

# THE IMPACT OF AUSTRALIAN SCIENCE

## POSSIBLE REASONS FOR THE PERCEIVED DECLINE IN THE AUSTRALIAN SHARE OF SCIENTIFIC CITATIONS IN THE INTERNATIONAL LITERATURE

### 1. INTRODUCTION

#### 1.1 Background

Recent systematic and sophisticated analyses of the bibliometric<sup>1</sup> evidence related to research performance agree that while Australia's research effort is 'excellent and prolific' for a country of its size, accounting for just over 2 percent of the world's research (Bureau of Industry Economics (BIE) Report, 1996b), we may have reached a watershed in terms of visibility and performance level within some fields (BIE Report, 1996b; Bourke and Butler, 1993). This latter thesis, based on strong evidence of a declining share of world citations in a large number of fields of Australian research since the mid- to late- 1980s, has led to a call-to-arms within sections of the scientific community to examine possible reasons for the general decline in Australia's research impact.

The purpose of this discussion paper, therefore, is to do just that - present possible hypotheses for the decline in citation share, and to examine the evidence available for each hypothesis. It is not the interest of this paper to reassess the careful and important data produced by *Science Watch* (1993), Bourke and Butler (1993), or the BIE (1996a and b). Rather, this paper aims to provide at least some preliminary information regarding particular contexts surrounding the Australian research enterprise, together with accompanying policy implications, and to do this in a setting where pivotal government decisions are about to be made regarding the future funding of the research system.

#### 1.2 The range of possible reasons for declining citation share

Both the Bourke and Butler study and the BIE Report (1996b) consider a range of possible factors for the declining citation data, including a diminution of research resources for Australian scientists; structural changes in the fields of science, with a reorientation to fields with lower citation impacts; poor access to international networks by Australian academics; the ageing of the scientific population; a shift from basic to applied research; uniform displacement in the Institute for Scientific Information (ISI) by other countries; foreign library policy with regard to the journals used by Australian researchers for publication; data errors; and an exodus of quality researchers.

---

<sup>1</sup> The statistical analysis of published research papers

In turn, the above studies also reject many of these hypotheses as being unlikely to explain the results, or as having data relating to them that are insufficient to develop firm conclusions, or impossible to interpret. For example, the BIE Report notes that Australia's case of falling citation share is not exceptional, with other countries like Denmark, Norway and Sweden showing similar patterns of reduction. What is exceptional in Australia, however, is the very large number of fields in which the decline appears to be occurring. In addition, both the BIE Report and Bourke and Butler provide evidence that Australia is probably not being displaced by the newly industrialised countries, some of whom are also experiencing a decline.

There is also little evidence that changes in the field structure of Australian science from high impact to low impact areas has had anything more than a slight effect on the citation data (BIE, 1996b). The 'ageing scientific population' is also rejected as implausible by the BIE, although this continues to remain a popular hypothesis in many scientific circles.

Neither is it the case that Australian scientific publication patterns have a local/regional rather than an international focus, thus affecting the visibility of Australian science. A recent study by Bourke, Butler and Biglia (1996) reports a 'strikingly international orientation in the publication patterns of Australian basic research, especially in science' (p.56), with 75 percent of all Australian science journal articles appearing in the ISI data base.

A recent Dutch policy statement (NWO, 1996) has highlighted *systemic* problems in the Dutch university sector thought to be having a negative impact on research. Many of the problems listed in the document bear a strong resemblance to the situation in Australia. For example:

- the decline in student numbers in certain disciplines, and the effects this may have on the amount of research in those disciplines;
- reduced job opportunities for post docs at a time when there is actually an urgent need for new blood;
- the danger that it will not be possible to retain the best of the younger generation;
- administrative structures and terms of employment that make it difficult to take decisive action;
- forms of competition between universities which are less than healthy;
- government financial cuts; and
- fading political support. (p.11)

The current study has considered these and other hypotheses, largely generated by Bourke and Butler (1994) and the BIE Report, in terms of their credibility and data availability. The hypotheses focussed on for this report, together with a brief discussion of the data pitfalls involved in interpretation and in reaching conclusions, are described in the following sections.

