RESEARCH ONLINE

University of Wollongong
Research Online

Faculty of Commerce - Papers (Archive)

Faculty of Business

2006

The distribution of research performance across Australian universities, 1992-2003, and its implications for higher education funding models

Simon Ville
University of Wollongong, sville@uow.edu.au

A. Valadkhani
University of Wollongong, abbas@uow.edu.au

M. O'Brien
University of Wollongong, martinob@uow.edu.au

Publication Details

This article was originally published as Ville, S, Valadkhani, A and O'Brien, M, The Distribution of Research Performance Across Australian Universities, 1992-2003, and Its Implications for Building Diversity, Australian Economic Papers, 45(4), 2006, 343-361.

Research Online is the open access institutional repository for the University of Wollongong. For further information contact the UOW Library: research-pubs@uow.edu.au

RESEARCH ONLINE

The distribution of research performance across Australian universities, 1992-2003, and its implications for higher education funding models

Abstract
We contribute to the debate on research performance by comparing the distribution of research inputs and outputs across Australian universities during 1992-2003. We have calculated annual Gini coefficients for various performance measures and Lorenz curves for the final year of the study. Various findings are evident. Research-input measures have remained relatively unevenly distributed across universities. Output measures were more evenly distributed and this exhibited a gradual and rather consistent decline through time, supporting the view that the research output is being generated gradually more equally across Australia's universities. Excluding the "Group of Eight" (Go8) universities, results in a more even distribution of performance. However, in 2003 this group took the lion's share of research inputs but produced a smaller share of outputs. Our findings are relevant to current funding policy discussion.

Keywords
Higher education, Research output distribution, Gini coefficient

Disciplines
Business | Social and Behavioral Sciences

Publication Details
This article was originally published as Ville, S, Valadkhani, A and O'Brien, M, The Distribution of Research Performance Across Australian Universities, 1992-2003, and Its Implications for Building Diversity, Australian Economic Papers, 45(4), 2006, 343-361.

This journal article is available at Research Online: http://ro.uow.edu.au/commpapers/381

THE DISTRIBUTION OF RESEARCH PERFORMANCE ACROSS AUSTRALIAN UNIVERSITIES, 1992-2003, AND ITS IMPLICATIONS FOR HIGHER EDUCATION FUNDING MODELS*

By

SIMON VILLE
ABBAS VALADKHANI
MARTIN O'BRIEN

School of Economics
University of Wollongong
Wollongong NSW 2522

* Corresponding author: Dr Abbas Valadkhani, School of Economics, University of Wollongong, NSW 2522, Australia. Email: abbas@uow.edu.au Website: www.uow.edu.au/~abbas
Tel: 02-4221 4022 and Fax: 02-4221 3725

THE DISTRIBUTION OF RESEARCH PERFORMANCE ACROSS AUSTRALIAN UNIVERSITIES, 1992-2003, AND ITS IMPLICATIONS FOR HIGHER EDUCATION FUNDING MODELS

Abstract: We contribute to the debate on research performance by comparing the distribution of research inputs and outputs across Australian universities during 1992-2003. We have calculated annual Gini coefficients for various performance measures and Lorenz curves for the final year of the study. Various findings are evident. Research-input measures have remained relatively unevenly distributed across universities. Output measures were more evenly distributed and this exhibited a gradual and rather consistent decline through time, supporting the view that the research output is being generated gradually more equally across Australia's universities. Excluding the "Group of Eight" (Go8) universities, results in a more even distribution of performance. However, in 2003 this group took the lion's share of research inputs but produced a smaller share of outputs. Our findings are relevant to current funding policy discussion.

Keywords: Higher education, Research output distribution, Gini coefficient

JEL classification: A11; A19; C63; I29

I. INTRODUCTION

It is well-recognised that Australian universities play a vital role in national research and the scholarship of research, partially justifying sizeable Commonwealth government funding. Between 1965 and 1988, for example, a binary divide existed in the higher education sector whereby the smaller number of research-oriented 'universities' were automatically funded at a higher level than the larger number of teaching-oriented 'colleges of advanced education' and 'institutes of technology'. For the most part, such funding was more concerned with this division and institutional size and course mix, rather than any attempt to recognise and reward research.

However, from 1989 a series of policy changes, collectively known as the 'Dawkins reforms', created a Unified National System, wherein the establishment of a series of agreed operating profiles for universities facilitated a large and rapid expansion in their number. Within this system, during the 1990s, Commonwealth research funding was directed through four main channels. First, support for research training was provided through operating grants made on the basis of enrolments and disciplines, as well as in the form of Australian Postgraduate Research Awards (APRA) scholarships for postgraduate research and exemptions for domestic students from the requirement to pay fees (in the form of HECS, the *Higher Education Contribution Scheme*). Second, funding in the form of a Research Quantum was allocated on the basis of a composite index to support university research and research-training more generally, taking into account both research inputs (private research and special government research funding) and research outputs (publications and postgraduate completions). Thirdly, Research Infrastructure Block Grants supported project-based infrastructure within an institution. Finally, program-specific funding is also allocated, encompassing, amongst other things, Australian Research Council (ARC) awards for projects (both wholly and industry-linked) and fellowships. This system was modified with the implementation of the 1999 White Paper, *Knowledge and Innovation*; in particular the Research Quantum was replaced with the Institutional Grants Scheme. Despite these changes and the apparent dissimilarity of these funding channels, all have been allocated, at least indirectly, on the basis of an institution's research performance, partially facilitated by the Commonwealth's DEST monitoring and assessment of research output.

The Commonwealth government has recently initiated discussions about moving to a differentiated trinary system of classification with universities categorised as 'research intensive', 'teaching and research' or 'teaching intensive', which it labels 'building diversity' in a recent discussion paper (Department of Education, Science and Training, DEST, 2005a, p. 2). Not unexpectedly, this reclassification is generally thought to be associated with a move away from the current unitary system of performance-based funding. The means by which such a classification is to be obtained is subject to some conjecture, and there are concerns, especially by newer universities, that it would fall more or less along the lines of the older binary divide, despite argued gains in research performance in the interregnum. In this manner, the larger, more established universities (comprising the Go8[1]) would be classified as research intensive, with the remaining universities (comprising the Innovative Research Universities Australia, the Australian Technology Network, New Generation Universities and Ungrouped Universities) taking up the lesser role, funding and status of 'teaching and research' or 'teaching only' universities.

Unfortunately, there has been very little quantitative work on the ranking of Australian university research performance that would provide guidance on these proposed policy changes. DETYA[2] (Department of Education, Training and Youth Affairs, 1998), for example, classified Australian universities on a wide range of research and teaching characteristics for 1996/1997 using cluster analysis. More than twenty different indicators were used to operationalise six performance measures: size, overseas orientation, diversity, internal/full-time orientation, financial research orientation and staff research orientation. Based on these six measures, universities were grouped into between four and seven clusters and ranked on the basis of a single composite indicator. While arguably "a workable measure of the characteristics and performance of institutions in terms of their teaching and research activities" (DETYA, 1998, p.41), this study is cross-sectional and rather unwieldy.

