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A Multi-Dimensional Ranking of Australian Economics Departments

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This study uses cluster analysis to classify Australian economics departments into groups that have similar quantities of research output, measured by two publication counts, and similar quality of research output, measured by a citation count. Three groups of departments are identified and factor analysis is used to rank the groups. Whether research output is measured in total or on a per staff basis, Melbourne is in the group that ranks first, the remaining members of the 'group of eight' are in one or other of the top two groups, and at least 15 other departments are in the third-ranked group.

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A Multi-Dimensional Ranking of Australian Economics Departments*

I Introduction

Economics departments should be judged according to the extent to which they contribute to the discipline of economics. They do this in three main ways: by contributing to knowledge within the discipline (research), by advancing the formation of human capital (teaching), and by facilitating the useful application of economics in the wider community (service and extension). There are synergies between these activities, most obviously between research and teaching at the postgraduate level. Research is also necessary for certain types of service activities, such as the provision of various forms of expert advice. The relationship between research and undergraduate teaching is more tenuous.

Ranking economics departments is a well established way of judging their performance. Dozens of studies have ranked U.S. economics departments and several studies have ranked economics departments in other countries including Australia, New Zealand, Canada, and the United Kingdom. Recently, the European Economics Association commissioned four studies to rank economics departments in universities worldwide but with emphasis on European universities.[1]

Most existing rankings of economics departments are based on objective measures of research output only. The relative ease with which publications can be counted is probably a partial explanation for the focus on research rather than on teaching and service. However, given the synergies among research, teaching and service, research-based rankings convey information to the profession, not only about scholarship but also about the capacity for certain types of teaching and service activities. Rankings also provide useful information to specific groups. In the United States, where rankings have a long

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history, they are used by academic-job seekers to evaluate the research expectations of potential employer institutions. They provide recruitment committees with information about the academic qualifications and work experience of applicants for academic positions. They help potential postgraduate students evaluate departments in which they might wish to undertake a research degree. Undoubtedly, universities whose economics departments rank highly use this information in their marketing and fund-raising activities.

One characteristic of Australian economics departments is the highly skewed nature of their research publications (Harris, 1990; Towe and Wright, 1995; Pomfret and Wang, 2003). In some cases just one or two very productive researchers are responsible for a department's high ranking.[2] Despite the synergies between research and teaching, time spent teaching is not available for research so recruiting a prolific researcher with the lure of little or no teaching, or rewarding the most research-productive staff with reduced teaching loads, are strategies that are likely to improve a department's position in the rankings table. It is debatable whether such policies are desirable from a broader perspective. To the extent that teaching and research are complements rather than substitutes such policies are arguably undesirable. Furthermore, a department with a large proportion of young well-trained academics might contribute to the discipline substantially but not rank well until these people build extensive research records of their own.

Whatever their limitations, any new set of rankings can be guaranteed to attract interest as it seems that academics are insatiably curious to see how their department compares with others. Any new set of rankings will also attract criticism because all rankings depend upon the author's choice of methodology. A crucial issue is how to take account of quality, as well as quantity, of research output. Most studies rank departments according to some variant of the number of publications by department members. Ranking departments according to the number of citations received by department members is also common, the assumption being that citations reflect impact, if not research quality. Many authors produce two sets of rankings, one based on publications and the other based on citations. However, no previous study has produced a single ranking based on both publications and citations.

This study produces a ranking of departments that is based on multiple criteria. The method is demonstrated with data that were recently used by Pomfret and Wang (2003)[3] to rank economics departments in Australian universities. We have used cluster analysis to group departments according to three measures of research output, one of which is a citation count and two of which are publication counts. Factor analysis was then used to rank the groups. The result is a partial ranking of departments, which we contend better reflects the relative research strengths and weaknesses of Australian economics departments than does a complete ranking where the difference between two departments that are closely ranked can be more apparent than real.

The rest of the paper is organised as follows. In Section II we review the methodology of ranking with emphasis on how previous studies have handled the quantity-versus-quality issue. Section III raises the issue of whether a complete ranking of economics departments is meaningful and argues in favour of methods that produce a partial ranking. Section IV describes the data that are used in this study. The use of cluster analysis to form similar groups of departments is explained in Section V. The results of grouping departments using cluster analysis and ranking the groups using factor analysis are reported in Section VI. Section VII offers some concluding remarks.

II Methodology of Ranking: Quantity and Quality

Rankings of economics departments come in two basic forms: perception-based rankings and rankings based on objective measures of research output. Perception-based rankings are constructed using surveys of experts who are asked to rate each department according to ‘quality’ on a scale of (say) zero to five. The mean score given to each department establishes the department’s rank. Perception-based rankings reflect departments’ reputations in the eyes of the survey respondents. Experts’ perceptions are derived from multiple sources, from personal knowledge and experience of the department and its members to written reports of the departments’ research outputs. In that sense, perception-based rankings are multi-dimensional, but in an opaque kind of way. Rankings based on objective measures of scholarship are favoured in the academic literature. They are more transparent than perception-based rankings in that once the methodology is disclosed the ranking is reproducible. Subjective judgements are unavoidable, however, in the choice of methodology.

An important element of the methodology is the metric used to measure research output. There are two approaches: one is to count publications, the other is to count citations. Generally speaking, the number of publications produced by members of a department is an accepted measure of research quantity whereas the number of citations received by members of a department is regarded as a measure of research impact, if not quality. It is common practice to report two separate rankings in the same paper, one based on publications, the other based on citations. Each ranking is uni-dimensional but by considering them simultaneously the reader can draw his or her own conclusions about departments in terms of both quantity and quality of research.

Although academic economists produce various types of publication, most ranking studies only count articles in refereed journals because ‘only published journal articles undergo a widely accepted process of peer review which is the essence of quality control in any scientific discipline’ (Neary, Mirrlees and Tirole, 2003, p.1241). Refereed journals, however, differ according to the scholarship required to produce articles that are likely to be accepted for publication. Many studies that use publication counts to rank departments address the quality dimension by only counting articles published in a small subset of prestigious journals. For instance, Dusansky and Vernon (1998) restrict their analysis of U.S. departments to publications in eight core economics journals. Australian economics departments were ranked by Pomfret and Wang (2003) according to publications in 88 top journals.

An alternative way to take account of quality in a count of publications is by weighting each journal article by an index that purports to reflect the quality of the journal in which it is published. Journal weights have been devised using two different methods. The first method uses subjective perceptions of journal quality. The perceptions can be those of the authors undertaking the ranking study (Combes and Linnemer, 2003; Lubrano *et al.*, 2003) or those of respondents to a survey (Axarlaglou and Theoharakis, 2003). The second method is based on the number of citations of the journal's contents during a given period of time. These are probably better called impact factors as not all types of citations reflect positively on a journal's quality. The Journal Citation Reports of the Social Science Citation Index report an impact factor for each journal, which is based on the number of citations issued in a given year that refer to articles published in that journal during the previous ten years. More sophisticated methods adjust for journal size and age, and take account of the prestige of the publication in which each citation appears (which is itself determined by the rate at which its contents are cited). A recent example is the set of weights compiled by Kalaitzidakis, Mamuneas and Stengos (2003), based on 1998 citations of articles published from 1994 to 1998.

A quality-weighted count of publications is a uni-dimensional measure of a multi-dimensional phenomenon, but it is not entirely satisfactory for two reasons. First, there is variation in the quality (or impact) of articles within journals. Second, economists in small countries, such as Australia or New Zealand, who produce high-quality research on domestic issues, cannot reasonably expect to publish their work in the hundred or so top-ranked economics journals. Most of the top journals are edited by economists who are located in the United States and the journal's readership consists primarily of economists working in the United States. Empirical research on, or research that has policy implications for, small countries is not of sufficient interest to economists in the United States to warrant publication in the elite journals. Although Australian-based journals such as *The Economic Record*, *Australian Economic Review* or *Australian Economic Papers* are appropriate outlets for much empirical or policy work related to the Australian economy, the weights typically attached to these journals are very small – if not zero. It might be argued therefore that in ranking economics departments in small countries, publications in local journals should be treated differently from publications in top international journals.

To complete this section we return to the second method used to rank departments: counting citations received by members of each department. The major advantage of using citations is that it takes account of the variation in the quality (or impact) of articles within journals. However, our comment about the use of citations to rank journals applies here also: the reasons for citing are many and varied and not all indicate quality of scholarship. For example, self citations and gratuitous reciprocal citations are of dubious value in assessing quality and uncomplimentary citations more likely signal poor quality. Ideally, they should be excluded from a citation count.[4] One might also want to distinguish between valid citations of different types such as those acknowledging the source of an idea and those recognising previous empirical studies of the same phenomenon.

III Complete and Partial Rankings

Close examination of the metric used to measure research output reveals that in many studies there is little difference between departments with adjacent ranks or even between departments that are separated by several ranks. Thursby (2000) tested for significant differences across departments in the distribution of perception-based scores assigned by respondents to the National Research Council's 1993 survey into the quality of those U.S. departments that grant Ph.Ds in economics. Thursby concluded: 'there's not a hill of beans difference across large groups of departments' (Thursby, 2000, p.383).

Given that publication counts constitute a population of outcomes for the journals and years used to produce the ranking, does it make sense to conduct tests of significance? Thursby (2000, p.386) argues that to the extent that publication counts 'are used as indicators of a broader index or notion of quality, they are a sample, and a proper interpretation requires statistical testing'. We agree that perception-based rankings of departments – the type used in Thursby's study – are subject to statistical testing because a different sample of respondents would have produced another set of scores for each department. We also argue, however, that rankings based on publication counts or citation counts are not a sample, let alone a random sample. Nevertheless, an observed difference between two departments of a tenth of a page, or a tenth of a citation, per person per year[5] strikes us as mighty small, particularly in view of subjective decisions that have to be made about which academics to include in the study, which journals or types of citations to include, the time period over which to count publications or citations, whether to adjust for page size, whether and how to adjust for journal quality, not to mention any errors that are made in compiling lists of publications or citations. It seems to us that complete rankings of departments are likely to mislead by their precision and that a partial ranking is likely to be a more reliable indicator of the research strengths and weaknesses of a given set of departments.

The methodology used in this paper to rank Australian economics departments produces a partial ranking. To the best of our knowledge this methodology has not been used to compare economics departments before although it was used by the Department of Science, Education and Training (1998) to categorize (entire) Australian universities on the basis of a wide range of characteristics related to teaching and research. Abbott and Doucouliagos (2003) examine efficiency of Australian universities, and Thursby (2000) and Johnes and Johnes (1995) assess efficiency of economics departments in the U.S. and the U.K., respectively. These authors confront the issue of multiple measures of research output, as do we. However, the first two studies use data-envelopment analysis, and the last frontier analysis, to evaluate the relative efficiency of academic units given the resources available to them. Our analysis does not involve inputs and so does not address the issue of efficiency – although it would certainly be interesting to do so, if the necessary data on inputs were available. Unfortunately, data on inputs are difficult to obtain, even at the level of the department. Furthermore, departmental resources are not necessarily evenly distributed among department members. Therefore, relationships between research output and resource inputs that hold at the individual level are unlikely to be observed at the level of the department.

IV Data

The data employed in our analysis are those compiled by Pomfret and Wang (2003) and used in their comparison of the research output of 27 Australian economics teaching departments that, in April 2002, had at least eight academic staff with the designation of Lecturer or above. Pomfret and Wang rank departments by their ‘stock’ of research output, as do most Australian (Towe and Wright, 1995; Sinha and Macri, 2002; Macri and Sinha, 2005) and many overseas ranking studies. Under the stock approach credit for research published during a given time period is allocated to the academic's current department regardless of where the research was actually carried out. The stock approach provides a picture of a department's level of human capital at a point in time, as reflected in the past achievements of its current members.[6]

Pomfret and Wang have made their data set available on their web site at http://www.economics.adelaide.edu.au/research/rankings/ and they describe in detail the conventions used in constructing the data set, which lists the research output of 640 academic economists, in Section IV of Pomfret and Wang (2003). In particular, an 'economics department' includes econometricians and economic historians, whether or not they are located in the same administrative unit as the 'regular' economists. Members of finance and industrial relations disciplines are included in an economics department only if they are located in the same administrative unit as the economists. None of the staff in the data set is a member (or a primary affiliate) of a research institute, a fact that is particularly important for some universities. For example, only economists in the teaching faculty at the ANU are included in the data set; members of the research schools are excluded. Staff holding research-only positions within a teaching department, such as those with ARC research fellowships, are included. Staff on leave are also included but emeritus and adjunct staff are excluded. All of the economists in the data set had formal teaching responsibilities during at least part of the time period over which their research outputs were observed.

Although the only publications in the data set are refereed journal articles, Pomfret and Wang (2003, p.421) recognize that substantial contributions have appeared in other types of publications, particularly books. Almost all ranking studies exclude books because the variability of book quality is much greater than the variability of articles published in top journals. Excluding books, particularly research books, might well disadvantage departments with a disproportionately large number of economic historians – such as the ANU, New England, UNSW and Sydney – because economic historians tend to rely more heavily on research books to disseminate their work than do other economists.

Refereed journal articles are recorded in the data set as article counts rather than page counts. There is no consensus in the literature as to whether to count articles or pages. Pomfret and Wang (2003, p.421 and p. 430) prefer to count articles, arguing that important contributions have been 'brief and succinct', although they exclude comments, replies, obituaries and book reviews. Other authors prefer to count pages, arguing that 'length is correlated with importance, at least as perceived *ex ante* by editors and referees' (Neary, Mirrlees and Tirole, 2003, p.1241). The methodology used in our paper could readily take account of research books as an additional dimension of research output and could accommodate publications measured in pages. However, we have pursued neither option because we wish to compare the results produced by our methodology with those produced by the conventional methodology of Pomfret and Wang on the same set of data.

The data, which are reproduced here in Table 1, are particularly suited to our methodology because they include for each department three important measures of research output: the total number of citations appearing in journal articles published during 1995-2002 that reference research by department members; the total number of articles published during 1990-2001 in the top 88 journals listed by Laband and Piette (1994, TableA2, final column); and the total number of articles published during 1990-2001 in the six major Australian economics journals.[7] Department size is reported, which allows the data to be converted to a per staff basis. The fact that articles, rather than quality-weighted pages, are counted allows citations to be used as a measure of quality.

[Table 1 about here]

The three measures of research output in Table 1 are referred to hereafter as total Cites, Top88 and Aus6. It should be noted that *Economic Record* is listed in both Top88 and Aus6 and to avoid the issue of double counting we have excluded it from Aus6, yielding a new series which is referred to as Aus5 in this study. In our multivariate statistical analysis we thus use Cites, Top88 and Aus5, each standardised to a mean of zero and a variance of one.[8] The use of Aus5 in lieu of Aus6 had no impact in the cluster membership results and very little effect on the factor scores presented later in the paper.

The standardised raw data show that only six departments (Adelaide, the ANU, Melbourne, Monash, Queensland and NSW) produce more than the average output according to all three measures. Four departments (La Trobe, New England, Sydney and Western Australia) produce more than the average according to two of the three measures. The remaining 17 departments produce less than the average amount of research output according to all three measures.

The outcomes are a little different when research output is measured on a per staff basis, standardised to a mean of zero and a variance of one. Five departments (Adelaide, the ANU, La Trobe, Melbourne and Western Australia) produce more than the average amount of research output per staff, of all three types. Five departments (Monash, New England, Sydney, Tasmania, and UNSW) produce more than the average per staff output according to two of the three measures. Canberra, Murdoch, Newcastle and Queensland produce more than the average output per staff according to exactly one measure. The remaining 13 departments produce less than the average amount of research output per staff according to all three measures.

V Methodology

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. The methodology 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 is used in this paper to classify the 27 Australian economics departments ranked by Pomfret and Wang (2003) into groups according to the three measures of research output (Cites, Top88 and Aus5). Two sets of clusters are produced: one based on the three measures of *total* research output, the other based on the three measures of *per staff* research output. Similarity between two departments, j and k, is measured by the squared Euclidean distance:

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

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

A hierarchical clustering technique was used to form clusters of similar departments. At the beginning of the hierarchical procedure there are 27 clusters each containing one department. At each stage that follows, the two most similar clusters are merged until, at the final stage, a single cluster of 27 departments is formed. 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 identifies the two clusters whose merger would result 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

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

where X_{ij} is the i[th] measure of research output by Department j, and $\overline{X}_{ik}$ is the i[th] measure of research output averaged across all departments 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∪K) is given by:

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

VI Empirical Results

(i) Clustering Departments Based on Similarity of Standardised, Total Research Output

The squared Euclidean distances (SED) between all pairs of departments, when research output is measured by standardised data on total Cites, Top88 and Aus5, are not reported here but are available from the authors on request. According to the SED matrix, the three most dissimilar pairs of departments are Melbourne-Edith Cowan (SED=57.0); Melbourne-ADFA (SED=55.5) and Melbourne-Griffith (SED=53.8). On the other hand, the four most similar pairs of departments are Victoria-RMIT (SED=0.004), Wollongong-Curtin (SED=0.008), Canberra-Murdoch (SED=0.013), and Griffith-Victoria (SED=0.019).

Table 2 shows the way in which clusters are formed at various stages of the hierarchical clustering procedure. At Stage 0 there are 27 clusters each containing a single department. Columns 1, 2 and 3 in Table 2 show the clusters that are merged at each stage of the procedure. For example, at Stage 1, RMIT (Cluster 1) and Victoria (Cluster 2) are merged. The number of clusters at the end of Stage 1 is 26 (see Column 5). The clusters that are formed at Stages 2 and 3 also involve the merging of two single-department clusters. At Stage 2 Curtin and Wollongong are merged and at Stage 3 Canberra and

Murdoch are merged. At Stage 4, Columns 2 and 3 indicate that Deakin and the cluster consisting of RMIT and Victoria are merged to form a new cluster. By the end of Stage 4 there are 23 clusters (see Column 5). Stages 5 through 26 are interpreted similarly.

[Table 2 about here]

The agglomeration coefficient in Column 4 of Table 2 can be used to determine the number of clusters. The agglomeration coefficient is the within-cluster sum of squares, aggregated across all clusters that have been formed by a given stage of the procedure. Small increases in the agglomeration coefficient indicate that fairly homogeneous clusters are being merged at the current stage. A large increase in the agglomeration coefficient between two stages signals that more heterogeneous clusters are being merged. Table 2 indicates that the optimal number of clusters is three because, between Stages 24 and 25, the agglomeration coefficient shows a relatively large increase from 10.22 to 36.21. However, the use of the agglomeration coefficient as a stopping rule has the tendency to indicate too few clusters (Hair, 1998, p.503), so we will report the four-cluster solution. We also describe the two-cluster solution to gain a better understanding of the way in which different Departments are being grouped.[9]

The two-cluster, three-cluster and four-cluster solutions are reported in the first four columns of Table 3. We have used symbols, rather than numbers, to indicate cluster membership to deter any inference that the clusters of departments are ordered – they are not (yet). A cursory look at Table 3 reveals that irrespective of the number of clusters, Melbourne is always a separate unique cluster. No other department forms a cluster with Melbourne in two, three or even four-cluster solutions. Furthermore, 17 departments – those in adjacent rows starting with Western Sydney – are always grouped together regardless of the number of clusters. The ANU, Monash and UNSW split from

Queensland, Sydney, New England, UWA, Adelaide and La Trobe in the four-cluster solution but are grouped together in the three-cluster solution.

[Table 3 about here]

It is important to identify the outliers in cluster analysis as they may distort the Euclidean distances and hence the clustering outcome. An outlier observation usually joins the clustering process very late. The agglomeration schedule in Table 2 clearly indicates that Melbourne is an outlier observation. Melbourne does not join any cluster until Stage 26 (the last stage) and in so doing increases the agglomeration coefficient substantially from 36.2 to 78.0.

To investigate whether the clusters are robust, we repeated the clustering procedure with Melbourne excluded (see the last three columns of Table 3). Departmental memberships of the three-cluster and four-cluster solutions in Columns 3 and 4, respectively, have not been distorted by the outlier. The two clusters in Column 6 are identical to the two clusters that do not involve Melbourne in Column 3. The three clusters reported in Column 7 have exactly the same memberships as the three clusters that do not involve Melbourne in Column 4.

Therefore, we can conclude that: (1) the Economics Department at Melbourne University, in terms of total research output, forms a separate cluster that is not merged with any other of the 26 departments despite the fact that the number of clusters varies from two to four; (2) the 'group of eight' (Adelaide, the ANU, Melbourne, Monash, Queensland, Sydney, UNSW and UWA) plus two (New England and La Trobe) are different from the other 17 departments; and (3) there is also some evidence that ANU, Monash and UNSW are more similar to each other than to other members of the 'group of eight plus two'.

Following MacQueen (1967), Milligan (1980) and Hair *et al.* (1998), we finetuned the results of the hierarchical cluster analysis (HCA) using a non-hierarchical procedure known as K-means clustering. The results of K-means clustering did not change the cluster memberships produced by the HCA. Based on the 'finetuned cluster centres' we have observed the distances between final cluster centres. The distance (2.29) between the six-department Cluster-○ in Column 4 of Table 3 and the 17-department Cluster-∆ is approximately the same as the distance (2.26) between Cluster-○ and the three-department Cluster-✞. But the distance (or dissimilarity) between Cluster-✞ (the ANU, Monash and UNSW) and Cluster-∆ (the other 17 departments) is much larger (4.43). We also undertook an analysis of variance (ANOVA) across the three variables used in the clustering process. The ANOVA results indicate that the cluster differences in terms of the standardised magnitudes of the means of the three variables are all significant at the one per cent level of significance, supporting the view that all three variables play an important role in differentiating the resulting clusters. These results are available from the authors upon request.

(ii) Clustering Departments Based on Similarity of Standardised, Per Staff Research Output

Dividing total research output by the number of academic staff in each of the 27 departments adjusts for department size. The proximity matrix among the 27 departments using the SED as a measure of dissimilarity was computed but we do not report it due to the lack of space. The lower the SED, the more similar are the two departments in terms of per staff Cites, Top88 and Aus5. The following five pairs of departments were observed to have the most similar research output per staff: Western Sydney-Deakin (SED=0.007); RMIT-Victoria (SED=0.015); Victoria-ADFA (SED=0.019); Deakin-Curtin (SED=0.024) and RMIT-ADFA (SED=0.031). On the other hand, Melbourne, ANU and UWA appear to be very different from the other 24 departments in terms of their research output per staff.

We clustered departments in terms of their research output per staff using HCA and Ward's method. The agglomeration schedule is reported in Table 4. The agglomeration coefficient in Column 4 shows that the optimal number of clusters is two. However, we will base our analysis on the three-cluster solution because (a) the use of the agglomeration coefficient as a stopping rule has the tendency to indicate too few clusters (Hair, 1998, p.503) and (b) the increase in the agglomeration coefficient from Stage 24 (19.99) to Stage 25 (33.96) is substantial. Consistent with Table 3, Table 5 reports the cluster memberships for the two-cluster, three-cluster and four-cluster solutions. In a two-cluster solution Melbourne, the ANU and UWA are grouped together in one cluster and the other 24 departments form the other cluster. With a three-cluster solution, Melbourne, the ANU and UWA remain in a separate group; the other members of the group of eight (Adelaide, UNSW, Sydney, Monash and Queensland) together with La Trobe and New England and two relatively small departments (Tasmania and Newcastle) form a second group. The remaining 15 departments constitute their own group. We have also allowed the number of clusters to increase from three to four just to see what happens to the classification of departments. The only modification to the three-cluster solution is the appearance of Melbourne as a separate cluster.

[Tables 4 and 5 about here]

The initial cluster centres obtained by HCA have been finetuned by the K-means cluster analysis approach. Based on the magnitude of the resulting cluster centres we can conclude that Cluster-□ (Melbourne, the ANU and UWA) is more different from the 15-department Cluster-∆ than from the nine-department Cluster-○. However, Cluster-○ is more homogenous with the Cluster-∆ than with Cluster-□. This highlights the difference between the cluster comprised of Melbourne, the ANU and UWA and other members of the group of eight in terms of research output per staff. Similar to the results obtained using total research output measures, all three measures of per staff research output have significantly contributed to the resulting distances in the clustering process at the one per cent level of significance. These results are also available from the authors on request.

(iii) Ranking Clusters of Australian Economics Departments Using Factor Analysis

Having clustered departments into three groups based on multiple measures of research output, we used factor analysis to rank the clusters. Separate factor analyses were conducted for total and per staff measures of (standardised) Cites, Top88 and Aus5. The first principal component was used to calculate a single factor score for each department. This composite index explains 83.5 per cent of variation in total output measures and 81.0 per cent of variation in per staff output measures. The results of factor analysis are not reported here due to the lack of space but they are available from the authors upon request.[10]

The factor scores for the 27 departments are presented in Table 6 in descending order. Differences in factor scores indicate differences between the research outputs of the various departments. The fact that the factor scores of many departments that are adjacent in Table 6 differ very little provides further evidence that a partial ranking of departments is appropriate. For example, Flinders, RMIT and Victoria have factor scores of -0.633, -0.638 and -0.646, respectively. Furthermore, comparing Columns 2 and 3 of Table 6, we see that the results of the cluster analysis and the factor analysis are perfectly consistent: all departments in Cluster-Δ receive smaller factor scores than departments in Cluster-○, and all departments in Cluster-○ receive smaller factor scores than departments in Cluster-□. This consistency allows us to use the factor scores to impose an order on the clusters.

[Table 6 about here]

The salient features of the partial ranking of departments in the first three columns of Table 6 are as follows. The first rank goes to Cluster-☐, containing only Melbourne with a factor score that is more than twice as large as that of any other department. Cluster-○ consisting of the ANU, Monash, UNSW, Queensland, Sydney, New England, UWA, Adelaide and La Trobe – all with positive factor scores – ranks second. Thus, the top two clusters consist of the group of eight plus New England and La Trobe. The remaining 17 departments in the third-ranked Cluster-∆ all have negative factor scores, indicating that their research output is below the average. Comparing our results with those of Pomfret and Wang (2003, Table VIII, Columns 4 and 12) we see that all ten departments in our top two clusters rank in the top ten according to total citations alone. Furthermore, nine of the ten departments in our top two clusters rank in the top ten according to total Top88 publications alone. New England is able to join our top ten departments because its citations compensate for its lack of publications.

From the last three columns of Table 6, the following major findings emerge in relation to a partial ranking of departments according to per staff Cites, Top88 and Aus5. Cluster-☐ (Melbourne, ANU and UWA) appears at the top of our ranking. Cluster-○ (La Trobe, Adelaide, Tasmania, UNSW, New England, Sydney, Monash, Queensland and Newcastle) ranks second, all with positive factor scores except for Newcastle. The top two clusters consist of the group of eight plus New England and La Trobe, together with Tasmania and Newcastle. The remaining departments all have negative factor scores and form the third-ranked Cluster-∆. Comparing our results with those of Pomfret and Wang (2003, Table VIII, Columns 9 and 11) we see that the ten departments with the largest per staff Top88 publications and the ten departments with the largest per staff citations are subsets of the 12 departments in our top two clusters.

In conclusion, the members of the group of eight are among the top ten departments in terms of both total research output and per staff research output. Furthermore, the correlation coefficient between the factor scores of total research output and per staff research output is 0.95, so one can argue that departments with the least (most) total research output tend to be those with the least (most) research output per staff.[11] There are 15 departments which have negative factor scores, and therefore are below average, in terms of both total research output and research output per staff member.

VII Conclusions

Previous rankings of economics departments have been based either on the number of publications or on the number of citations but not both. Many studies that use publications take account of research quality by restricting the type of publications that 'count' to articles published in a small subset of prestigious journals or by weighting each publication by an index reflecting the quality (or impact) of the journal in which it was published. But not all articles published in the same journal are cited to the same degree and some articles appearing in less prestigious field journals have more impact than some articles published in higher ranked journals. Furthermore, papers reporting empirical or policy-orientated research on small countries are unlikely to be published in the elite journals, even if they embody high levels of scholarship, because they are not of sufficient interest to the journals' editors or readers, most of whom are located in North America. It can be argued therefore that in ranking economics departments in small countries, publications in local journals should be treated differently from publications in international journals. A method that can rank departments according to various kinds of publications and citations would overcome some of these problems.

We have used cluster analysis to categorise Australian economics departments into three groups using the three measures of research output reported in Pomfret and Wang (2003): the number of citations during 1995-2002; the number of articles published during 1990-2001 in 88 top journals (including *Economic Record*); and the number of articles published during 1990-2001 in five major Australian economics journals (excluding *Economic Record*). We then used factor analysis to rank the groups of departments. We contend that a partial ranking better reflects the research accomplishments of the departments than does a complete ranking, which is likely to mislead by its precision. Two partial rankings are presented: one based on the three measures of total research output and the other based on the three measures of per staff research output. According to total research output Melbourne is in a group of its own, which ranks first. The remaining members of the group of eight plus New England and La Trobe rank second. The remaining 17 departments rank third. According to per staff research output, Melbourne, the ANU and UWA comprise the first-ranked group. The remaining members of the group of eight plus New England, La Trobe, Tasmania and Newcastle rank second. The remaining 15 departments form the third-ranked group.

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TABLE 1

Total Research Output - Citations 1995-2002 and Publications 1990-2001

Economics Department		Number of Staff	Citations	Publications		
				Top88	Aus6	Aus5
1	Adelaide	19	1,265	24.17	14.75	12.25
2	ADFA	15	68	0	2.00	2.00
3	ANU	20	2,898	56.91	31.17	25.17
4	Canberra	13	174	2.33	8.17	7.17
5	Curtin	27	257	11	12.42	8.92
6	Deakin	14	98	7.42	5.75	4.50
7	Edith Cowan	16	9	0	0	0
8	Flinders	14	265	4.33	3.00	2.00
9	Griffith	10	113	4.83	3.83	2.00
10	La Trobe	19	640	27.58	28.25	20.50
11	Macquarie	22	431	13.17	5.33	1.00
12	Melbourne	39	2,287	137.92	139.25	103.25
13	Monash	54	2,229	62.5	20.33	16.41
14	Murdoch	10	146	5.5	8.58	7.58
15	New England	24	1,623	12.83	19.50	17.50
16	Newcastle	11	367	9.17	3.50	3.50
17	Queensland	38	1,792	29.83	18.25	14.75
18	QUT	21	112	14.17	5.75	2.25
19	RMIT	33	83	4.42	6.92	5.67
20	Sydney	31	1,332	43.17	11.33	7.50
21	Tasmania	8	239	14.33	10.33	6.33
22	UNSW	38	1,942	68.92	19.67	12.50
23	UTS	34	634	6.5	3.00	2.00
24	UWA	14	1,121	37.5	18.33	11.00
25	Victoria	43	108	4.5	6.67	4.67
26	Western Sydney	35	223	18.33	13.00	9.67
27	Wollongong	18	225	9	10.50	8.00

Source: Pomfret and Wang (2003), Table VI.

TABLE 2

Agglomeration Schedule (Total Research Output Measures)

Stage (1)	Cluster 1 (2)	Cluster 2 (3)	Agglomeration Coefficient (4)	No. of Clusters (5)
1	RMIT	Vict	0.0018	26
2	Curt	Wgong	0.0059	25
3	Canb	Murd	0.0122	24
4	Deak	RMIT; Vict	0.0196	23
5	ADFA	ECU	0.0273	22
6	Flind	Griff	0.0437	21
7	Macq	N'castle	0.0639	20
8	Curt; Wgong	Tas	0.0859	19
9	Canb; Murd	Deak; RMIT; Vict	0.1147	18
10	Curt; Wgong; Tas	UWS	0.1621	17
11	ADFA; ECU	Flind; Griff	0.2200	16
12	Syd	UWA	0.2855	15
13	Macq; N'castle	UTS	0.3535	14
14	Curt; Wgong; Tas; UWS	QUT	0.4480	13
15	Monash	NSW	0.5492	12
16	ADFA; ECU; Flind; Griff	Canb; Murd; Deak; RMIT; Vict	0.6813	11
17	UNE	Qld	0.8727	10
18	Adel	Syd; UWA	1.0847	9
19	Curt; Wgong; Tas; UWS; QUT	Macq; N'castle; UTS	1.4190	8
20	ADFA; ECU; Flind; Griff; Canb; Murd; Deak; RMIT; Vict	Curt; Wgong; Tas; UWS; QUT; Macq; N'castle; UTS	1.9798	7
21	Adel; Syd; UWA	LaTr	2.6135	6
22	ANU	Monash; NSW	3.4926	5
23	Adel; Syd; UWA; LaTr	UNE; Qld	4.4522	4
24	Adel; Syd; UWA; LaTr; UNE; Qld	ANU; Monash; NSW	**10.2194**	**3**
25	Adel; Syd; UWA; LaTr; UNE; Qld; ANU; Monash; NSW	ADFA; ECU; Flind; Griff; Canb; Murd; Deak; RMIT; Vict; Curt; Wgong; Tas; UWS; QUT; Macq; N'castle; UTS	**36.2135**	**2**
26	Adel; Syd; UWA; LaTr; UNE; Qld; ANU; Monash; NSW; ADFA; ECU; Flind; Griff; Canb; Murd; Deak; RMIT; Vict; Curt; Wgong; Tas; UWS; QUT; Macq; N'castle; UTS	Melbourne	78.0000	1

Source: Author's calculations based on the standardised data.

TABLE 3

Cluster Membership Based on Total Research Output Measures

Economics Department	With Melbourne			Economics Department	Without Melbourne	
	Two Clusters	Three Clusters	Four Clusters		Two Clusters	Three Clusters
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Melbourne	□	□	□	Melbourne	-	-
ANU	○	○	✞	ANU	○	✞
Monash	○	○	✞	Monash	○	✞
UNSW	○	○	✞	UNSW	○	✞
Queensland	○	○	○	Queensland	○	○
Sydney	○	○	○	Sydney	○	○
New England	○	○	○	New England	○	○
UWA	○	○	○	UWA	○	○
Adelaide	○	○	○	Adelaide	○	○
La Trobe	○	○	○	La Trobe	○	○
Western Sydney	○	Δ	Δ	Western Sydney	Δ	Δ
Curtin	○	Δ	Δ	Curtin	Δ	Δ
Tasmania	○	Δ	Δ	Tasmania	Δ	Δ
UTS	○	Δ	Δ	UTS	Δ	Δ
Macquarie	○	Δ	Δ	Macquarie	Δ	Δ
Wollongong	○	Δ	Δ	Wollongong	Δ	Δ
Newcastle	○	Δ	Δ	Newcastle	Δ	Δ
QUT	○	Δ	Δ	QUT	Δ	Δ
Murdoch	○	Δ	Δ	Murdoch	Δ	Δ
Canberra	○	Δ	Δ	Canberra	Δ	Δ
Deakin	○	Δ	Δ	Deakin	Δ	Δ
Flinders	○	Δ	Δ	Flinders	Δ	Δ
RMIT	○	Δ	Δ	RMIT	Δ	Δ
Victoria	○	Δ	Δ	Victoria	Δ	Δ
Griffith	○	Δ	Δ	Griffith	Δ	Δ
ADFA	○	Δ	Δ	ADFA	Δ	Δ
Edith Cowan	○	Δ	Δ	Edith Cowan	Δ	Δ

Source: Author’s calculations based on the standardised data.

TABLE 4

Agglomeration Schedule (Per Staff Research Output Measures)

Stage (1)	Cluster 1 (2)	Cluster 2 (3)	Agglomeration Coefficient (4)	No. of Clusters (5)
1	Deak	UWS	0.0037	26
2	RMIT	Vict	0.0111	25
3	ADFA	RMIT; Vict	0.0252	24
4	Curt	Deak; UWS	0.0441	23
5	Flind	UTS	0.0646	22
6	Curt; Deak; UWS	Griff	0.1055	21
7	Monash	Murd	0.1466	20
8	ADFA; RMIT; Vict	ECU	0.2065	19
9	Canb	Wgong	0.2882	18
10	N'castle	Qld	0.3898	17
11	Flind; UTS	Macq	0.4941	16
12	Curt; Deak; UWS; Griff	QUT	0.6205	15
13	Canb; Wgong	Murd	0.8130	14
14	LaTr	Tas	1.0317	13
15	Monash; Murd	N'castle; Qld	1.3168	12
16	Adel	UNE	1.6551	11
17	Curt; Deak; UWS; Griff; QUT	Flind; UTS; Macq	2.1107	10
18	Monash; Murd; N'castle; Qld	NSW	2.7571	9
19	ADFA; RMIT; Vict; ECU	Curt; Deak; UWS; Griff; QUT; Flind; UTS; Macq	3.5771	8
20	ADFA; RMIT; Vict; ECU; Curt; Deak; UWS; Griff; QUT; Flind; UTS; Macq	Canb; Wgong; Murd	5.1512	7
21	Adel; UNE	Monash; Murd; N'castle; Qld; NSW	6.7637	6
22	Adel; UNE; Monash; Murd; N'castle; Qld; NSW	LaTr; Tas	9.1553	5
23	ANU	UWA	11.5837	4
24	ANU; UWA	Melbourne	**19.9996**	**3**
25	Adel; UNE; Monash; Murd; N'castle; Qld; NSW; LaTr; Tas	ADFA; RMIT; Vict; ECU; Curt; Deak; UWS; Griff; QUT; Flind; UTS; Macq; Canb; Wgong; Murd	**33.9593**	**2**
26	Adel; UNE; Monash; Murd; N'castle; Qld; NSW; LaTr; Tas; ADFA; RMIT; Vict; ECU; Curt; Deak; UWS; Griff; QUT; Flind; UTS; Macq; Canb; