University of Wollongong
Economics Working Paper Series 2008

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WP 08-03

March 2008

Identifying the Most Research Intensive Faculties of Business in Australia: A Multidimensional Approach

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There is a growing policy focus in Australian higher education on quantitative research performance assessment. However, most of the analysis has addressed aggregate performance at the institutional level, an approach inconsistent with recent policy emphasis on diversity among universities, and one that ignores performance variations across disciplines. Using averaged and all available data for 2000-2004, cluster analysis is used to classify Australian Commerce Faculties into groups that exhibit similar research performance, measured by publication, PhD completion and secured competitive research grant funding. We also use factor analysis to generate full-multidimensional rankings within the resulting two or three clusters. It is found that in terms of total research output, with the exception of Adelaide all the Go8 members plus UTS and Griffith always belong to "Clusters A". However, when research performance is expressed in per academic staff terms, an additional eleven universities join this same cluster. Our results additionally show that eight Australian faculties of Commerce not only possess low total research output but their per capita performance is also poor.

Keywords: Faculties of Business, Australian higher education, Cluster analysis, Factor analysis

JEL codes: A11; A19; C63; I29

I. INTRODUCTION

Measuring research performance in higher education has become an important issue in Australia as an increasing volume of discretionary funding is attached to these results.

However, most of the analysis currently informing policy has addressed aggregate performance at the institutional level, comparing university with university using a variety of techniques. This approach is at variance with the recent policy emphasis on diversity among universities (Department of Education, Science, and Training, DEST, 2005), which implies that individual or groups of universities have distinctive roles to play in the higher education system. A focus on research performance at the institutional level also ignores the varied performance that occurs within universities at the disciplinary level. The application of funding on an institutional basis stifles innovation in key research areas and maintains underperforming and outdated research areas (see the discussion presented at the end of Section V). To provide an incentive for focused, responsive, innovative and diverse research in Australian universities, emphasis needs to shift from the institutions to the disciplines.

A series of studies has extended our knowledge of university-wide performance in the higher education system of Australia. DEST (1998) classified Australian universities on a wide range of research and teaching characteristics from single-year data (1996-7) using cluster analysis. While arguably "a workable measure of the characteristics and performance of institutions in terms of their teaching and research activities" (DEST, 1998, p.41), this study is at an aggregate level and is also now outdated and rather unwieldy.

Abbott and Doucouliagos (2003) examined the technical and scale efficiency of Australian universities, again at an aggregate level, with data envelopment analysis[1]. After considering different measures of output and input and mixing both teaching and research, they concluded that the results were insensitive with respect to the selection of the chosen output-input mix, suggesting that Australian universities in general recorded high levels of relative efficiency. Clearly such analyses add to our understanding of the production process in universities in Australia and elsewhere [see, for instance, Johnes and Johnes (1995), Coelli

[1] DEA, first introduced by Charnes, Cooper Rhodes (1978), is a performance measurement technique, which has been widely used for evaluating the relative efficiency of decision-making units including higher education institutions.

(1996), Athanassopoulos and Shale (1997), Carrico et al. (1997), Glass et al. (2002), Olave and Salvador (2006)] but are computationally complex, rely on data difficult to obtain over time and are prone to misspecification and misinterpretation.

Williams and Van Dyke (2004) have also 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 (2006) and the Times Higher Education Supplement (2004) [for Australian media coverage see Aitkin (2004) and Perry (2005)]. While encompassing a broad scale of measures, the resultant index indicated that the Group of Eight (Go8) universities were highest ranked on an Australian basis, thereby confirming similar results from the international studies. However, given the reliance on surveyed perceptions of standing, the study by Williams and Van Dyke (2004) 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, includes Bowden (2000), Federkeil (2002), Vaughin (2002) and Pomfret and Wang (2003).

Williams and Van Dyke (2006) provide rankings of 39 Australian universities by discipline, based on responses to their surveys and a number of research performance measures. This study is a step in the right direction but blurred disciplinary boundaries (seven broad categories), the reliance on surveyed perceptions of standing, and the use of total but not per capita data are shortcomings of this study. Furthermore, Williams and Van Dyke (2006, p.7) in their unpublished mimeo state that "we have concentrated on disciplines that are strongest in the well-established Go8 universities[2]. It is therefore not unexpected that Go8 universities dominate the rankings-with the exception of Education".

A very recent study by Valadkhani and Worthington (2006) clustered and ranked the research performance of thirty-seven Australian universities over the period 1998-2002. They defined research performance in terms of DEST-audited PhD completions, publications and grants, and the results were analysed in both total and per academic staff terms by institution. Their hierarchical cluster analysis supported a binary division between fifteen higher and twenty-two lower-performing universities, with the specification in per academic staff terms identifying the Go8 universities plus Flinders, Macquarie, Murdoch, New England, Newcastle, Tasmania and Wollongong in the better-performing group. Valadkhani and Worthington (2006) argued that the least (most) research-productive universities were those with the least (most) total research output. Their work however can be further improved by using discipline-specific data to identify heterogeneities across Australian universities.

This paper addresses the question of research performance for one of the ten broad fields of education.[3] Our major objective is to extend the novel approach employed by Valadkhani and Worthington (2006) to provide both partial and full rankings and clusterings of Australian university performance at the disciplinary level. As noted earlier, comparatively little analysis of research performance has been conducted at the disciplinary level, and this has mostly focussed on research training in the sciences (Neumann 2001). Our results are intended primarily to provide input into policy debates about the manner in which research funding occurs at the sub-institutional level. These are issues of significance to policy

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[2] The Group of Eight (Go8) consists of The Australian National University, Monash University, The University of Adelaide, The University of Melbourne, The University of New South Wales, The University of Queensland, The University of Sydney and The University of Western Australia.

[3] According to the DEST, these ten broad fields of education are: natural and physical sciences; information technology; engineering and related technologies; architecture and building; agriculture, environmental and related studies; health; education; management and commerce; society and culture; and creative arts. Commerce includes disciplines such as economics, management, marketing, accounting, finance, business and other related disciplines.

formulators at both the governmental and university institutional level. Extrapolating from our literature review above, we believe the best way to do this is to focus on a particular education field not by institutions, to use cluster analysis rather than straight rankings, and to calculate on a per capita as well as total output basis.

In economics, there has been some interest in research performance, which has largely focussed on compiling rankings of journals and of departments according to their productivity (Pomfret & Wang 2003; Smyth & Smyth 2001; Rodgers and Valadkhani 2006; Macri & Sinha 2006). Rather than focus upon a specific discipline such as economics, our approach is to analyse the clustering of disciplines represented in Commerce (Business) faculties across Australia. Together, these disciplines represent homogenous groups that exhibit similar quantities of research. In addition, this enables us to mitigate the issue of blurred disciplinary boundaries among the inter-related disciplines, such as economics, finance, management, that exist within Commerce faculties.

The rest of the paper is structured as follows. Section II provides a brief discussion of the hierarchical clustering technique used for partial rankings of Commerce faculties in Australian universities. Section III discusses the source, description and type of data employed in the analysis. Section IV presents the clustering of Commerce research performance followed by the ranking of research performance using factor analysis. Section V highlights the policy implications of the paper followed with some concluding remarks in Section VI.

II. THEORETICAL FRAMEWORK

Close examination of the metric used to measure research output in previous studies reveals that there is little difference between departments with adjacent ranks or even between departments that are too far apart by several ranks (Rodgers and Valadkhani, 2006). Thursby (2000) examined the differences across those U.S. departments that grant PhDs in economics and concluded that: “there’s not a hill of beans difference across large groups of departments” (p.383). An observed difference between two disciplines at two different universities of a third of a refereed article, or a tenth of a PhD completion, per person and per year appears to be very small. The methodology used in this paper will thus produce a partial ranking first using cluster analysis and a full ranking using factor analysis next.

To the best of our knowledge this methodology has not been used previously to compare Australian Commerce faculties. Cluster analysis is a multivariate statistical technique that is widely used to classify objects or items according to the similarity or dissimilarity of the characteristics they possess. This methodology, which falls under the general class of hierarchical agglomerative clustering techniques, strives to minimise within-group variance while also maximising between-group variance, resulting in a number of heterogeneous groups with homogeneous contents (Hair, et al., 1998, p.470).

Cluster analysis will be utilised in this paper to classify one of the ten broad fields of education within 27 Australian universities (for which we had the Commerce publication data) into groups according to the following three research measures: the audited numbers of PhD completions, research expenditure including grants (in accordance with rules established by the DEST), and the number of refereed articles. In order to avoid any abnormal observation in a particular year for any given discipline, the above indicators will be averaged using all available data from 2000 to 2004. In this study Commerce dissimilarity between two universities, j and k, are measured by the Squared Euclidean Distance (SED):

$$D(j,k) = \sum_{i=1}^{3} (X_{ij} - X_{ik})^2 \qquad (1)$$

where X_{ij} and X_{ik} represent the i^{th} measure of research output of the commerce faculties at universities j and k, respectively. The smaller (larger) is D(j,k), the more (less) similar are faculties j and k.

A hierarchical clustering technique will be used to form clusters of similar disciplines. At the beginning of the hierarchical procedure there will be 32 clusters each containing one case. At each stage of cluster analysis, the two most similar clusters are merged until, at the final stage, a single cluster containing 32 disciplines is formed. The optimal number of clusters has been chosen according to a number of stopping rules such as the largest percentage change in the resulting agglomeration coefficients. Hierarchical methods differ in the way that the most similar pair of clusters is identified at each stage. We use Ward's (1963) method, which would identify the two clusters whose merger results in the smallest increment to the aggregate sum of squared deviations within clusters. The sum of squared deviations within (say) Cluster k is given by

$$\mathrm{ESS}(k) = \sum_{j \in k} \sum_{i=1}^{3} (X_{ij} - \overline{X}_{ik})^2 \tag{2}$$

where X_{ij} is the i^{th} measure of research output by discipline j, and $\overline{X}_{ik}$ is the i^{th} measure of research output averaged across all disciplines in Cluster k. With the sum of squared deviations within (say) Cluster K given by ESS(K), the increment to the aggregate sum of squared deviations within clusters resulting from the merger of Cluster k and Cluster K to form Cluster ($k \cup K$) is given by:

$$d_{\mathrm{Ward}}(k,K) = \sum_{j \in (k \cup K)} \sum_{i=1}^{3} (X_{ij} - \overline{X}_{i(k \cup K)})^2 - \mathrm{ESS}(k) - \mathrm{ESS}(K) \tag{3}$$

Using this method our aim is to minimize the sum of squares of any given two clusters that can be formed at each step. Although the Ward's method is very efficient in achieving this, it tends to generate clusters of small size. In practise, two techniques seem to dominate the literature on cluster analysis: k-means if the researchers choose partitioning techniques, and Ward's, if they use hierarchical clustering. The other techniques, such as complete linkage clustering, single linkage clustering, average linkage clustering and nearest centroid sorting, do not enjoy the same level of popularity.

III. THE DATABASE

Thirty-two Australian universities have initially been included in the analysis, all of which are publicly funded and members of the Australian Vice-Chancellor's Committee (AVCC). Valadkhani and Ville (2008) have estimated the discipline-specific number of refereed articles for each of the ten broad fields of education including Commerce but for only thirty-two universities. We have used their Commerce estimates in this paper. This has imposed a constraint on the number of universities analysed in this paper.

An unpublished database was purchased from the Department of Education, Science and Training (DEST) in December 2005 (see below for more details). The data includes the number of PhD completions (the DEST source reference number OZUP-2002-2004) as well as the number of academic staff members (the DEST source reference number: Staf2001.dat - Staf2004.dat) by institution and across 10 consistently defined broad fields of education (including Commerce), all of which we have averaged using available annual observations within the period 2000-2004. In order to minimise bias in our results, we consider only those academic staff members who are classified as undertaking 'research-only' and 'teaching-and-research' activities. In other words, the variable that is referred to as academic staff does not include 'teaching only' staff.

The data on annual average expenditure on research and experimental development, also available by university and the same disciplines, has been averaged in the same way using all available data during the period 2000-2002 ($A'000). These variables includes: (1) National Competitive Research Grants (*i.e.* Commonwealth Schemes and Non-Commonwealth Schemes); (2) State and Local Government; (3) Other Commonwealth Government; (4) Other Australian Sources (*i.e.* Business Enterprises; General University Funds; and Other); and (5) Overseas sources. This variable is available from the DEST website. The data sources have been summarised in Table 1.

Table 1. *Descriptive statistics of the data employed, 1998-2002*

Variables	Mean	Maximum	Minimum	Std. dev.	Jarque-Bera	P-value	Source
Annual average no. of academic staff members (full-time equivalent)- 2001-2004 (persons)	100	233	22	59	2.6	0.27	Data purchased from the DEST (source reference number: Staf2001.dat - Staf2004.dat)
No. of refereed articles published 2000-2004	34	87	5	23	2.6	0.28	Valadkhani and Ville (2008)
Annual average Expenditure on Research and Experimental Development- 2000-2002 ($A'000)	5845	16655	389	4959	3.6	0.17	The DEST website
Annual Average number of PhD completions 2001-2003 (persons)	9.7	32.0	0.3	7.4	8.0	0.02	Data purchased from the DEST (source reference number OZUP-2002-2004).
Per capita publications	0.32	0.43	0.11	0.07	3.9	0.14	Authors' calculations
Per capita research expenditures	53.6	134.3	9.3	29.5	3.0	0.23	Authors' calculations
Per capita PhD completions	0.09	0.22	0.01	0.05	1.1	0.56	Authors' calculations

Table 1 also presents a summary of descriptive statistics of the annual averages for the twenty-seven universities employed in this analysis. Sample means, maxima, minima, standard deviations, and Jacque-Bera statistics and *p*-values are reported. As shown, PhD completions average about 10 per annum (Macquarie lies closest to the average) with a range between less than half (Flinders) and 32 (Monash); publications average 34 (Deakin lies closest) with a range between 5 (Flinders) and 87 (Monash); while research expenditures average \$5845 thousand (Victoria is closest) with a range of \$389 thousand (Ballarat) and \$16655 thousand (Melbourne). The average number of academic staff is also included in Table 1, with Deakin lying closest to the average of 100 and Ballarat (22) and Monash (233) at the minimum and maximum, respectively.

Finally, three univariate measures are calculated and included in Table 1: namely, PhD completions, publications and research expenditure per academic staff (scaling in univariate ratio normally removes the size effects found across most organisations). On average, academics across all faculties of Commerce supervised about one-tenth of a PhD completion, contributed less than one-third of a publication and accounted for \$A54 thousand in research expenditures per academic staff member, per year during the period specified in Table 1 for each variable. The calculated Jarque-Bera statistics and corresponding p-values in Table 1 are used to test the null hypotheses that the variables are normally distributed. Apart from the annual average number of PhD course completions; all *p*-values are greater than the 0.05 level of significance suggesting the null hypothesis cannot be rejected. Thus six out of seven variables presented for 27 universities are well approximated by the normal distribution. If we had included all the thirty-two universities in our analysis, none of these variables would have passed the normality test.

Table 2. *Total and per capita commerce research performance of Australian universities*

University	Annual average no. of academic staff members (full-time equivalent)- 2001-2004 (persons)	Annual average no. of refereed articles published 2000-2004	Annual average Expenditure on research and experimental development- 2000-2002 ($A'000)	Annual average number of PhD completions 2001-2003 (persons)	Per capita publications (articles)	Per capita research expenditures ($A'000)	Per capita PhD completions (persons)
Adelaide	66	19	3935	3	0.288	60	0.041
ANU	132	28	21913	3	0.212	166	0.020
Aus.Catholic	34	0	338	0	0.000	10	0.000
Ballarat	22	5	389	1	0.227	18	0.045
Canberra	55	14	512	5	0.255	9	0.091
Central Qld	61	7	642	1	0.115	11	0.011
Charles Darwin	7	3	1553	2	0.429	222	0.329
Curtin	109	28	2436	13	0.257	22	0.117
Deakin	100	34	3813	7	0.340	38	0.073
Edith Cowan	63	26	1842	12	0.413	29	0.195
Flinders	23	5	696	0	0.217	30	0.013
Griffith	128	55	8373	16	0.430	65	0.127
James Cook	43	10	1159	2	0.233	27	0.040
La Trobe	99	22	5004	4	0.222	51	0.040
Macquarie	123	45	5170	10	0.366	42	0.079
Melbourne	124	50	16655	15	0.403	134	0.119
Monash	233	87	13849	32	0.373	59	0.137
Murdoch	50	20	2032	11	0.400	41	0.220
New England	28	11	3197	5	0.393	114	0.179
Newcastle	67	19	4386	2	0.284	65	0.030
Queensland	175	61	11236	15	0.349	64	0.086
QUT	112	42	6602	13	0.375	59	0.119
South Australia	169	59	4621	45	0.349	27	0.268
Southern Cross	60	28	1452	35	0.467	24	0.583
Sydney	205	74	15493	10	0.361	76	0.050
Tasmania	43	15	2807	4	0.349	65	0.093
UNSW	221	78	14551	24	0.353	66	0.110
UTS	151	51	11041	14	0.338	73	0.093
Victoria	85	31	5285	9	0.365	62	0.102
Western Aus.	146	51	8316	14	0.349	57	0.094
Western Sydney	89	29	1807	10	0.326	20	0.116
Wollongong	75	25	6586	9	0.333	88	0.116

Source: See Table 1.

Table 3. *Normalised total and per capita research performance of commerce and management across Australian universities*