As an alternative, Abbott and Doucouliagos (2003) examined the technical and scale efficiency of Australian universities with data envelopment analysis. After considering different measures of output and inputs (both teaching and research), it was concluded that the results were insensitive with respect to the selection of the chosen output-input mix, suggesting that Australian universities overall recorded high levels of relative efficiency. More recently, Abbott and Doucouliagos (2004) investigated the relationship between research output, research income, academic and non-academic labour and other university characteristics. They concluded that research income, academic staff and postgraduates were all positively related with research output, but that substantial differences exist, since a number of newer universities are finding it difficult to catch up with the more established universities in terms of research performance. Clearly such analyses add to our understanding of the production process in universities in Australia and overseas [see, for instance, Johnes and Johnes (1993; 1995), Johnes (1988; 1990; 1992; 1995), Beasley (1995), Glass et al. (1995a; 1995b), Coelli (1996), Athanassopoulos and Shale (1997), Carrico et al. (1997), Hashimoto and Cohn (1997), Glass et al. (1998), Ng and Li (2000)], but are computationally complex, rely on data difficult to obtain over time, and are prone to misspecification and misinterpretation. Worthington (2001) provides a useful survey outlining the limitations of efficiency measurement techniques in educational contexts.

Finally, Williams and Van Dyke (2004) conducted a recent study on the international standing of Australian universities using a range of performance measures. These included the international standing of academic staff, the quality of the graduate and undergraduate programs, resource availability, and a subjective assessment of standing by surveyed

educationists in Australia and overseas. In part, this study was intended to complement and confront some of the well-publicised (and often contentious) international rankings produced by the Institute of Higher Education at Shanghai Jiao Tong University (2003) and the Times Higher Education Supplement (2004).[3] While encompassing a broad scale of measures, the resultant index indicated that the Group of Eight universities were highest ranked on an Australian basis, thereby confirming similar results from the international studies. However, given its reliance upon surveyed perceptions of standing, the study by Williams and Van Dyke (2004) suffers from subjectivity and is unlikely to be easily replicated in the future. Other work on the ranking of university performance in Australia and overseas, either wholly or in part, include Bowden (2000), Clarke (2002), Federkeil (2002), Filinov and Ruchkina (2002), Vaughin (2002), Yonezawa et al. (2002) and Pomfret and Wang (2003).

Two major shortcomings exist in much of the literature. Performance measures are often calculated without an adjustment for institutional size, thus biasing in favour of the larger Go8 universities. Where adjustments are undertaken, significant methodological problems are encountered in deciding upon an adjuster (for example employees, budget size, student load) and in accurately enumerating that adjuster. Secondly, many studies have followed official policy in intermixing research inputs (grant monies) with a range of research outputs such as publications and PhD completions in measuring performance. If we are to measure performance in terms of productivity we need to separate but compare inputs with outputs. Our paper, by separating out various inputs from a range of outputs and comparing each university's contribution to both, seeks to provide a measure of productivity and avoids the bias of size.

Therefore, we are interested in investigating the general distribution of both research inputs and output across universities, and whether this has exhibited any observable trends over the time period 1992 to 2003. Furthermore, this analysis is conducted both including and excluding the Go8 in order to assess their impact on this distribution. Note that it would be unwise to conduct the analysis using just the Go8 universities, because of too few observations when ungroup data are used.

The rest of the paper is organised as follows. In Section II we briefly explain the methodology of calculating the Gini coefficient using ungrouped data. Section III discusses the source and type of the data employed for the eleven measures of research performance of 38 universities during the period 1992-2003. Section IV presents and analyses the empirical results of the study. Section V discusses some policy implications and Section VI offers concluding remarks.

II. METHODOLOGY

The Gini coefficient (G) is a measure of inequality and is typically used by economists to measure the income distribution of individuals or households with an economy. In the literature G is used as a quantitative measure of the extent to which income distribution is different from a hypothetical uniform distribution. In terms of magnitude, it ranges from zero for absolute income equality (each individual receiving the same share of income), to unity for absolute inequality (one single individual receiving the entire income). The Gini coefficient was developed by the Italian statistician Corrado Gini. One can compute the Gini coefficient using the Lorenz curve (Lorenz, 1905), which is generally assumed to be twice-differentiable and monotonically increasing (Kakwani, 1980).

Let $l = l(z)$ be a convex Lorenz function, where z is the cumulative proportion of output producers and l is the corresponding cumulative proportion of output produced. Then mathematically the Gini coefficient can be obtained in the following manner:

$$G = 1 - 2\int_0^1 l(z)dz \tag{1}$$

Theoretically speaking, G lies between zero and unity (*i.e.* $0 \le G \le 1$), where G=0 means every university yields the same level of research performance and G=1 implies that only one university generates/consumes total research output/input, and all other universities have a zero share of research performance. The higher the Gini coefficient, the more uneven the distribution of research would be. In practice we do not have a well-defined mathematical function such as $l = l(z)$ and thus one has to approximate the Lorenz curve by say a frequency polygon. There is a plethora of work on Lorenz curves and how to approximate the Gini coefficient for both the grouped and ungrouped data. See *e.g* Milanovic (1994, 1997), Wan (1999), Abounoori, E and McCloughan (2003). Following Milanovic (1994) the Gini coefficient for the ungrouped data in this study can be approximated as follows:

$$G = \frac{2}{n(n+1)}.\begin{bmatrix} n & n-1 & n-2 & \dots & 1 \end{bmatrix}.\begin{bmatrix} 1-\frac{Y_1}{\bar{Y}} \\ 1-\frac{Y_2}{\bar{Y}} \\ 1-\frac{Y_3}{\bar{Y}} \\ . \\ . \\ 1-\frac{Y_n}{\bar{Y}} \end{bmatrix} \tag{2}$$

Where n=the number of individual universities, and Y_j=research produced by the jth university in such way that $Y_1<Y_2<Y_3<\ldots<Y_n$, and $\bar{Y}$ =the average research output. Abounoori and McCloughan (2003) have recently simplified the above relation and presented the following equation to compute the Gini coefficient:

$$G = \frac{2}{n(n+1)}\sum_{j=1}^{n} j\left(1-\frac{Y_{n-j+1}}{\bar{Y}}\right) \tag{3}$$

More specifically, in order to compute the Gini coefficient for example for the number of PhD completions *(i.e.* Y_j*),* say in the year 2003, we have taken the following two steps: (a) the number of PhD completions by all 38 Australian universities (n=38) are sorted in Excel in ascending order; and (b) equations (2) and (3) are then used to estimate the Gini coefficient. The above-mentioned procedure has been adopted to calculate the Gini coefficient for each of 11 measures of research performance and for each year during the period 1992-2003.

