Grey literature*, 2002). This published material is not likely to be included in any of the ISI indices and covers conference proceedings, company/technical reports, maps, theses and dissertations, field guidebooks and many types of government documents.

4. ARE THESE ACTIVITIES RESEARCH?

There are many areas of activity over and above publication in which the researchers engaged and that deserve consideration as components of their research activity. They were broadly classified as professional activity, education and securing funding.

Professional Activity

Traditional professional expectations (e.g. Reif, 1961; de Solla Price, 1965) have expanded. The ease with which researchers can travel to achieve professional networking or communicate using electronic means brings with it a busyness and an urgency which was not experienced in earlier times. The professional activities of the researchers in the centres were busy and complex.

The majority of the respondents belonged to at least one professional association**.** A number of them have achieved Fellow status: 25% from the KCTR, 20% from the CRC and 12.5 % from the SRC. The senior members of each of the centres have spent time on the national and/or international executive committees of at least one professional association. They and other respondents had also undertaken general committee duties for their respective professional associations at other times. Editorial duties were not as evident, with editorial panel membership being the most common option. In this instance the main duty described was refereeing papers for a relevant journal. Membership on advisory committees was well represented amongst the senior members of the centres, some examples include liaison committee, Geological Survey; research committee, Minerals and Energy Research Institute of Western Australia (MERIWA); National Seismic Imaging Committee and international scientific committees.

Professional activity in these various categories indicates a dedication to the science and its future. It is through professional association membership that the geoscientists have access to networks, conferences and professional meetings. A number of prestigious awards have been received by individuals and teams within the three centres. They contribute to the prestige of the groups, the teaching school and can enhance student numbers.

All of this professional activity is implicitly considered to be part of the researcher's role in geoscience, though it receives scant recognition in performance studies.

Education

The university base of the KCTR and the SRC and the conditions of employment for some of the academic researchers in the CRC mean that they must continue their educational role. The qualitative significance of undergraduate teaching for research is largely ignored. The federal funding is based on an equivalent full time student unit basis and does not reflect the original ethos and culture of why universities teach in the first place, i.e. to take advantage of and pass on the knowledge and wisdom derived from the research being undertaken and to encourage the brightest undergraduates to become researchers themselves.

Reif 's (1961) claim that there is a decrease in prestige from teaching undergraduate programs, particularly as it is considered as time stolen from research and publications. This attitude still persists in university circles today. Whilst the commitment to teaching and student supervision is mostly at the higher degree level in each of the centres, there was a representation of undergraduate involvement, particularly from the KCTR and SRC, and some of the CRC researchers.

Teaching at the postgraduate level is one of the prime ways in which each of the centres conveys its work to the industry which supports it: by educating those employed in the mining industry in their research findings and methods. A number of the researchers undertook considerable postgraduate teaching, either for courses in Masters programs or for industry short courses. It involves the organisation of many technical workshops and field trips, including to international locations in order to best demonstrate the tested theories and practices. The valuable information as compiled in the many course notes and technical report series is reaching a public, but not in the form of refereed articles.

Securing Funding

The continuity of funding to carry out strategic research programs (Lisle, 1995) is the biggest challenge for each of the centres. While they may have been successful in gaining financial support from industry, government funding can provide them with stability. This is not the case for the KCTR which failed in its bid to secure the continuation of government funding. The SRC's and CRC's funding is currently more secure with a nine- and seven-year horizon respectively. While seven or nine years might seem a long time in the mind of an economist or a policy maker, it is not a long time in the life of a geoscientific research program.

Support from industry however is still a crucial component for all centres. Whilst success in obtaining external funding is recognised by DEST, it also means that the life span of the centres is tenuous. There is thus a collision between funding timelines and continuity in research programs. The senior researchers in particular are continually seeking external income and spend time and efforts on grant applications with insecure outcomes.

5. RESEARCH DISSEMINATION

Geoscience researchers have been shown to be heavy users of geoscientific information in order to inform their research process. They also produce considerable quantities of information.

The analysis of publication output of the three centres revealed that the CRC uses 21, the KCTR 11 and the SRC 7 different types. The range is indicative of the projected audiences. The publication production analysis showed continued use of the formal publication types, particularly by the KCTR and the SRC, but there was also an increasing appreciable use of grey literature.

Formal Publication

A summary of the formal publication output by all participant researchers from the centres is shown in Table 1. It was expected that there would be significant number of formal publications because of the desire by research geoscientists to have their work in the published, indexed and cited literature. The records from the past, which are represented by the "before" figures, provided an indication of whether the researcher was publishing in the same media as prior to joining the research centre.