University	Annual average number of academic staff members (full-time equivalent)	Annual average no. of refereed articles published	Annual average expenditure on research and experimental development	Annual average number of PhD completions	Per capita publications	Per capita research expenditures	Per capita PhD completions
Adelaide	-0.517	-0.574	-0.346	-0.766	-0.308	0.008	-0.674
ANU	0.590	-0.184	2.873	-0.766	-1.088	2.313	-0.855
Aus.Catholic	-1.053	-1.397	-0.990	-1.022	**-3.271**	-1.068	-1.037
Ballarat	-1.255	-1.180	-0.980	-0.927	-0.932	-0.900	-0.633
Canberra	-0.701	-0.790	-0.958	-0.549	-0.651	-1.082	-0.229
Central Qld	-0.601	-1.093	-0.935	-0.955	-2.090	-1.055	-0.935
Charles Darwin	-1.506	-1.267	-0.772	-0.804	1.141	**3.523**	1.882
Curtin	0.204	-0.184	-0.614	0.178	-0.627	-0.799	-0.002
Deakin	0.053	0.076	-0.367	-0.332	0.229	-0.457	-0.389
Edith Cowan	-0.567	-0.271	-0.720	0.141	0.977	-0.650	0.697
Flinders	-1.238	-1.180	-0.926	-0.993	-1.033	-0.628	-0.921
Griffith	0.523	0.985	0.449	0.518	1.152	0.134	0.094
James Cook	-0.903	-0.963	-0.843	-0.861	-0.877	-0.699	-0.686
La Trobe	0.037	-0.444	-0.154	-0.644	-0.984	-0.188	-0.678
Macquarie	0.439	0.552	-0.124	-0.105	0.495	-0.373	-0.336
Melbourne	0.456	0.769	1.932	0.367	0.880	1.626	0.016
Monash	2.284	2.371	1.429	2.002	0.573	0.004	0.183
Murdoch	-0.785	-0.530	-0.686	0.018	0.847	-0.403	0.917
New England	-1.154	-0.920	-0.478	-0.549	0.773	1.190	0.549
Newcastle	-0.500	-0.574	-0.265	-0.833	-0.352	0.135	-0.772
Queensland	1.311	1.245	0.962	0.396	0.317	0.108	-0.276
QUT	0.255	0.422	0.132	0.235	0.589	-0.006	0.018
South Australia	1.211	1.158	-0.223	**3.258**	0.323	-0.691	1.344
Southern Cross	-0.617	-0.184	-0.790	2.285	1.533	-0.759	**4.145**
Sydney	1.815	1.808	1.724	-0.048	0.445	0.354	-0.591
Tasmania	-0.903	-0.747	-0.548	-0.644	0.320	0.131	-0.211
UNSW	2.083	1.981	1.555	1.274	0.362	0.143	-0.060
UTS	0.909	0.812	0.927	0.301	0.206	0.301	-0.213
Victoria	-0.198	-0.054	-0.104	-0.200	0.483	0.064	-0.128
Western Aus.	0.825	0.812	0.439	0.273	0.325	-0.049	-0.203
Western Sydney	-0.131	-0.141	-0.727	-0.048	0.083	-0.843	-0.009
Wollongong	-0.366	-0.314	0.129	-0.200	0.160	0.619	-0.007

Source: Table 1 and the authors' calculations.

Table 2 presents the data on the research performance of the faculties of Commerce in thirty-two Australian universities for which all the above variables were available in both aggregate and per academic staff terms. In Table 3 we have also standardised all the variables to a mean of zero and a variance of one. If the normalised figure for a particular cell is greater than 3, we then excluded the corresponding university from our analysis. As can be seen from Table 3, based on this criterion, four universities (Australian Catholic, Charles Darwin, South Australia, and Southern Cross) were considered as abnormal observations and hence excluded from the database. If we did not exclude these four universities, each would have occupied a single cluster of its own and would not merge with other clusters or universities. In other words, the inclusion of these abnormal observations would distort the clustering results. These abnormal observations are shown with boldface letters in Table 3.

It should be noted that the per capita publication in Australian Catholic was zero in Table 2 (corresponding to a normalised score of -3.271 in Table 3), the per capita research expenditures in the faculty of Commerce in Charles Darwin with only seven staff members was $222000 which was significantly more than any other universities (a factor score +3.523). Also compared to the performance of other Commerce Faculties in Australia, the following two observations seem excessively high: the annual average number of PhD completions of 45 in South Australia (with the standardised score of 3.258 in Table 3) and the annual per capita PhD completion of 0.583 (with the standardised score of 4.145) in Southern Cross. There are three explanations for this: the staff members at these two universities are “super-persons” or producing a sheer quantity rather than quality output or there are problems with the data reported to the DEST. In addition to these four universities, the Australian National University (ANU) has been excluded from this study because accurate and consistent research output data could not be obtained. This was mainly because the Institute of Advanced Studies at the ANU did not fully participate in the competitive research schemes of the Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) until 2004. Therefore we use 27 universities in this paper.

IV. EMPIRICAL RESULTS

The first methodological requirement is to cluster the research performance of the twenty-seven faculties of Commerce. Cluster analysis is a multivariate statistical technique that has been widely used to classify objects or items based on the similarity or dissimilarity of the characteristics they possess. This technique is especially relevant in the current context as it permits the minimisation of within-group variance and maximisation of between-group variance based on a range of research output indicators, resulting in heterogeneous groups with homogeneous contents (Hair, et al*.*, 1998, p.470). This approach has been used to determine how many homogenous research groups exist and define exactly which comparable group each Commerce unit belongs to.

Before conducting the analysis, all six output variables were standardised so that they had a mean of 0 and a standard deviation of 1. The Squared Euclidean Distance (SED) is used as a dissimilarity measure to define the pairwise distance between Commerce faculties in terms of total and per academic research performance. The upper triangle (the part above the main diagonal) of the proximity matrix presented in Table 4 shows the total research performance dissimilarities among the twenty-seven and the lower triangle part reveals the per capita research differences. Higher (lower) SEDs are associated with more (less) dissimilar faculties. This matrix is then quite useful for universities to identify their single most similar (and dissimilar) pairing in terms of research performance.

Table 4. *The squared Euclidean distance matrix (dissimilarity) of both total (upper triangular) and per staff (lower triangular) research measures*

