Research output of Australian universities: are the newer institutions catching up?

Ross Williams

Melbourne Institute, University of Melbourne

Two decades on from the abolition of the binary divide in higher education in Australia, what has happened to the relative research performance of institutions that started from quite diverse positions? We use two databases, Thomson Reuters ISI and Scopus, to measure growth rates in research output. We find that there has been some convergence in research publications, with the newer universities catching up on the traditional research-intensive universities. No Go8 university is in the top quartile of growth rates. In absolute terms, however, the output differences remain very large. The findings are not unduly sensitive to the choice of database.

Introduction

The abolition of the binary divide in higher education in Australia is now two decades old. Institutions have now had time to adjust to new mission statements and financial incentives. In the 1990s the former colleges of advanced education were still adapting to the new requirements, especially in research and research training. At the same time, many established universities were preoccupied with bedding down changes arising from amalgamations and takeovers. With the greater stabilization of the system in the last decade, now is an appropriate time to look at whether there has been any convergence in the research performance of Australian universities.

Research funds have for many years been allocated competitively but, more recently, federal governments have signalled that performance will play an increased role in government funding of research. The disbandoned Research Quality Framework (RQF) has been replaced by the Excellence in Research for Australia (ERA) initiative.

With government funding for teaching Australian undergraduate students, stagnant and full-fee undergraduate places are now not permitted, Australian universities can increase revenue from three sources: international students, fee-paying postgraduate students, and research funds. An improved research performance increases income from all three sources: directly from research funding allocations, indirectly through an improvement in international rankings and its effect on fee-paying student demand.

The financial incentives are for less research-intensive universities to improve their research output; in relative terms this is easier to do from a low base. Some convergence in research performance is there-

fore expected as, unlike many European and Asian countries, federal governments have not chosen to fund selected institutions at a higher rate for either teaching or research.

The measurement of research performance is a key driver of international rankings and will become of greater importance in allocating government research funds in Australia with the phasing in of the Sustainable Research Excellence in Australia (SRE) initiative. It follows that the attributes of the databases used to measure performance are of growing importance. Two databases dominate the measurement of research performance: the ISI Web of Knowledge, provided by Thomson Reuters, and Scopus, provided by Elsevier.

The two most objective measures of international research performance are based on Thomson Reuters' ISI: Shanghai Jiao Tong (SJT) and the rankings by the Higher Education Evaluation and Accreditation Council of Taiwan (HEEACT). The other popular ranking has been Times Higher Education-QS which, although based primarily on surveys, in recent years used Scopus to derive its quantitative measures. From 2010 the Times Higher Education rankings are to be totally rethought and the database will change to Thomson Reuters. QS (Quacquarelli Symonds) will provide separate rankings using the Scopus database. Within Australia, Scopus is the database used in the ERA exercise, the results of which are planned to feed into the SRE initiative.

Because of the dominant positions of these two databases we evaluate them as alternative measures of research output of Australian universities. Does one database favour a particular type of institution or do they yield similar results?

Data

We measure research performance by publications in the form of articles, conference papers and reviews. The three categories are listed separately in ISI Web of Science and in Scopus. We choose to work with the aggregate figure as there is some arbitrariness in allocating publications between the three categories. Also, the aggregate publication figure for ISI Web of Science can be cross-checked against the data from another Thomson Reuters product, ESI. ESI is specifically designed to provide information on institutions, whereas ISI Web of Science (and Scopus) is designed primarily for locating publications on topics and the work of individual authors.

The databases were interrogated by searching the affiliations of authors. Care needs to be taken with universities that have international namesakes, such as Newcastle, Victoria and New England, and those with overlapping names, such as the University of South Australia and Flinders University of South Australia. It is relatively easy to use ISI for our purpose but Scopus requires a search over the different styles that can be used for affiliation, e.g. University of Sydney, Sydney Univ. Unfortunately, it was not possible to get reliable estimates for Victoria University and this institution was deleted from all the analysis. We also exclude non-members of Universities Australia, namely, The University of Notre Dame Australia and the offshoots of overseas universities.

We look at annual output of Australian universities over the period 2004–2008, which, allowing for institutional and publication lags, will reflect changes in government policy over the last decade. The period will also begin to pick up the effect on institutional policies of international rankings following the first SJT rankings in 2003. The importance that institutions place on international rankings has been documented by Hazelkorn (2007).