Table 1. Formal publications use

Centre/ Publications	KCTR before/ during	SRC before/ during	CRC before/ during
Book - author	1.8 / 3.3	0.5 / nil	9.4 / 2.8
Book-editor	4.7 / 2.2	1.0 / 0.5	6.5 / 2.0
Book-chapter	11.2 / 11.1	14.5 / 3.2	63.1/13.7
Journal - international ISI	23.0 / 29.1	54.6 / 34.6	121.0/19.4
Journal - international non-ISI	5.1 / 7.0	8.6 / 2.2	38.0 / 4.5
Journal - Australian ISI	3.0 / 2.6	7.1 / 6.1	33.1/ 4.2
Journal - Australian non-ISI	6.7 / 2.5	5.7 / 6.4	48.6 / 26.9
Journal-sole author*	7.0 / 5.0	26.0 / 16.0	78.7 / 12.5
Journal-senior author			
•fractionated	15.2 / 7.1	22.3 / 11.0	45.0 / 9.6
•unit count*	29.0 / 24.0	58.0 / 29.0	107.1/21.9

Notes: All counts are fractionated unless otherwise noted; * CRC unit counts are pro-rated for researchers' time with the centre.

The formal publication output of the members of the KCTR before and after joining the centre is reasonably static. The consistency is well illustrated in the category book-chapter with 11.2 publications before and 11.1 since joining the centre. Decreases in formal publication output are

evident in editing books (a drop from 4.7 to to 2.2) and Australian non-ISI indexed journals (a drop from 6.7 to 2.5).

The formal publication output for the SRC (as shown in Table 1) has decreased in all categories except Australian ISI and non-ISI indexed journals where the number of publications is relatively even. This can be explained by the short term existence of the centre as a SRC and the newness of some of its participants. As with the KCTR, the favoured publication type are ISI indexed journal titles.

The participants from the CRC have come from a variety of geoscientific research backgrounds, a number having had a long history with CSIRO and Geoscience Australia. Publishing in the Australian ISI indexed journals has fallen sharply for the CRC members from 33.1 to 4.2 (82% drop). The drop is even more noticeable in the ISI indexed international journals (84% from 121.0 to 19.4).

There is a decline in sole authorship in all centres. In the case of the CRC, the significant decrease is due to an increase in multiple authorship. Sole authorship is not a common practice for the KCTR or the SRC. Many of the journal papers have multiple authors (one paper prior to joining a centre had 28 authors). It appeared that publications in earlier years (1960s and 1970s) might have followed a convention for alphabetic order of authorship listing while those in more recent years use an order based on contribution. When the fractionated count of senior authorships is considered, there is a decrease in this category for researchers from all centres.

A number of the geoscience journal titles, particularly those published by Elsevier and Springer, are also available in electronic format through personal or library subscription. They were not counted as electronic since the titles are still a paper copy production.

Grey Literature

The heavy dependence of geoscientists on grey literature is reported by Haner (1989) and Bichteler (1991). The contributions to this category are shown in Table 2.

There are a number of electronic journals in the geosciences, with some of the more formal electronic journals following the same refereeing and monitoring procedures as those that appear in the paper domain. Yet as can be seen in Table 2, there is little to no indication that the participants from any of the centres target e-journals.

Conferences play an important role in information exchange for all of the centres. Although the funding model for research in Australian universities distinguishes between refereed and non-refereed conferences, only a few of the researchers make this separation. Conference papers in Australian and international geoscience are for the most part refereed. After checking conference types, it was found that the majority of the papers were published in refereed conference publications. However there was also a high use of the "extended abstract" and “abstract” refereed conference proceedings unrecognized by DEST.

Table 2. Contributions to the grey literature

Centre/ Publications	**KCTR before/ during**	**SRC before/ during**	**CRC before/ during**
Electronic	nil / nil	nil / nil	0.3 / 1.8
Conference - Editor -	1.6 / 0.2	nil / nil	2.7 / 3.9
Conference - other -	10.1 / 8.2	18.2 / 34.3	132.0/73.9
Government report -	13.9 / 1.5	1.8 / 2.9	220.3/64.9
Company report -	nil / 1.8	27.6 / 78.8	53.7/ 3.5
Maps	nil / nil	nil / nil	2.4 / 0.8
Field guidebook	1.1 / 2.5	1.4 / 0.4	17.6 / 12.6
*Other	1.6 / 10.8	7.4 / 9.0	61.3 / 35.4

Note: All counts are fractionated; the main categories included under “other” are course notes.

The CRC uses technical reports as a primary medium for information dissemination. Its researchers continue to publish government reports (220.3 before and 64.9 after) and company reports (53.2 before and 3.5 after). The SRC also has high figures in the report category (company reports have increased from 27.6 to 78.8). The use of these technical reports is particularly because of the need for the SRC and CRC to report their work through a company-based funding model managed by the Australian Minerals Industries Research Association Ltd (AMIRA). They have also emphasised the need for confidentiality for some of their work. This issue is recognised in the literature. Narin et al. (1994) and Roush (1997) write that because of confidentiality, articles do not always represent all of the research work undertaken. At the political level, Lowe (1996/7) stresses that undertaking industry work and the resultant confidentiality clauses can reduce the freedom to pass on new knowledge.

Report production exceeds ISI indexed journal publication for the SRC and CRC since the centres commenced. The SRC's counts for ISI journal publication are 34.6 for international, and 6.1 for Australian, giving a total of 40.7. The total company report count for the SRC for the same period is 81.6. The respective figures for the CRC

are 19.4 for international, 4.2 for Australian and a total of 23.6, compared with 68.4 reports.