University	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1:Adelaide	**0.0**	0.9	0.6	0.8	2.1	0.8	2.0	0.9	6.7	0.5	0.1	2.2	11.0	28.6	1.4	0.2	0.0	8.3	3.4	12.2	0.1	19.8	6.3	1.0	4.9	1.4	1.0
2:Ballarat	2.7	**0.0**	0.4	0.0	3.7	2.8	3.3	0.0	11.6	0.1	1.6	5.3	18.0	37.8	2.4	0.7	1.0	14.3	6.9	19.8	0.6	28.2	11.7	3.3	9.5	2.8	3.4
3:Canberra	4.0	1.0	**0.0**	0.4	1.6	1.3	1.3	0.6	8.0	0.2	1.0	3.1	14.8	30.7	0.8	0.3	0.8	10.7	4.3	16.4	0.2	22.6	8.6	1.7	6.5	1.0	2.0
4:Central Qld	8.5	2.8	5.9	**0.0**	3.6	2.6	3.2	0.0	11.3	0.0	1.4	5.0	17.5	37.2	2.4	0.6	0.9	13.8	6.7	19.1	0.5	27.6	11.3	3.1	9.2	2.7	3.2
5:Curtin	3.9	2.0	0.4	7.9	**0.0**	0.7	0.0	4.0	3.0	2.9	1.7	1.0	9.2	18.7	0.2	1.7	2.4	5.3	1.1	11.0	1.7	13.2	4.0	0.6	2.4	0.1	1.0
6:Deakin	1.4	3.0	2.4	11.4	2.2	**0.0**	0.7	2.9	3.2	1.9	0.5	0.4	8.2	20.7	0.8	1.1	1.0	4.7	1.1	8.7	0.9	13.7	3.5	0.1	2.1	0.4	0.5
7:Edith Cowan	12.7	14.6	9.0	28.9	6.7	6.6	**0.0**	3.5	3.6	2.6	1.7	1.3	10.1	20.0	0.1	1.5	2.3	6.0	1.4	12.0	1.5	14.3	4.7	0.8	2.9	0.1	1.2
8:Flinders	2.2	0.6	3.0	2.3	4.3	4.1	19.1	**0.0**	11.8	0.1	1.6	5.5	18.0	38.3	2.6	0.7	1.0	14.4	7.1	19.7	0.6	28.5	11.8	3.4	9.7	3.0	3.5
9:Griffith	6.4	12.5	9.6	26.3	7.5	3.4	3.3	14.4	**0.0**	9.9	5.3	1.4	2.9	7.7	4.5	7.1	6.9	0.4	0.6	3.4	7.1	3.7	0.4	2.5	0.2	3.7	2.9
10:James Cook	1.8	0.1	1.4	3.1	2.3	2.6	14.8	0.3	11.5	**0.0**	1.0	4.1	15.9	34.7	1.8	0.4	0.6	12.3	5.6	17.4	0.3	25.4	9.9	2.4	7.9	2.1	2.5
11:La Trobe	0.9	1.3	3.1	4.2	3.3	3.1	15.9	0.8	10.8	0.7	**0.0**	1.6	9.1	25.6	1.3	0.4	0.1	6.7	2.5	10.3	0.3	17.2	4.9	0.6	3.8	1.2	0.5
12:Macquarie	2.0	4.6	3.5	14.2	3.1	0.2	5.6	5.7	2.2	4.0	4.3	**0.0**	5.9	15.6	1.6	2.7	2.4	2.5	0.3	5.9	2.5	9.6	1.8	0.4	0.8	0.9	0.9
13:Melbourne	11.0	23.1	22.2	36.8	18.2	12.1	14.8	22.7	5.6	20.8	16.2	10.6	**0.0**	8.4	10.6	12.0	10.9	1.4	4.3	1.5	12.2	3.4	1.3	6.6	2.8	10.2	6.0
14:Monash	4.8	9.0	6.2	20.6	4.2	2.2	2.6	11.1	0.6	8.3	7.7	1.6	6.7	**0.0**	22.3	29.0	29.0	6.9	12.4	9.1	29.2	1.3	8.7	18.9	9.9	20.9	19.4
15:Murdoch	14.5	17.2	11.1	31.7	8.0	8.6	0.4	21.9	4.0	17.3	17.7	7.6	13.9	3.1	**0.0**	0.9	1.7	6.9	1.9	12.9	1.0	16.0	5.3	0.8	3.5	0.2	1.0
16:New England	12.4	22.2	18.9	36.6	14.4	11.2	8.4	23.7	3.9	20.5	16.9	9.8	1.8	4.1	6.8	**0.0**	0.3	9.2	3.6	14.1	0.1	20.6	7.0	1.2	5.5	1.2	1.1
17:Newcastle	0.1	3.3	5.1	8.7	5.0	2.1	14.6	2.3	7.4	2.2	1.0	2.7	10.9	5.8	16.5	13.0	**0.0**	8.4	3.6	12.0	0.2	19.9	6.4	1.1	5.1	1.7	1.1
18:Queensland	1.4	5.7	5.1	15.2	3.9	0.9	6.6	6.4	1.8	4.8	3.8	0.6	6.6	1.1	7.8	6.4	1.9	**0.0**	1.6	1.5	9.1	2.6	0.2	3.9	0.6	6.0	4.1
19:QUT	3.6	7.9	5.7	19.1	4.1	1.5	3.4	9.5	0.6	7.1	6.6	0.9	6.7	0.1	4.3	4.9	4.5	0.6	**0.0**	5.3	3.6	7.2	1.0	0.7	0.3	1.4	0.9
20:Sydney	1.3	7.1	7.7	16.3	6.8	1.9	10.7	6.6	3.2	5.7	4.2	1.6	6.0	3.1	12.3	8.0	1.3	0.6	2.1	**0.0**	13.8	3.7	2.1	7.8	3.3	11.4	7.8
21:Tasmania	1.7	6.1	5.2	15.8	3.8	1.0	6.1	6.9	1.6	5.2	4.2	0.7	6.2	0.9	7.1	5.8	2.2	0.0	0.4	0.8	**0.0**	20.7	7.0	1.1	5.4	1.1	1.2
22:UNSW	2.6	7.0	5.5	17.3	3.8	1.4	4.9	8.2	1.2	6.2	5.1	1.0	5.9	0.4	5.6	4.7	3.2	0.2	0.2	1.4	0.1	**0.0**	3.8	12.1	5.0	14.7	12.4
23:UTS	1.6	6.5	5.9	15.9	4.3	1.5	7.1	7.1	2.0	5.5	4.0	1.3	5.3	1.2	7.9	5.2	2.1	0.1	0.7	0.8	0.1	0.2	**0.0**	2.6	0.3	4.6	2.6
24:Victoria	2.5	6.9	5.4	17.4	4.0	1.1	4.8	8.0	1.0	6.0	5.2	0.7	6.3	0.5	5.9	5.4	3.1	0.2	0.1	1.2	0.1	0.1	0.3	**0.0**	1.6	0.5	0.1
25:Western Australia	1.7	5.3	4.2	14.9	3.1	0.6	5.4	6.4	1.7	4.6	4.0	0.4	7.6	0.8	6.6	6.7	2.4	0.1	0.4	1.1	0.1	0.2	0.3	0.1	**0.0**	2.8	1.9
26:Western Sydney	4.1	3.6	1.3	12.1	0.9	1.1	3.8	6.1	4.3	3.8	5.1	1.3	16.0	2.3	5.5	12.4	5.4	2.6	2.2	5.3	2.6	2.5	3.4	2.3	1.8	**0.0**	1.0
27:Wollongong	3.4	9.5	8.4	19.5	6.0	3.5	7.4	10.1	2.3	8.2	5.9	3.1	3.4	1.4	7.3	2.9	3.8	1.0	1.3	1.9	0.8	0.6	0.5	1.0	1.3	5.2	**0.0**

Source: The Authors' calculations using the normalised data.