Data are taken from the online data banks as at August 2009. The Scopus data incorporated the enlarged list of journals in the humanities that were added in June 2009. Scopus included around 15,500 peer-reviewed journals, ISI around 12,500 journals. Of course, with the growing emphasis in the ERA and elsewhere on quality of research, greater coverage per se is not necessarily an aim in its own right.

The aggregate output for all Australian universities as measured by the two databases is given in Table 1. Overall, Scopus indexed 15 per cent more articles published by researchers in Australian universities than ISI. Comparing Thomson Reuters data, publications as indexed by ISI were a little above those from ESI, but the maximum difference, for any institution, over the whole period 2004–2008 was 7 per cent.

Table 1: Australian university publications ('000)‡: 2004–2008

Data Base	*Articles*	*Conference proceedings*	*Reviews*	*Total*
Scopus	140.7	30.3	18.1	189.1
ISI	122.4	13.1	9.1	144.6
Scopus/ISI	1.15	2.31	1.99	1.31

‡ Includes all members of Universities Australia except Victoria University (see text).

Research performance of groups of universities

We first look at the performance of groups of universities using the two databases. We classify universities into four groups, based on the nomenclature used by Marginson and Considine (2000), except that we shift Swinburne University from 'New' to 'Unitech'. The groups are given below and the allocations in Table 2.

- *Sandstone* or *Brick*: Go8 universities plus Tasmania
- *Gumtrees*: Universities established from the early 1960s to mid 1970s whose surrounds are typically planted with native flora.
- *Unitechs*: Institutions strong in technological areas
- *New Universities*: Mainly established after 1987, the post Dawkins era.

Universities that have a clinical medical program have an inbuilt advantage when ranking institutions by research performance. For example, over the period 2004-2008, 23 per cent of publications of Australian universities were in clinical medicine, as indexed by ESI. We therefore also divide institutions between those that have a medical school (with first student intakes earlier than 2006) and those that do not.

Table 3 compares the percentage of Australian university publications that are accounted for by each group of institutions over the period 2004-08, using the two databases. Using ISI, the Sandstone/Brick universities accounted for nearly 68 per cent of all publications; this percentage rises to 76 per cent if all institutions with a clinical medical school are included. Using Scopus, the contribution of the Sandstone/Brick universities was three percentage points lower (two per cent lower if only articles are included). The obverse of this is that the contribution of Unitechs was higher in Scopus than in ISI, but in part this is because Scopus included more conference proceedings, a form of publication that is more common in engineering and related disciplines. The Unitechs accounted for 20 per cent of all Australian conference proceedings papers in Scopus.

We now turn to the question of improvements in relative performance. In particular, are the newer universities catching up? To answer this question we look at the share of output of each university group in each of the five years 2004-2008. The results are given in Table 4 for the two databases. The general finding is that the Unitechs and New universities have increased their share of total publications at the expense of the Sandstone/Brick universities. Under either database, the share of publications attributable to the Sandstone/Brick universities has fallen by just under 2 percentage points. Thus, there is evidence of some convergence in research performance, although the research-intensive Sandstone/Brick universities still dominate, producing a little under two-thirds of total output in 2008.

Table 2: Classification of Australian Universities

Sandstone and Brick (Go8 + Tas)
Australian National University (ANU)*
Monash University*
University of Adelaide*
University of Melbourne*
University of New South Wales (UNSW)*
University of Queensland*
University of Sydney*
University of Tasmania*
University of Western Australia (UWA)*

Gumtrees
Deakin University
Flinders University of South Australia*
Griffith University*
James Cook University*
La Trobe University
Macquarie University
Murdoch University
University of Newcastle*
University of New England (UNE)
University of Wollongong

Unitechs (ATN + Swinburne)
Curtin University of Technology
Queensland University of Technology (QUT)
RMIT University
Swinburne University of Technology
University of South Australia (UniSA)
University of Technology, Sydney (UTS)

New Universities
Australian Catholic University (ACU)
Bond University*
Charles Darwin University
Charles Sturt University
CQUniversity
Edith Cowan University
Southern Cross University
University of Ballarat
University of Canberra
University of Southern Queensland (USQ)
University of Western Sydney (UWS)
Victoria University *(not included in analysis – see text)*