### 1.3 The hypotheses examined

A recent paper by Linke (1995) has reviewed the literature surrounding those factors thought to have the potential to systematically affect research performance. The paper groups the factors under two broad headings - personal factors, such as the characteristics and background of individual researchers, and environmental factors defining the circumstances in which researchers operate. While performance *per se* is not the major issue here, the hypotheses below contain elements related to the personal characteristics of researchers, such as age and background issues, specifically, international experience; and environmental factors such as the funding of disciplines, funding per researcher, shifts from basic to applied research, and library practices. In addition, further hypotheses related to bibliometric explanations for the citation data are also examined.

Data have been gathered (or accessed) to examine the following hypotheses:

1. The visibility of Australian science has declined because of a reduction by Australian scientists in the tapping of international networks.
2. There has been a 'greying' of Australian science.
3. There has been a shift from 'basic' to 'applied' research activity.
4. There has been an inadequate funding of research so that researchers do not have adequate resources to undertake high quality science.
5. Foreign libraries have policies and practices related to the management of international journals that may impact on the visibility of Australian science.
6. Various bibliometric<sup>2</sup> hypotheses:
  - There has been a decline in the proportion of Australia's publications that are very highly cited ('big bangs'), leading to a decline in citation shares;
  - Australians are finding it harder to publish in the 'top' journals and this is a major contributing factor to the decline in Australia's citation shares; and,
  - Australians may be publishing fewer review articles, leading to a reduction in citation shares.

As mentioned previously, while many hypotheses have been put forward to explain the Bourke and Butler and the BIE data, the credibility of each hypothesis, together with the availability of reliable data, played a major role in the selection of reasons for consideration in this preliminary report. Even so, data problems abound, particularly in the collection of time series data dating back to the early 1980s, part of the time period of interest in this study. In addition, a recent NBEET/ARC Report (in press) notes that while national data sets such as those collected by the Australian Bureau of Statistics (ABS) and the Department of Employment, Education, Training and Youth Affairs (DEETYA) have improved in recent years,

---

<sup>2</sup> Further bibliometric analyses are included within discussion of other hypotheses. All the bibliometric analyses are reported in detail in Appendix 2.

*...there are still some difficulties in making direct comparisons between the different collections. For example, academic organisational units, to which staff are identified, do not correspond with fields of research against which research income and publication output are identified. In addition, fields of study, against which post-graduate students are identified, reflect yet another order of reporting. (p.x)*

This report goes on to say with regard to national data sets that,

*...although they do suggest areas where changes in patterns of research may be occurring, they have not been in place, with consistency for sufficient time to reliably document such change. Nor are the national data sets adequate for assessing the characteristics of Australian researchers across different fields or institutions. (p.5)*

To add to the difficulties, the problems associated with the use of OECD Higher Education Statistics have also recently been highlighted (OECD Workshop, Restricted Report, 1995), particularly in relation to the use of OECD data to make international comparisons. The findings of the OECD Report suggest that the error margin in much of the Higher Education R&D statistics is quite high, leading to queries being raised regarding the robustness of findings based on OECD statistics, including the recent BIE Reports' findings (ARC, 1996).

Because of the serious problems involved in producing meaningful international comparisons noted by both the BIE (1996a) and the ARC (1996), this discussion paper refrains from making such comparisons, even though the ideal situation would suggest that international comparisons provide an appropriate context for discussions of this type.

With these provisos in mind, the following sections describe data that may in some way point to possible reasons for Australia's declining citation shares, or alternatively, help discard popularly held assumptions.

As most of the basic research conducted in Australia occurs in the higher education sector, it is here that we focus our investigation. However, because of the time period under investigation in the Bourke and Butler study, which prompted this investigation, and issues related to time lags in citations and so on, the data collection has been restricted where possible to that related to the pre-1987 universities. Similarly, not all fields of research have been included. The fields and sub-fields of research were chosen to be representative of the range of performances noted in the Bourke and Butler study. That is, fields are represented whose citation trends were found to be rising or holding steady, or were declining over the time period. For the field of Medical and Health Sciences, the sub-fields chosen were all found to be experiencing a declining trend in the Bourke and Butler study. The Medical Sciences feature very highly in the overall size of Australian research output, and any change in this area has a noticeable impact on the whole. The universities, and the fields of research are listed in Appendix 1.