A perennial problem with the Gini coefficient, however, relates to the fact that it is not efficient at picking up marginal changes in income distributions over time. The index has a tendency to be quite stable with rare significant inter-temporal changes. In other words, if the achievement of "middle performers" remain unchanged through time, the Gini coefficient will not exhibit much variation and it can mask differences in research performance when the Lorenz curve intersects (Zoli, 1999). That is to say, the Gini coefficient is more sensitive to changes in research performance (income in the literature) of the middle classes and the "high achievers" and "low achievers" are ignored to a certain extent. Furthermore, this index does not provide us with a scalar measure of inequality either. For a detailed account of the shortcomings associated with the Gini coefficient see Atkinson (1983).

Having said that, the Gini coefficient is reasonably simple to compute and it can be compared through time and be easily interpreted. This useful index demonstrates how the distribution of research output/input can change for Go8 and Non-Go8 universities. If the Gini coefficient declines and total research output/input grows, one can conclude that overall it is highly likely that the research performance of most universities would improve. Therefore, the Gini coefficient can be used to evaluate the distribution of research performance. It is useful to know whether the disparity and inequality in terms of research performance among universities over a period of time are on the rise or are being narrowed. It is obvious that it is not feasible or rational to have universities with the same level of research productivity. However, a reasonable reduction in research inequality will ensure students in various parts of Australia benefit from the resulting research spillovers and quality education associated with the research-teaching nexus.

III. THE DATA

All thirty-eight Australian universities have been included in the analysis, all of which are publicly funded (with the exception of Bond University) and members of the Australian Vice-Chancellor's Committee (AVCC). Twenty-nine of these universities belong to one of four groupings: the Group of Eight (Go8); the Innovative Research Universities Australia (IRUA), the Australian Technology Network (ATN) and the New Generation Universities (NGU). A full list of these university groupings is included in Table I.

The performance measures specified in the analysis have all been obtained from a report entitled "Higher Education Research Data Collection time series data 1992-2003" published by The Australian Vice-Chancellors' Committee (AVCC, 2005). The full database in Excel form is available online free of charge at http://www.avcc.edu.au (one needs to click on "Publications" and then under the heading of "Statistics" choose "Research"). The eleven measures of research performance in our analysis are: (1) Commonwealth competitive grants ($); (2) Non-Commonwealth competitive grants ($); (3) total national competitive grants (known as 'Category 1' $); (4) total other public sector funding ('Category 2' $); (5) total industry and other funding ('Category 3' $); (6) the number of authored research books; (7) the number of book chapters; (8) the number of articles published in scholarly refereed journals; (9) the number of refereed conference (proceedings) papers; (10) Weighted DEST publication points; and (11) the number of PhD completions (persons). The annual time-series data on the first 10-performance measures are available for the period 1992-2003 and the data on the number of PhD completions are available for the period 1991-2003. All the available time-series data by 38 institutions have been used in this empirical analysis.[4]

IV. EMPIRICAL RESULTS

We have used equations (2) and (3) to calculate the Gini coefficient for each of the eleven performance indicators during the period 1992-2003. As mentioned earlier, in Australia there are 38 universities in total. These cross-sectional observations (*i.e.* ungrouped data) are used to calculate the corresponding Gini coefficient for each of the eleven research measures in each year. In order to distinguish the Go8 universities from the other 30 Australian universities, first we have calculated the Gini coefficient using the data for all 38 universities, then we recalculated the relevant Gini coefficient using the data on the 30 non-Go 8 universities. The Gini estimates would be open to inaccuracy if we calculated the coefficient for the Go8 universities using only eight observations. Tables II and III present the estimated Gini coefficients for the Australian universities including and excluding the Go8 universities, respectively. To facilitate the comparison, the results are also presented graphically in Figures 1 and 2.

Table I List and groupings of Australia's universities

No.	University	Group
1	Adelaide	Go8
2	Australian Catholic University	NGU
3	Australian National Universities	Go8
4	Ballarat	NGU
5	Bond	UGU
6	Canberra	UGU
7	Central Queensland	NGU
8	Charles Darwin University	UGU
9	Charles Sturt	UGU
10	Curtin University of Technology	ATN
11	Deakin	UGU
12	Edith Cowan	NGU
13	Flinders	IRUA
14	Griffith	IRUA
15	James Cook	UGU
16	La Trobe	UGU
17	Macquarie	IRUA
18	Melbourne	Go8
19	Monash	Go8
20	Murdoch	IRUA
21	New England	UGU
22	New South Wales	Go8
23	Newcastle	IRUA
24	Queensland	Go8
25	Queensland University of Technology	ATN
26	Royal Melbourne Institute of Technology	ATN
27	South Australia	ATN
28	Southern Cross	NGU
29	Southern Queensland	NGU
30	Sunshine Coast	NGU
31	Swinburne University of Technology	UGU
32	Sydney	Go8
33	Tasmania	UGU
34	University of Technology, Sydney	ATN
35	Victoria University of Technology	NGU
36	Western Australia	Go8
37	Western Sydney	NGU
38	Wollongong	UGU

Notes: Go8=Group of Eight; IRUA=Innovative Research Universities Australia; ATN=Australian Technology Network; NGU=New Generation Universities; and UGU= Ungrouped Universities.

Table II The estimated Gini coefficients for various measures of research performance (all 38 universities)

Research performance indicators	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Annual average growth rate (%) 1992(1)=2003
Commonwealth Competitive Grants		0.657	0.653	0.633	0.646	0.628	0.629	0.642	0.637	0.641	0.639	0.652	0.657	0.00
Non-Commonwealth Competitive Grants		0.719	0.698	0.74	0.761	0.762	0.793	0.834	0.81	0.793	0.707	0.719	0.675	-0.57
Total National Competitive Grants (Category 1)		0.658	0.653	0.635	0.649	0.63	0.634	0.647	0.642	0.643	0.641	0.652	0.655	-0.04
Total Other Public Sector Funding (Category 2)		0.572	0.532	0.495	0.502	0.513	0.562	0.531	0.52	0.544	0.537	0.524	0.529	-0.71
Total Industry & Other Funding (Category 3)		0.678	0.672	0.697	0.688	0.659	0.642	0.635	0.629	0.621	0.641	0.664	0.671	-0.09
The Number of Authored Research Books		0.489	0.479	0.477	0.505	0.51	0.486	0.475	0.473	0.52	0.525	0.542	0.506	0.31
Book Chapters		0.553	0.547	0.507	0.523	0.483	0.55	0.478	0.509	0.536	0.495	0.506	0.498	-0.95
The Number of Articles Published in Scholarly Refereed Journals		0.573	0.57	0.569	0.556	0.555	0.541	0.531	0.532	0.536	0.53	0.522	0.516	-0.95
The Number of Refereed Conference (Proceedings) Papers		0.56	0.555	0.507	0.495	0.49	0.499	0.489	0.451	0.447	0.431	0.416	0.417	-2.64
Weighted DEST Publication Points		0.535	0.537	0.497	0.54	0.534	0.513	0.489	0.483	0.493	0.485	0.472	0.464	-1.29
PhD Completions	0.678	0.698	0.675	0.639	0.621	0.591	0.568	0.544	0.526	0.54	0.523	0.514	0.501	-2.49

Sources: AVCC (2005) and the authors' calculations.