Table 5. *Agglomeration schedule based on the Ward linkage*

Stage	Total research performance			Research performance per academic staff		
	Combined cluster		Coefficients	Combined cluster		Coefficients
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	4	8	0.005	18	21	0.011
2	2	4	0.012	22	24	0.041
3	1	17	0.020	1	17	0.085
4	5	7	0.033	18	25	0.136
5	16	21	0.060	2	10	0.195
6	2	10	0.112	14	19	0.259
7	1	11	0.176	6	12	0.334
8	5	26	0.244	18	23	0.455
9	24	27	0.312	18	22	0.604
10	9	25	0.390	7	15	0.806
11	5	15	0.481	3	5	1.025
12	18	23	0.585	2	8	1.305
13	12	19	0.755	9	14	1.705
14	3	16	0.927	2	11	2.286
15	6	24	1.119	3	26	2.927
16	9	18	1.458	18	27	3.625
17	1	3	1.984	18	20	4.482
18	14	22	2.618	13	16	5.389
19	6	12	3.287	6	18	7.084
20	13	20	4.036	6	9	9.089
21	1	2	5.494	2	4	11.392
22	5	6	7.137	1	2	15.223
23	9	13	9.577	1	3	21.730
24	9	14	17.299	6	13	31.324
25	1	5	**26.196**	6	7	**41.330**
26	1	9	**78.000**	1	6	**78.000**

Note: As can be seen from the boldface agglomeration coefficients, with either specification the biggest relative percentage change occur between stages 25 and 26, thus the optimal number of clusters is equal to two."

Source: The Authors' calculations using the normalised data.

On the basis of the three selected performance criteria (PhD completions, publications and research expenditures), this matrix provides a comprehensive snapshot of the pairwise differences among Commerce faculties in Australia. For example, let us consider the total research performance of Melbourne in Table 4 (see the elements above the main diagonal). The five most dissimilar pairs (SED in brackets) in descending order are: Ballarat (18), Flinders (18), Central Queensland (17.5), James Cook (15.9) and Canberra (14.8). On the other hand, the five most similar pairs are: UTS (University of Technology, Sydney, 1.3), Queensland (1.4), Sydney (1.5), Western Australia (2.8), and Griffith (2.9). We can also look at the pairwise comparison in terms of per academic research performance of Melbourne in

Table 4 (see the elements below the main diagonal). Similarly the five most similar pairs are: New England (1.8), Wollongong (3.4), UTS (5.3), Griffith (5.6) and UNSW (5.9).

A dendrogram (not shown) and agglomeration coefficients (Table 5) can now be used to determine the optimum number of clusters. Table 5 shows the agglomeration schedule at the various stages of hierarchical cluster analysis using both total and the normalized per academic staff research data. In this approach, small variations in the agglomeration coefficient indicate that fairly homogeneous clusters are being merged. Likewise, if the agglomeration coefficient varies markedly between stages, it indicates that more heterogeneous cases are being clustered together. Given the percentage changes in the agglomeration coefficient at each step, it appears that the optimal number of clusters is 2 as the coefficient between stages 25 and 26 shows a sharp increase from 41.33 to 78.00 (last and second-to-last rows in column 7 of Table 5). Exactly the same procedure is used to determine the number of clusters based on total research output measures.

Clearly, with either specification the optimal number of clusters is 2 as in the case of total research performance the agglomeration coefficient again shows the biggest relative percentage change between stages 25 and 26 increasing from 26.20 to 78.00 (last and second-to-last rows in column 4 of Table 5). However, given that the use of the agglomeration coefficient as a stopping rule has a tendency to indicate too few clusters (Hair, 1998, p.503), the results of three-cluster solutions for both total and per academic staff research performance are also included [the alternative cubic clustering criterion could have also been used as a stopping rule, but this has the tendency to indicate too many clusters].

V. DISCUSSION AND POLICY IMPLICATIONS

This section discusses major findings and policy implication of the paper. Table 6, *inter alia*, presents the cluster membership for the 2-cluster and the 3-cluster solutions for both per academic staff research performance and total research output. A cursory examination of Table 6 reveals that in terms of total research output (size), with the exception of Adelaide all the Go8 members (Melbourne, Monash, New South Wales, Queensland, Sydney, and Western Australia) plus UTS and Griffith always belong to clusters A or A1 depending on the number of clusters. There are also nineteen universities whose Commerce faculties are considered as group B. It should be noted that the bottom ten faculties will continue to stay together despite increasing the number of clusters from 2 to 3.

In a two-cluster solution based on per academic staff research performance, besides all eight universities reported in cluster A for total output, nine additional Commerce faculties (Deakin, Edith Cowan, Macquarie, Murdoch, New England, QUT (Queensland University of Technology), Tasmania, Victoria and Wollongong) are also included, taking cluster A membership to seventeen. With a three-cluster solution based on per academic staff research performance, the universities in cluster B, as in the two-cluster solution, remain unchanged but cluster A is now reclassified into clusters A1 and A2 with fifteen and two members (Edith Cowan and Murdoch), respectively.

As far as cluster membership based on total research performance is concerned, the results of a three-cluster solution are also similar to a two-cluster solution in that the universities in cluster A continue to be in A1 cluster. However, cluster B is now sub-divided into clusters A2 and B. The results of an analysis of variance (ANOVA) across the three variables used in the clustering process also indicate that the cluster differences in terms of the standardised magnitudes of the means of the three performance measures are all highly significant, supporting the view that they all play an important role in differentiating the resulting clusters (the ANOVA results are not reported but they are available upon request from the corresponding author).