** denotes university had a clinical medical school before 2006.*

Table 3: Share of Australian publications by university groupings, 2004-08 (per cent)

Group	*ISI (total)*	*Scopus (total)*	*ISI (articles)*	*Scopus (articles)*
Sandstone/ Brick	67.9	64.5	68.0	65.7
Gumtree	18.4	18.4	18.6	18.8
Unitech	8.9	11.4	8.5	9.9
New	4.8	5.7	4.9	5.5

Research performance of individual universities

The use of groupings facilitates analysis by controlling for variables such as age and profile, but within

some of the groups there is considerable heterogeneity. In this section we look at performance of individual institutions. We again ask: does the choice of database matter greatly and which universities have exhibited the greater rate of growth in publications?

The ranking of institutions by absolute output is not particularly sensitive to whether ISI or Scopus is used as the database. The only noticeable effects are that the Unitechs improve their rank when Scopus is used (QUT, for example, increases 5 places), and Macquarie, Tasmania, James Cook and Flinders each fall 4 places when Scopus replaces ISI. The rankings at the top (Sandstone/Brick) and the bottom (New) are virtually identical using the two databases. At the top lie the Go8 universities in the same order: Sydney, Melbourne, Queensland, UNSW, Monash, ANU, UWA and Adelaide. These rankings are not adjusted for size of institution.

To look at changes in performance we fit exponential time trends to the five years of data for each institution. Rates-of-growth measures have the advantage that they control for profile. The section 3 findings for the groupings would suggest that some of the new universities are likely to have the fastest rates of growth.

In Table 5 we present rates of output growth of individual universities grouped into quartiles. We do this based on both the ISI and Scopus databases. In general, the two databases produce quite similar results. Note, however, that all the rates of growth have some upward bias imparted by the inclusion of some Australian journals only in the later years of the period covered. As expected, the highest rates of growth are exhibited by the New universities and by the Unitechs, albeit in several cases the growth is from a very low base. No Sandstone/Brick universities appear in the top quartile and three are located in the bottom quartile using either database.

Table 4: Annual shares of publications by university group, 2004-08 (per cent)

Group	*2004*	*2005*	*2006*	*2007*	*2008*
ISI					
Sandstone/ Brick	68.2	68.6	68.3	68.2	66.5
Gumtree	18.8	18.2	18.1	18.2	18.8
Unitech	8.6	8.5	8.8	8.8	9.4
New	4.3	4.7	4.9	4.8	5.3
Scopus					
Sandstone/ Brick	65.6	64.7	64.6	64.1	63.8
Gumtree	18.9	18.6	18.4	18.4	18.2
Unitech	10.3	11.2	11.4	11.7	12.0
New	5.2	5.5	5.6	5.8	6.0

At least as measured by research output, there is evidence of convergence in the research performance of Australian universities. The correlation coefficients between base output levels in 2004 and rates of growth over the period 2004-2008 are negative: -0.30 for Scopus and -0.29 for ISI, both significant at the 10 per cent level.

Publications and other research performance measures

Research performance measures include total publications, publications in prestigious journals, citations, competitive grants obtained and election of researchers to academies. Publications *per se* have historically

Table 5: Annual rates of growth of research publications, Australian universities, 2004-2008.

Quartile	*ISI*	*Scopus*
Q1 [highest growth]	*ACU, Ballarat, Bond, Charles Darwin, Charles Sturt, Curtin, Sunshine Coast, UniSA,* Wollongong	*ACU, Ballarat, Bond, Charles Darwin, Charles Sturt, Curtin,* QUT, *Sunshine Coast, UniSA*
Q2	*CQUniversity, Deakin, Griffith,* James Cook, *Melbourne, Monash,* QUT, Sydney, *USQ*	*CQUniversity, Deakin, Griffith, Melbourne, Monash,* RMIT, UTS, *UWS*, Wollongong
Q3	Adelaide, Edith Cowan, Flinders, *Macquarie, Queensland*, Southern Cross, *Tasmania,* UTS, *UWS*	Canberra, James Cook, *Macquarie, Queensland,* Swinburne, Sydney, *Tasmania,* UNSW, *UWS*
Q4	*ANU*, Canberra, *La Trobe, Murdoch, Newcastle,* RMIT, Swinburne, *UNE*, UNSW, *UWA*	*ANU*, Adelaide, Edith Cowan, Flinders, *La Trobe, Murdoch, Newcastle,* Southern Cross, *UNE, UWA*