Table III The estimated Gini coefficients for various measures of research performance (30 non-GO 8 universities)

Research performance indicators	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Annual average growth rate (%) 1992(1)=2003
Commonwealth Competitive Grants		0.544	0.514	0.493	0.494	0.463	0.457	0.471	0.445	0.46	0.461	0.459	0.451	-1.7
Non-Commonwealth Competitive Grants		0.706	0.663	0.65	0.687	0.672	0.697	0.709	0.704	0.66	0.58	0.595	0.686	-0.3
Total National Competitive Grants (Category 1)		0.544	0.515	0.494	0.493	0.463	0.46	0.472	0.445	0.459	0.461	0.456	0.454	-1.6
Total Other Public Sector Funding (Category 2)		0.495	0.465	0.408	0.419	0.45	0.45	0.441	0.444	0.432	0.429	0.417	0.418	-1.5
Total Industry & Other Funding (Category 3)		0.593	0.525	0.557	0.548	0.514	0.58	0.479	0.516	0.459	0.462	0.47	0.489	-1.7
The Number of Authored Research Books		0.378	0.319	0.44	0.475	0.405	0.43	0.422	0.449	0.421	0.456	0.392	0.393	0.4
Book Chapters		0.468	0.405	0.444	0.496	0.447	0.476	0.435	0.461	0.415	0.325	0.342	0.351	-2.6
The Number of Articles Published in Scholarly Refereed Journals		0.393	0.372	0.419	0.432	0.399	0.387	0.379	0.361	0.371	0.36	0.347	0.338	-1.4
The Number of Refereed Conference (Proceedings) Papers		0.46	0.442	0.418	0.439	0.415	0.397	0.419	0.421	0.445	0.431	0.403	0.414	-1.0
Weighted DEST Publication Points		0.383	0.361	0.369	0.42	0.394	0.367	0.354	0.351	0.351	0.336	0.315	0.327	-1.4
PhD Completions	0.681	0.663	0.663	0.579	0.553	0.48	0.442	0.431	0.394	0.413	0.375	0.363	0.375	-4.9

Sources: AVCC (2005) and the authors' calculations.

Based on the results presented in Tables II and III and Figures 1 and 2 we can conclude that the distribution of research performance among non-Go8 universities is more evenly distributed than that of all Australian universities. See the corresponding vertical axes, all of which have a minimum of 0.3 and a maximum of 0.85. That is, there is an obvious difference between the Gini coefficient calculated for non-Go8 versus all universities. This clearly indicates that once Go8 universities are added to the sample, any of the eleven research performance measures point to a more unequal distribution. One can argue that the Go8 universities are well-established and are more research intensive institutions than the other 30 Australian universities. It is obvious that when the "larger and thus stronger universities" are bundled up with rather "smaller and hence weaker universities" and they start competing over a larger portion of "the cake", the outcome is less equitable. Furthermore, this gap is particularly noticeable for competitive grants, articles published in scholarly refereed journals, and weighted DEST publication points. In contrast, the gap is much smaller for authored research books, book chapters, and refereed conference (proceedings) papers.

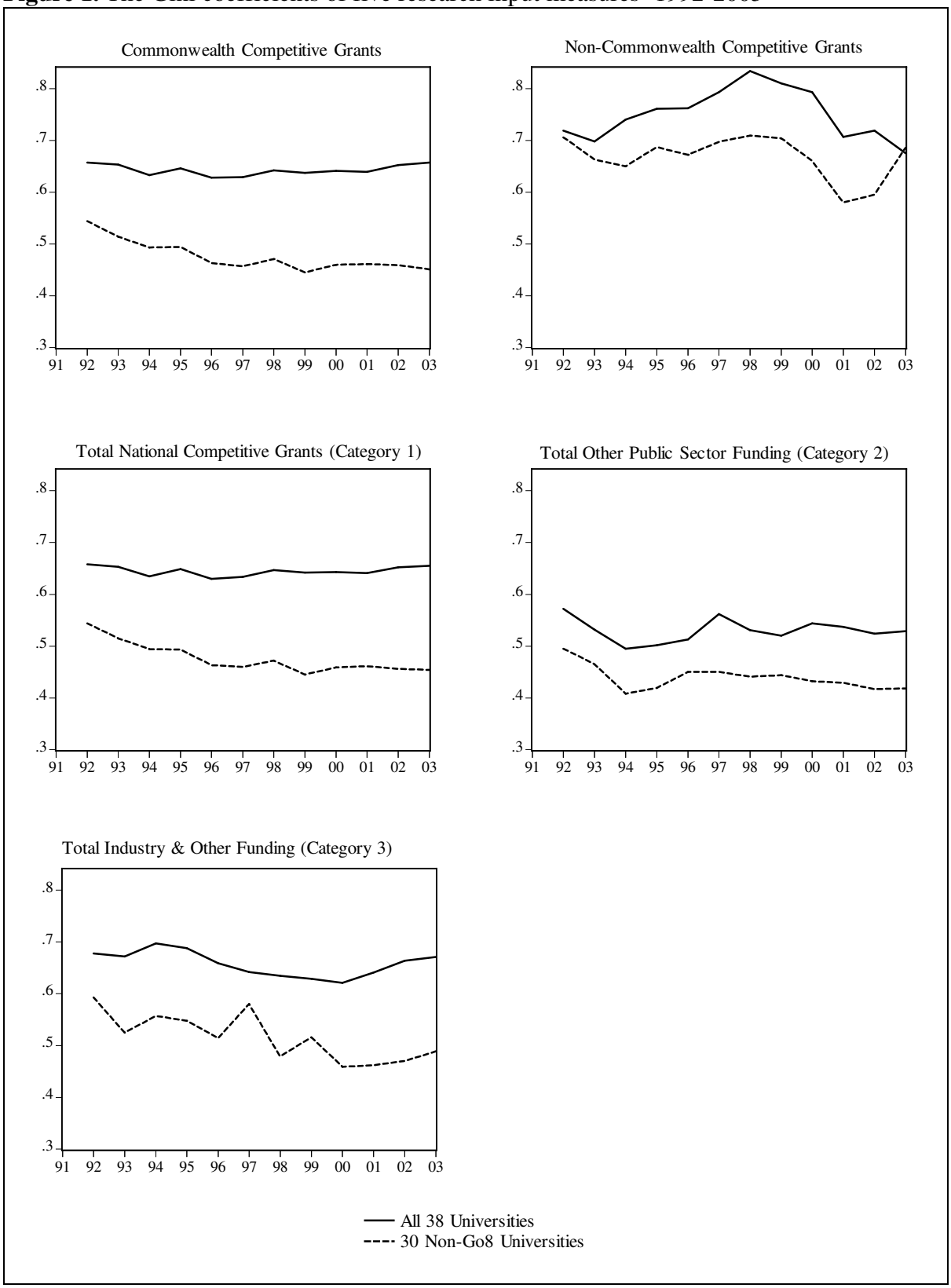
Moreover, there is generally a higher level of inequity in research inputs than research outputs. The current distribution of research inputs (funding) is not mirrored in the distribution of research output. For example, the mean Gini coefficient of research inputs over time for all universities is 0.645 versus 0.522 for research outputs.