Although the figures for map production are low, little technical information is not accompanied by a map. The "other" category includes course notes and teaching aides which are relevant to the dissemination of research results to sponsoring and other interested parties and are considered a component of the research output of the centres. References to web design and web page maintenance are also included here.

What is the quality of today's published paper? One of the participants, an elder statesman in geoscience, emailed that the push to publish for his centre was so intense that whereas one would have published one good paper in the past, one might now be producing three. The quality maintenance is left to the refereeing process. How does this place papers that, according to researchers from all centres, are "lightly refereed"? How does it place extended conference abstracts which are fully refereed, yet these conference abstracts are not accepted by ISI or DEST? Where does it place the technical report?

6. IN SUMMARY

The key observations from the analysis are outlined below:

- The funding mechanism for geoscientific research encourages refereed publications. The KCTR and SRC have high figures for international and Australian ISI indexed categories. However the researchers in the CRC which experience much more pressure from industry had lower figures.
- Each centre shows a strong record for refereed conference participation, including "extended abstract" refereed geoscientific proceedings.
- The publication of technical reports, while not recognised in the federal funding model, dominates the research output of the CRC and is significant for the SRC. Those publications form a major component of the assessment of each centre's public research dissemination.
- The research outputs of the participant researchers covers considerably more than formal publication. The participant researchers from each centre are highly qualified and committed scientists and represent a useful sample of the populations of each centre. They are recognised by their peers and others for the research that they do. The evidence is that they are committed to their research, their profession and to passing on the results of their work to their respective industries and to students.
- Each centre has a significant commitment to education and plays a major role in passing on research information to their relevant industries through their short course and coursework masters programs.
- Seeking research grant support is a consistent issue for the centres and is of crucial importance to the KCTR whose main federal funding grant was not renewed. The duration of the centres at this stage apears finite. The constant need to seek grant and other support monies for the centres does not diminish, and takes up considerable time of particularly the senior researchers.

6. CONCLUSIONS

This discussion has revealed a number of anomalies in the generalisations made when one uses ISI indices on which to base policy decisions. It has not negated their use as an indicator of events, but there is devil in the detail. The analysis reveals that there are important qualitative aspects in the research process, particularly those of professional commitment, influence, reputation and scientific recognition which are not captured by the bibliometric models.

There is an apparent conformity with the data produced by the Australian research performance studies. Further reflection reveals that this could be because the researchers are using the system, rather than the system measuring an authentic level of research output. However the researchers are now publishing in those journals which, although indexed by ISI, are not the highest ranked titles. They are believed to be more relevant titles.

Is the tail wagging the dog? In a novel twist to this question, Eugene Garfield, Chairman Emeritus for ISI asks the same question regarding the impact that the Science Citation Index has had on the study of informetrics (Garfield, 1998). He bolsters his case by quoting Le Pair (1995): "Citation Analysis is a fair evaluation tool for those scientific sub-fields where publication in the serial literature is the main vehicle of communication" (Garfield, 1998: 67). As we have seen in the case of the CRC, publication in the serial (or journal) literature is not the main vehicle of publication. In addition to this:

- there is little choice for the Australian geoscience researcher when it comes to publication in Australian geoscience journal titles indexed by ISI - there is only one such title; and
- of the many ISI indexed international titles in geoscience, only two are significantly preferred by the researchers and these have not ranked highly in the ISI journal impact figures for 2001.

How their research productivity is measured remains the crux of the existence of the three centres. The reliance of the Australian government on the journal indices reports of Bourke et al. means that this method cannot be ignored. The importance of publication is still present, though

its emphasis has been reduced. Australian universities are moving into new performance measurement areas with more emphasis being placed on research student completions and attracting research funding from diverse sources. The study observed how time exhausting the search for research funding can be. Where does the education and training of industry fit into these criteria? Where do field trips, conferences and technical report writing gain acknowledgment?

The flexibility of the modus operandi of the three centres indicates that they will be able to meet the aims of all of these measures: they publish, though for the CRC this is not in the scholarly media as for the other centres; they obtain their research grants from a variety of sources; and they encourage research students into their midst. Publications in the form of course notes do not reach the cited literature, the sharing of research ideas through industry courses, teaching and through student supervision is not easily quantified, yet these remain a significant component of the research output of the participants and many of their fellow researchers. Except for the CRC review process, there is no obvious effort by any government funding body to give credit for this.

Whilst the university-based centres do not escape being reviewed, their research culture is more accepted and protected under the funding arrangements in which they exist, provided the funding continues. In the case of all three centres, continuity of funding is the main uncertainty and in the case of the KCTR, has become a stark reality. How long is long enough for research funding? The study confirmed what has been often stated: that it takes time to build a solid and successful research profile. It makes one wonder whether the government might not be better served to study the building of strong collaborations and support in university based research centre environments over the years instead of applying bibliometric models. In the case of all three centres, if they were not providing industry-relevant research and programs, then their industry would not support them. If the CRCs are to become the research centre of the future, then we must expect a decrease in the performance of these centres in the ISI bibliometric measures as their publication in the grey literature increases.

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