Notes:
Universities in same quartile for both data bases are in italics.
ISI: Q1 is > 14.5% per year, Q2 is 10.3% to 14.5%, Q3 is 7.5% to 10.3% and Q4 is < 7.5 %.
Scopus: Q1 is > 14.0 % per year, Q2 is 10% to 14.0%, Q3 is 7.5% to 10%, Q4 is < 7.5%

been important for Australian universities because they are used to allocate research funding.

In previous work (Williams and Van Dyke, 2007, 2008) we have found high correlations between alternative measures of research performance for Australian universities. Australian data, at least at the institutional level, tend to confirm a strong empirical regularity between citations and publications first observed at the international level by Katz (2000). Katz found that for both countries and a range of scientific disciplines citations increased more than proportionately with publications. Large research groups generate more citations per paper. More precisely, he found:

$$\text{citations} = k.\ \text{publications}^{\beta}$$

where $\beta > 1$. Using data for nations he found $\beta = 0.27$, but it was a little lower for countries and disciplines. Katz's findings extend to data for Australian universities. For example, using ESI data for the period 2004-2008, the exponent on publications is 1.18 with a standard error of 0.04.

Within academia, the international research standing of an institution depends heavily on publications in the top journals in the various disciplines. The existing databases do lop off the lower-quality tail of journals; ISI, for example has well-established criteria for inclusion in its citation indexes. However, further truncation is frequently used for quality measures.

The importance of adjusting output measures for quality depends on the extent to which the distribution of output across journals varies between institutions. However, there is little empirical evidence on the relationship between publications in quality journals and total publications. The HEEACT rankings provide data on both total ISI publications in the last two years and publications in the top 5 per cent of journals within each field of study, as measured by ISI journal-impact factors. The (Spearman) rank correlation between the two series in the 2009 rankings, for the top 100 ranked institutions, is relatively high at 0.80. Completion of the ERA exercise in Australia will provide further evidence on the extent to which measuring quality affects the rankings of research performance.

Concluding remarks

In this paper we have used two commercially available databases, ISI and Scopus, to provide output measures of research performance. The results are not particularly sensitive to the database used, except that the more technologically oriented institutions are favoured by the inclusion of more conference proceedings in the Scopus database we used. We conjecture that the two databases are similarly unlikely to give markedly different results for citation counts.

We found evidence of some convergence across institutions in the number of publications produced, with the more technological institutions and newer universities gaining ground at the expense of the older research-intensive universities. But is this an evening up or an evening down of research performance across institutions? Influenced by their relatively poor performance in the international rankings, countries such as China, Germany and France have introduced differential funding models. Greater concentration of research funding on selected research-intensive institutions may not increase total research output, but it is likely to lead to an improved national presence in the international rankings and thus greater recognition of the academic standing of a nation's universities. In Australia, rather than differential funding of institutions, government policy is directed towards concentration of research funding on teams, irrespective of their location. This policy will contribute to an increase in the total sum of quality research in Australia but it is an open question as to whether such an approach fully exploits the synergies that arise from large clusters of researchers.

Ross Williams is a Professorial Fellow in the Melbourne Institute, University of Melbourne.

References

Hazelkorn, E 2007, 'The impact of league tables on ranking systems on higher education decision making', *Higher Education Management and Policy,* 19 (2), pp. 81-105.

Katz, JS 2000, 'Scale-independent indicators and research evaluation', *Science and Public Policy*, 27, pp. 23-36.

Marginson, S & Considine, M 2000, *The enterprise university: power, governance and reinvention in Australia,* Cambridge University Press, Cambridge.

Williams, R & Van Dyke, N 2007, 'Measuring the international standing of universities with an application to Australian universities', *Higher Education*, 53, pp. 819-841.

Williams, R & Van Dyke, N 2008, 'Reputation and reality: ranking major disciplines in Australian universities', *Higher Education,* 56, pp.1-28.