Finally, there is a general trend of declining inequity over time for research outputs, indicating that research output is becoming more equally distributed across universities. This is particularly evident for the Gini attached to refereed conference proceedings papers and PhD completions which have declined at an annual rate of approximately 2.5%, and weighted DEST points which have declined at an annual rate of approximately 1.3%. Complementing the finding above, this pattern of declining inequity is not reflected in trends in research funding.

The existence of lower and declining levels of inequity in research outputs relative to inputs raises questions about comparative research productivity between institutions. As a consequence, it also has implications for the distribution of research funding if some institutions are more effective than others at converting grant money into scholarly publications and doctoral completions. A Gini coefficient provides a measure of overall distribution within a cohort. However, it tells us nothing about the pattern or shape of that distribution among cases; whether for example there is relative equity until the final few readings. To understand more about the pattern of the distribution, we must return to the Lorenz curve from which the Gini coefficient is derived.

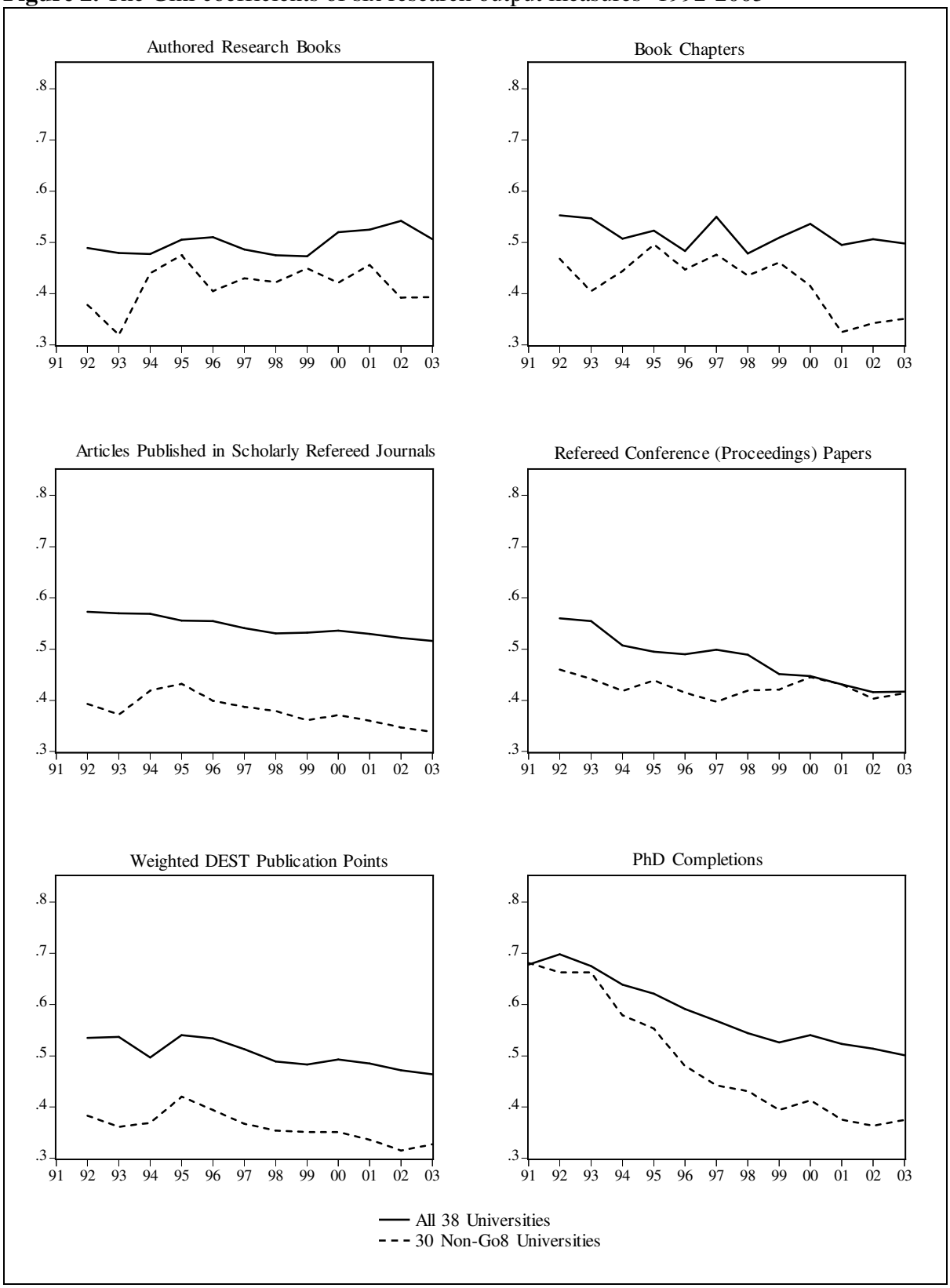
In studying the Lorenz curve, we have focused upon three of our indicators: Commonwealth competitive grants for research inputs and weighted DEST publications and PhD completions for outputs. These are considered among the major performance indicators and are a key part of the formula for the Institutional Grants Scheme. In addition, they all closely follow the pattern described above: Commonwealth competitive grants as an input showed a high and unchanging Gini (0.657), while weighted DEST publications and PhD completions as outputs declined from 0.535 to 0.464 and 0.698 to 0.501, respectively. In order to avoid a confusing proliferation of Lorenz curves and to focus on the most recent pattern of distribution, we have drawn the curves for the final year of our data, 2003, in Figure 3. In effect, these are the Lorenz curves for the 2003 readings for the first, penultimate and final rows in Table II covering all 38 universities.

Figure 1. The Gini coefficients of five research input measures -1992-2003



Sources: AVCC (2005) and the authors' calculations.

Figure 2. The Gini coefficients of six research output measures -1992-2003



Sources: AVCC (2005) and the authors' calculations.

The curves confirm the relatively unequal distribution of inputs and outputs across the 38 universities, which is in large part the consequence of the greater size and the historically-derived reputations of the Go8 universities. For each curve, the final eight readings, those with the largest shares, are all of the Go8 universities. They confirm the greater inequity between universities in terms of research inputs than in outputs, with the Commonwealth competitive grants curve being to the right of the DEST-weighted publications and PhD completions, and thus further away from the equal shares (45◦) line.