Table 6. *Commerce ranking and cluster membership based on per staff and total research output*

University	Total research performance			Research performance per academic staff			
	Normalised factor scores	3 Clusters	2 Clusters	University	Normalised factor scores	3 Clusters	2 Clusters
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Monash	2.455	A1	A	New England	1.769	A1	A
UNSW	2.000	A1	A	Melbourne	1.607	A1	A
Sydney	1.346	A1	A	Murdoch	1.282	A2	A
Melbourne	1.250	A1	A	Griffith	1.043	A1	A
Queensland	1.061	A1	A	Edith Cowan	1.040	A2	A
UTS	0.841	A1	A	Monash	0.707	A1	A
Griffith	0.826	A1	A	Wollongong	0.627	A1	A
Western Australia	0.636	A1	A	QUT	0.570	A1	A
QUT	0.354	A2	B	UNSW	0.448	A1	A
Macquarie	0.133	A2	B	Victoria	0.420	A1	A
Victoria	-0.129	A2	B	UTS	0.308	A1	A
Wollongong	-0.134	A2	B	Tasmania	0.288	A1	A
Curtin	-0.189	A2	B	Queensland	0.218	A1	A
Deakin	-0.250	A2	B	Western Australia	0.201	A1	A
Edith Cowan	-0.281	A2	B	Sydney	0.155	A1	A
Western Sydney	-0.330	A2	B	Macquarie	0.016	A1	A
Murdoch	-0.425	A2	B	Western Sydney	-0.197	B	B
La Trobe	-0.513	B	B	Deakin	-0.231	A1	A
Adelaide	-0.697	B	B	Adelaide	-0.545	B	B
Newcastle	-0.698	B	B	Curtin	-0.588	B	B
New England	-0.768	B	B	Newcastle	-0.588	B	B
Tasmania	-0.778	B	B	Canberra	-0.947	B	B
Canberra	-0.908	B	B	La Trobe	-1.054	B	B
James Cook	-1.081	B	B	James Cook	-1.269	B	B
Central Qld	-1.212	B	B	Ballarat	-1.363	B	B
Ballarat	-1.248	B	B	Flinders	-1.525	B	B
Flinders	-1.259	B	B	Central Qld	-2.389	B	B

Source: The authors' calculations using the normalised data.

A number of salient points are noted from the cluster analysis of Commerce faculties. First, it is clear that the scale and long tenure of the Go8 universities places them in the highest (relative) grouping of research performance, whether in total or partial productivity terms. This is unsurprising, although the addition of UTS and Griffith to this group and the omission of Adelaide are noteworthy. Second, what is more interesting is that once an attempt is made to take into account for the vastly different scales of faculties, with research performance expressed in per academic staff terms, an additional eleven universities (Deakin, Edith Cowan, Griffith, Macquarie, Murdoch, New England, QUT, UTS, Tasmania, Victoria and Wollongong) are virtually indistinguishable in terms of research performance.

Third, the following ten Commerce faculties (see clusters coded B in columns 4 and 8 of Table 6 together) not only produce less research output, but also their per academic research performance is at a much lower level: Adelaide, Ballarat, Canberra, Central Qld, Curtin, Flinders, James Cook, La Trobe, Newcastle and Western Sydney (in alphabetical order). Similar to what Valadkhani and Worthington (2006) found at an institutional level, we can also conclude that in terms of research performance of Commerce units the least (most) research-productive universities are those with the least (most) total research output.

The second methodological requirement is to rank the research performance of the twenty-seven Commerce faculties. In brief, the method involves using the first principal component to calculate a separate single normalised factor score for each of the three-total and the-three per academic staff research measures. These two composite indices are found to explain 89 and 70 percent of total variation of the three total and per academic staff measures, respectively. Only the first eigenvalue in each case exceeds unity and according to the scree plot just the first principal component is sufficient. Also (i) Bartlett's test of sphericity is rejected at the 1 percent level for the respective total and per academic staff measures [$\chi(3)$ = 78.1, p-value = 0.000 and $\chi(3)$ = 32.7, p-value = 0.000]; (ii) the Kaiser-Meyer-Olkin measure of sampling adequacy for total and per academic staff performance are 0.62 and 0.49, respectively; (iii) all of the elements on the diagonal of the anti-image correlation matrix are between 0.50 and 0.66; and (iv) the communalities vary between 0.51 to 0.97. The results of the factor analysis, as briefly outlined, suggest that they were statistically acceptable. These results are not reported here in details but they are available from the authors upon request.

Based on the results of the factor analysis, the regression method is used and the corresponding factor scores for each of the twenty-seven universities are presented in Table 6 in descending order. In total research performance terms the results are once again fairly unsurprising with six of the Go8 universities ranking highest. It is interesting to note that Commerce in Adelaide is not ranked highly in terms of its size or even the magnitude of its per capita research performance.

In terms of size of research output Monash is ranked highest followed by UNSW, Sydney, Melbourne, Queensland, UTS, Griffith, and Western Australia. However, when research performance is expressed in per academic staff terms only two of Go8 (Melbourne and Monash) continue being ranked among the top eight. The following six improve in rank from total research performance to per academic staff research performance: New England, Murdoch, Griffith, Edith Cowan, Wollongong and QUT. For this group it is clear that while total output is relatively low, staff productivity is relatively high.

On the basis of results presented in Table 6, one can well argue that in many faculties they not only produce less output but also their staff productivity is relatively low. The eleven universities appearing in the bottom of column 5 in Table 6 all have Commerce faculties with negative factor scores for both total and per staff research (see columns 2 and 6). These eleven faculties are at Central Queensland, Flinders, Ballarat, James Cook, La Trobe, Canberra, Newcastle, Curtin, Adelaide, Deakin and Western Sydney. Their research outputs are below average, in terms of both total research output and research output per staff member. These universities are consistently the poorest performers in terms of both total and per academic staff research performance.

It is interesting to recognise that most of these less productive and small Commerce faculties also belong to cluster B (See columns 3, 4, 7 and 8 in Table 6). Exceptionally, New England and Tasmania move from cluster B, negative factor score to cluster A and positive factor score when adjusted for size.[4] Therefore, both the cluster and factor analyses have generated consistent results in relation to the classification and the ranking of Commerce disciplines. In Table 6 we have sorted the first four columns in terms of the total normalised factor scores (column 2) and the last four columns in terms of the per capita normalised factor scores. After identifying the consistency of the results of factor analysis with the results of cluster analysis, we decided to use labels such as A, A1, A2 and B to the resulting clusters. It should be noted that initially nothing could be implied from the ordering of cases in cluster analysis outside of their cluster membership. In fact, we could have used shapes such as squares or circles or triangles to show cluster memberships.

What seems most clear from these results is that there are not really 27 different levels of Commerce performance in Australian universities, as a straight league table would suggest, but rather only two or three. Moreover, the top cluster includes not only the Go8 universities, but several others as indicated, and excludes Adelaide. Finally, while most universities that come out in the top cluster for overall performance also do so for per capita, there are several that do not; notably New England and Tasmania, which come out in the lowest group for total output but in the top group for per capita. If funding were to be based only on total output, it would be doing a disservice to universities with small but excellent disciplinary groups.

Some significant policy implications, therefore, follow from our results and ensuing discussion. First, they suggest that it would be unreasonable to fund universities within the same cluster at different levels, because the difference between, say, UNSW and Griffith, is

[4] There are also small exceptions on the margin for Deakin, Western Sydney and Curtin.

insignificant. Second, these findings contribute to the debate over how funding should be targeted. Should funding be concentrated on those universities performing best, which would reinforce and support the hegemony of the Go8, or should it alternatively support New England and Tasmania so they can increase their size and thus move into the "A" group for total output? Another approach might be to focus on those universities in the top group per capita and middle in total (Wollongong, QUT, Victoria, Macquarie, Deakin). At the other end of the performance scale, our results question whether it is appropriate to maintain research funding at those universities that fall into the bottom clusters for both total and per capita output (Adelaide, Newcastle, Canberra, La Trobe, James Cook, Ballarat, Flinders, Central Queensland). Conceivably, these universities may be better suited to focus on teaching, and thus might receive the bulk of the funding geared towards building excellent teaching performance.

Finally, as indicated earlier, most of the analysis currently informing policy has addressed aggregate performance at the institutional level, comparing university with university using a variety of techniques. This approach ignores the varied performance that occurs within universities at the disciplinary level. Table 7 presents aggregate rankings of Australian universities based on total and per capita research performance (Valadkhani and Worthington, 2006) as well as another recent institutional ranking compiled by the Melbourne Institute of Applied Economic and Social Research (Williams and Van Dyke, 2004). By comparing Tables 6 and 7, it becomes clear that it is possible that an institution may perform very well at aggregate level but not so well in a particular discipline, say Commerce, or vice versa.

For instance, Adelaide is ranked the 8th top Australia university in terms of its research performance by Williams and Van Dyke (2004) and the 2nd (based on per capita research output) and the 7th (based on total output) top university (Valadkhani and Worthington, 2006).

Table 7. *Aggregate ranking and cluster membership based on per staff and total research output*

Institution	Normalised factor scores				Melbourne Institute Index	Rank
	Research performance per academic staff		Total research performance			
	Score	Rank	Score	Rank		
(1)	(2)*	(3)*	(4)*	(5)*	(6)**	(7)**
Melbourne	2.091	1	2.707	1	100	1
Adelaide	1.660	2	0.827	7	70	8
Western Australia	1.517	3	0.941	6	76	6
New South Wales	1.516	4	1.993	4	85	5
Sydney	1.398	5	2.412	2	95	3
Queensland	1.347	6	2.355	3	87	4
Tasmania	0.968	7	-0.101	10	53	12
Wollongong	0.862	8	-0.196	16	50	15
Murdoch	0.798	9	-0.348	20	51	14
Monash	0.754	10	1.640	5	76	6
New England	0.703	11	-0.389	22	47	19
Macquarie	0.681	12	-0.144	13	54	11
Flinders	0.379	13	-0.172	14	56	9
Newcastle	0.234	14	-0.080	9	52	13
La Trobe	0.007	15	0.048	8	55	10
James Cook	-0.048	16	-0.455	24	46	22
Griffith	-0.166	17	-0.102	11	49	16
Deakin	-0.196	18	-0.300	19	47	19
Curtin University of Technology	-0.216	19	-0.190	15	49	16
Queensland University of Technology	-0.293	20	-0.109	12	49	16
South Australia	-0.374	21	-0.288	18	44	24
Southern Cross	-0.401	22	-0.726	28	39	30
Northern Territory	-0.496	23	-0.818	33	41	27
Swinburne University of Technology	-0.498	24	-0.656	27	46	22
Canberra	-0.519	25	-0.738	30	42	26
University of Technology, Sydney	-0.521	26	-0.385	21	47	19
Edith Cowan	-0.644	27	-0.581	25	41	27
Royal Melbourne Institute of Technology	-0.690	28	-0.227	17	43	25
Victoria University of Technology	-0.777	29	-0.606	26	41	27
Ballarat	-0.816	30	-0.854	35	38	33
Western Sydney	-1.008	31	-0.417	23	39	30
Central Queensland	-1.151	32	-0.770	31	37	34
Charles Sturt	-1.320	33	-0.731	29	39	30
Southern Queensland	-1.438	34	-0.787	32	36	36
Sunshine Coast	-1.560	35	-0.912	36	32	37
Australian Catholic University	-1.783	36	-0.839	34	37	34

Source: * Valadkhani and Worthington (2006) and ** Williams and Van Dyke (2004).

However, when it comes to Commerce, Adelaide's performance (both on per capita and total research performance terms) is ranked 19th (See Table 6). The same can be said about Queensland and Western Australia. While these two universities are highly ranked in Table 7 at an institutional level, they both appear in the middle of Table 6 with the corresponding ranks of 13 and 15 out of 27 universities based on their per capita performance in Commerce.

VI. CONCLUDING REMARKS

The results in this paper suggest that size matters for research performance in commerce faculties, at least at the lower end of the scale. While size bears little correlation with performance at the upper end, we find that low total research output is a very good predictor of poor average performance on a per capita basis with very few exceptions. This result is consistent with UK research that concluded, while a simple relationship between size and technical efficiency could not be divined, "departments of economics with very small numbers of research staff can suffer severe allocative inefficiencies" (Johnes, 1995, 10). Why should this be the case? If economies of scale existed (Neumann 2002) we might expect that the largest output was associated with best per capita performance throughout the cohort, but this is not the case. Alternatively, perhaps there is a minimum scale of efficiency in output below which performance is likely to suffer.

One can easily imagine the disadvantages of working alone in a disciplinary area with no colleagues. Local collaboration would not be possible, neither would feedback on work in progress, nor the opportunity to participate in research seminars, discuss latest research trends, or have access to network nodes. Indeed, we may be able to talk about disciplinary groups as communities of practice, which nurture share and sustain tacit knowledge (Wenger 1998; Hildreth & Kimble 2004). However, numbers of staff is not sufficient alone, what matters is how active they are in terms of research output. A higher level of output enables the group to make strategic decisions more easily about whether to specialise in a few key areas or range more broadly. Similarly, an active PhD programme represents an additional enhancing element of the community of practice. It can also be argued that good faculties attract a good group of students which eventually results in an increase in the size of the faculty. In terms of the third measure of research activity, expenditures, our results raise questions of whether funding can fall below a point at which worthwhile and sustaining research projects can be undertaken. Smaller groupings may also find it difficult to provide the range of overheads and research management services to the degree necessary to support good research. The relative importance of these potential explanations of Commerce research performance merits the attention of future empirical research.

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