However, the key finding lies in the shape of the Lorenz curves. The two output curves describe a fairly continuous arc, whereas the input curve ascends initially on a more shallow trajectory with a major discontinuity occurring just before the 80th percentile after which it climbs much more steeply. The cases on the steep part of the curve, and the same part of the other curves, are entirely the Go8 universities, confirming the distinctive position of this group in the Australian higher education system. The shape of the three curves serves to emphasize the large share of research resources consumed by the Go8 relative to their share of research outputs. The fact that Commonwealth competitive grants are a major determinant of each university's research quantum funding serves to emphasize the significance of this inequity.

Table IV provides shares of input and outputs by university. Thus, the Go8, constituting 21 per cent of universities, consume 74 per cent of inputs (grants) but produce only 54 per cent of output (weighted publications and completed PhDs, averaged). The result is almost identical when 'grants' is compared individually with the Go8 share of publications (53 per cent) and PhD completions (55 per cent). Individually, among the Go8 universities, only Monash consumes a smaller share of inputs than it produces in outputs. Among the 30 non-Go8 universities only Tasmania consumes a greater share of inputs than it produces in outputs.

Finally, as an indication of the robustness of our data, in Table V we ranked universities on an average of our three principal indicators and compared this with Williams and Van Dyke's (2004) Melbourne Institute Index of International Standing of Australian Universities. The rankings provided in this analysis proved to be broadly consistent with a Spearman rank correlation coefficient of 0.924 (significant at the 0.01 level). Nonetheless, it should be emphasized again that such rankings largely reflect differences in institutional size and intermix inputs and outputs of research.

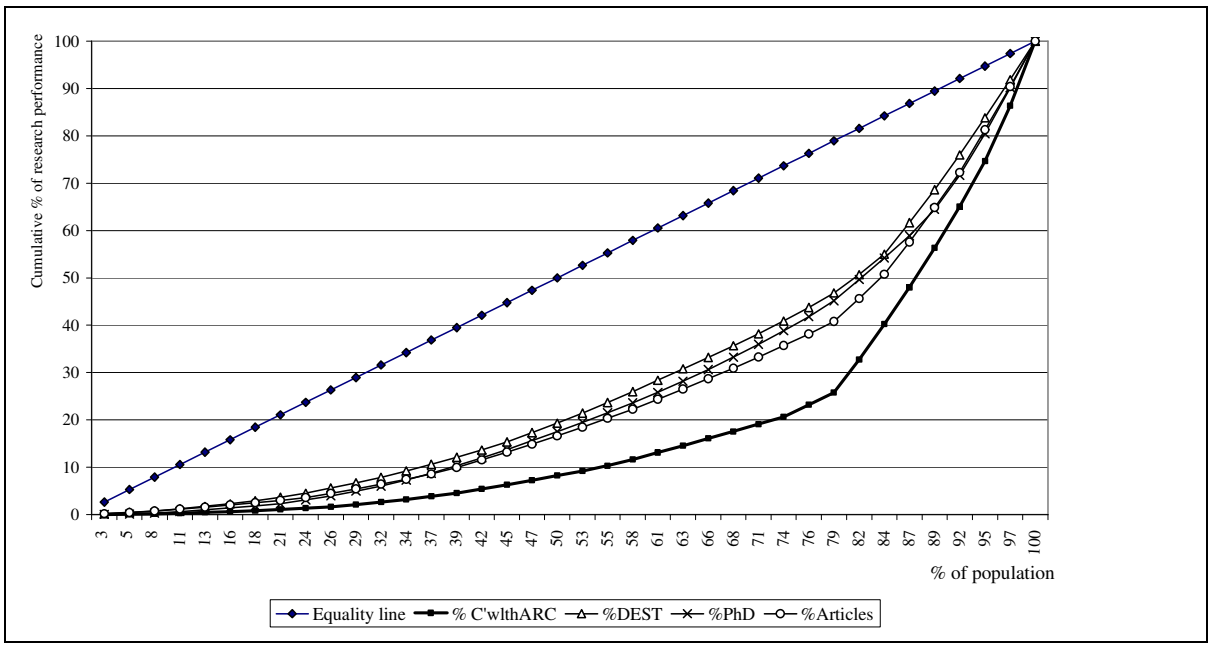
V. POLICY IMPLICATIONS

Our findings have implications for both past and future research policy. Inequity in research output between universities has declined in the decade since the Dawkins reforms provided a unitary system of performance-based funding. If policy were to swing back to differentiated funding models, it raises the question of whether this would consequently increase research output inequity again. Does rising research output inequity matter? Our examination of the Lorenz curves for particular measures of input and output for 2003 indicate lower levels of research productivity (units of output per unit of input) for those universities with the highest shares of total inputs and outputs. This suggests that a funding model differentiated in favour of the large Go8 universities would have a negative impact on total research output in Australian universities.

It might conversely be argued that DEST weighted publications provides an imperfect measure of the quality of research output. Indeed, there is some evidence to suggest that the Go8 universities have a strong record in publishing in the top international journals [Rodgers and Valadkhani, 2006; Williams and Van Dyke, 2004; and Pomfret and Wang, 2003). Since much of this criticism has been directed at conference papers and edited books, we have additionally plotted the 2003 Lorenz curve for refereed articles, as a sensitivity exercise.

While this curve shows a slightly higher degree of inequity than DEST weighted publications, there is still a large mismatch with the distribution of inputs. Making finer quality distinctions than the refereed article criteria currently used by DEST present difficult problems of measurement. If there are to be policy implications, naturally we must use the output measures adopted by DEST. The most recent ministerial statement foreshadows the development of a Research Quality Framework which, 'will provide a more consistent and comprehensive approach to assessing the quality and impact of publicly funded research' (DEST, 2005b, p. 138). We await further news of this policy.

Figure 3. The Lorenz curves for commonwealth competitive grants, DEST weighted publication points, articles published in refereed journals, and PhD completions in 2003 using the data for 38 Australian universities



Source: Authors' calculation based on Table IV.

VI. CONCLUSIONS

This paper has used the HERDC database to examine the distribution of its eleven measures of research performance across Australia's 38 universities over the last decade or so. Much of the academic literature and official policy has intermixed research inputs and outputs. We separate the two, which enables us to comment on research productivity and avoid some of the problems of adjusting for institutional size.

We calculated the annual Gini coefficient for each of the 11 performance measures for the period 1992-2003. From this, three main findings became evident. First, the five research-input measures capturing the distribution of various types of grants are relatively unevenly distributed across the universities and have not undergone a major change during the period under investigation. Second, on a relative basis the six research-output measures are more evenly distributed and exhibit a gradual and rather consistent decline through time, supporting the view that the research output is being generated gradually more equally across Australia's universities than research input measures. Third, as expected, the presence of the Go8 influences the distribution of research performance quite significantly. Excluding the Go8 results in a much more even distribution of research performance across Australian universities.

To understand more about the pattern of these distributions among individual or groups of universities, we drew the Lorenz curves for four critical indicators for 2003, Commonwealth competitive grants, weighted publications, refereed articles and PhD completions. This revealed a major discontinuity at the upper end of the inputs curve, where the disparity with the outputs distribution was most stark. These readings were for the Go8 universities whose lion share of competitive grants was not reflected in a similar share of weighted publications. There are of course many sources of data and forms of interpretation. However, on the basis of our analysis, a return to a pre-Dawkins differentiated system of funding would have a deleterious effect on the aggregate research performance of the Australian university system.

Table IV Distribution of research input and output across 38 Australian universities, 2003

University	C'wealth competitive grants (%)	University	Weighted DEST points (%)	University	PhD completions (%)
Melbourne	13.65	Melbourne	8.15	Melbourne	9.86
Sydney	11.67	Queensland	8.02	Queensland	9.67
Queensland	9.66	Sydney	7.85	Sydney	8.86
ANU	8.71	Monash	7.38	Monash	7.16
New South Wales	8.33	New South Wales	6.93	New South Wales	5.55
Western Australia	7.76	ANU	6.67	ANU	4.71
Adelaide	7.49	Western Australia	4.32	Adelaide	4.56
Monash	6.99	Adelaide	3.89	Western Australia	4.47
Tasmania	2.59	QUT	3.06	Curtin	3.35
Newcastle	2.51	Griffith	2.85	La Trobe	3.01
Wollongong	1.57	RMIT	2.69	RMIT	2.86
Murdoch	1.53	La Trobe	2.55	Griffith	2.71
Flinders	1.50	Newcastle	2.44	Newcastle	2.61
Griffith	1.49	Deakin	2.44	Tasmania	2.46
La Trobe	1.48	South Australia	2.39	QUT	2.40
Macquarie	1.48	Macquarie	2.39	Wollongong	2.18
UTS	1.29	Wollongong	2.33	Macquarie	2.10
QUT	1.09	Western Sydney	2.21	Deakin	2.03
New England	1.01	UTS	2.12	South Australia	1.97
Curtin	0.98	Curtin	2.02	Western Sydney	1.93
Deakin	0.93	Tasmania	1.98	Murdoch	1.82
James Cook	0.92	Flinders	1.69	New England	1.76
South Australia	0.85	Edith Cowan	1.54	Flinders	1.65
RMIT	0.69	Victoria	1.48	UTS	1.61
Western Sydney	0.65	Murdoch	1.43	Southern Cross	1.42
Swinburne	0.56	James Cook	1.33	James Cook	1.34
Charles Sturt	0.55	Charles Sturt	1.15	Swinburne	1.02
Victoria	0.46	New England	1.11	Victoria	1.00
Charles Darwin	0.28	Swinburne	1.11	Charles Sturt	0.87
Southern Cross	0.27	Central Queensland	0.82	Edith Cowan	0.78
Edith Cowan	0.23	Australian Catholic	0.77	Canberra	0.49
Southern Queensland	0.20	Canberra	0.63	Central Queensland	0.42
Central Queensland	0.19	Southern Cross	0.53	Southern Queensland	0.40
Canberra	0.18	Ballarat	0.52	Ballarat	0.36
Ballarat	0.13	Southern Queensland	0.46	Charles Darwin	0.32
Australian Catholic	0.09	Charles Darwin	0.30	Australian Catholic	0.21
Sunshine Coast	0.03	Bond	0.26	Sunshine Coast	0.08
Bond	0.00	Sunshine Coast	0.18	Bond	0.00

Sources: AVCC (2005) and the authors' calculations.

Table V Ranking of Australian universities' research performance, 2003

University	Rank based on:				
	Grants (1)	DEST (2)	PhD (3)	Average (4)=(1+2+3)/3	Melbourne Institute Index (5)
Melbourne	1	1	1	1	1
Queensland	3	2	2	2	4
Sydney	2	3	3	3	3
New South Wales	5	5	5	5	5
ANU	4	6	6	5	1
Monash	8	4	4	5	6
Western Australia	6	7	8	7	6
Adelaide	7	8	7	7	8
Griffith	14	10	12	12	16
Newcastle	10	13	13	12	13
La Trobe	15	12	10	12	10
QUT	18	9	15	14	16
Tasmania	9	21	14	15	12
Wollongong	11	17	16	15	15
RMIT	24	11	11	15	25
Curtin	20	20	9	16	16
Macquarie	16	16	17	16	11
Deakin	21	14	18	18	19
South Australia	23	15	19	19	24
Flinders	13	22	23	19	9
Murdoch	12	25	21	19	14
UTS	17	19	24	20	19
Western Sydney	25	18	20	21	30
New England	19	28	22	23	19
James Cook	22	26	26	25	22
Victoria	28	24	28	27	27
Swinburne	26	29	27	27	22
Charles Sturt	27	27	29	28	30
Edith Cowan	31	23	30	28	27
Southern Cross	30	33	25	29	30
Central Queensland	33	30	32	32	34
Canberra	34	32	31	32	26
Charles Darwin	29	36	35	33	27
Southern Queensland	32	35	33	33	36
Australian Catholic	36	31	36	34	34
Ballarat	35	34	34	34	33
Sunshine Coast	37	38	37	37	37
Bond	38	37	38	38	-

Sources: The authors' calculations and the data from Table IV.
Note: The universities are sorted based on the average ranking reported in column 4.

REFERENCES

Abbott, M. and Doucouliagos, C. 2003, 'The Efficiency of Australian Universities: A Data Envelopment Analysis', *Economics of Education Review*, vol. 22, pp. 89-97.

------ and Doucouliagos, C. 2004 'Research Output of Australian Universities', *Education Economics*, vol. 12, pp. 251-65.

Abounoori, E. and McCloughan, P. 2003, 'A Simple Way to Calculate the Gini Coefficient for Grouped as Well as Ungrouped Data', *Applied Economics Letters*, vol. 10, pp. 505-09.

Aitkin, D. 2004, 'Measuring the Things We Value Most, *Australian Financial Review*, 29 November, p. 35.

Atkinson, A. B. 1983, *The Economics of Inequality* (2nd ed.), Oxford University Press, London.

Athanassopoulos, A. and Shale, E. 1997 'Assessing the Comparative Efficiency of Higher Education Institutions in the UK by Means of Data Envelopment Analysis, *Education Economics*, vol. 5, pp. 117–134.

Australian Vice-Chancellors' Committee (AVCC) 2005, *Higher Education Research Data Collection Time Series Data 1992-2003*, http://www.avcc.edu.au (Accessed 19 September 2005).

Beasley, J.E. 1995, 'Determining Teaching and Research Efficiencies', *Journal of the Operational Research Society*, vol. 46, pp. 441–452.

Bowden, R. 2000, 'Fantasy Higher Education: University and College League Tables', *Quality in Higher Education*, vol. 6, pp. 41-60.

Carrico, C.S., Hogan, S.M., Dyson R.G. and Athanassopoulos, A.D. 1997, 'Data Envelopment Analysis and University Selection', *The Journal of the Operational Research Society,* vol. 48, pp. 1163-77.

Clarke, M. 2002, 'Some Guidelines for Academic Quality Rankings', *Higher Education in Europe*, vol. 27, pp. 443-459.

Coelli, T. 1996, 'Assessing the Performance of Australian Universities Using Data Envelopment Analysis', mimeo (Centre for Efficiency and Productivity Analysis, University of New England).

Department of Education, Training and Youth Affairs 1998, 'The Characteristics and Performance of Higher Education Institutions', *Occasional Paper Series 1A 98*, Commonwealth of Australia, Canberra.

Department of Education, Science and Training 2005a, *Building University Diversity*, http://www.dest.gov.au/sectors/higher_education/policy_issues_reviews/reviews/building_diversity/building_university_diversity.htm (Accessed 1 November 2005)

------ 2005b, *Higher Education Report 2004-5*, http://www.dest.gov.au/sectors/higher_education/ (Accessed 1 November 2005)

Dodd, T. 2004, 'Another High Score for ANU', *Australian Financial Review*, 4 December, p. 16.

Federkeil, G. 2002, 'Some Aspects of Ranking Methodology-The CHE-Ranking of German Universities', *Higher Education in Europe*, vol. 27, pp. 389-97.

Filinov, N.B. and Ruchkina, S. 2002, 'The Ranking of Higher Education Institutions in Russia: Some Methodological Problems', *Higher Education in Europe*, vol. 27, pp. 407-421.

Glass, J. C, McKillop, D.G. and Hyndman, N. 1995a, 'Efficiency in the Provision of University Teaching and Research: An Empirical Analysis of UK Universities', *Journal of Applied Econometrics*, vol.10, pp. 61–72.

------ 1995b, 'The Achievement of Scale Efficiency in UK Universities: A Multiple-Input Multiple-Output Analysis', *Education Economics*, vol. 3, pp. 249–263.

Glass, J. C., McKillop, D.G. and O'Rourke, G. 1998, 'A Cost Indirect Evaluation of Productivity Change in UK Universities', *Journal of Productivity Analysis*, vol. 10, pp. 153–175.

Hashimoto, K. and Cohn, E. 1997, 'Economies of Scale and Scope in Japanese Private Universities', *Education Economics*, vol. 5, pp. 107–115.

Illing, D. 2004a, 'Research Elites Win Top Spots', *The Australian*, 24 November, p. 23.

------ 2004b 'Our Unis Worthy of Global Honour Role', *The Australian*, 24 November, p. 2

Johnes, G. 1988, 'Determinants of Research Output in Economics Departments in British Universities', *Research Policy*, vol. 17, pp. 171–178.

------ 1990, 'Measures of Research Output: University Departments of Economics in the UK 1984–8', *Economic Journal*, vol. 100, pp. 556–560.

------ 1992, 'Performance Indicators in Higher Education: A Survey of Recent Work', *Oxford Review of Economic Policy*, vol. 8, pp. 19–34.

------ 1995, 'Scale and Technical Efficiency in the Production of Economic Research: Data Envelopment Analysis of the 1992 Research Assessment Exercise of British University Departments of Economics', *Applied Economics Letters*, vol. 2, pp. 7–11.

------ and Johnes, J. 1993, 'Measuring the Research Performance of UK Economics Departments: An Application of Data Envelopment Analysis', *Oxford Economic Papers*, vol. 45, pp. 332–341.

------ 1995, 'Research Funding and Performance in UK University Departments of Economics: A Frontier Analysis', *Economics of Education Review*, vol. 14, pp. 301–314.

Kakwani, N. 1980, *Inequality and Poverty: Methods of Estimation and Policy Applications*, Oxford University Press, New York.

Lorenz, M. C. 1905, 'Methods of Measuring the Concentration of Wealth', *Publication of American Statistical Association*, vol. 9, pp. 209–19.

Milanovic, B. 1994, 'The Gini-Type Functions: An Alternative Derivation', *Bulletin of Economic Research*, vol. 46, pp. 81–90.

------ 1997, 'A Simple Way to Calculate the Gini Coefficient, and Some Implications', *Economic Letters*, vol. 56, pp. 45–49.

Ng, Y. C. and Li, S. K. 2000, 'Measuring the Research Performance of Chinese Higher Education Institutions: An Application of Data Envelopment Analysis', *Education Economics*, vol. 8, pp. 140–56.

Perry, L. 2004, 'Ruction Over Global Ranking', *The Australian*, 1 December, p. 37.

------ 2005, 'Fear of Teaching-Only Stigma', *The Australian*, 27 April, p. 30

Pomfret, R. and Wang, L.C. 2003, 'Evaluating the Research Output of Australian Universities', *Australian Economic Papers*, vol. 42, pp. 418-41.

Rodgers, J. and Valadkhani, A. 2006, 'A Multi-Dimensional Ranking of Australian Economics Departments', *Economic Record*, vol. 82, forthcoming.

Shanghai Jiao Tong University 2003, *Academic Ranking of World Universities*, http://www.sjtu.edu.cn/, Accessed April 2004.

Times Higher Education Supplement 2004, *World University Rankings*, <http://www.thes.co.uk/>, Accessed April 2004.

Valadkhani, A. and Worthington, A. 2006, 'Ranking and Clustering Australian University Research Performance, 1998-2002', *Journal of Higher Education Policy and Management*, vol. 28(1), forthcoming.

Vaughin, J. 2002, 'Accreditation, Commercial Rankings, and New Approaches to Assessing the Quality of University Research and Education Programmes in the United States', *Higher Education in Europe*, vol. 11, pp. 433-41.

Wan, G. H. 1999, 'An Empirical Assessment of Alternative Functional Forms of the Lorenz Curve', *Applied Economic Letters,* vol. 6, pp. 597–99.

Williams, R. and Van Dyke, N. 2004, *The International Standing of Australian Universities, Melbourne Institute of Applied Economic and Social Research*, University of Melbourne, Melbourne.

Worthington, A. C. 2001 'An Empirical Survey of Frontier Efficiency Measurement Techniques in Education', *Education Economics*, vol. 9, pp. 245–65.

Yonezawa, A., Izuma, N. and Tetsuo K. 2002, 'University Rankings in Japan', *Higher Education in Europe*, vol. 27, pp. 373-82.

Zoli, C 1999, 'Intersecting Generalized Lorenz Curves and the Gini Index', *Social Choice and Welfare*, vol. 16, pp. 183-96.

ENDNOTES

[1] The Group of 8 universities consists of the Australian National University, University of Adelaide, University of Melbourne, Monash University, the University of New South Wales, University of Queensland, University of Sydney, and University of Western Australia.

[2] The responsible Commonwealth department was known as the Department of Education, Training and Youth Affairs or DETYA until 1998.

[3] For Australian media coverage see Aitkin (2004), Dodd (2004), Illing (2004a; 2004b) and Perry (2004; 2005).

[4] Data for University of Sunshine Coast commences in 1999 and for Bond University and ANU in 2000.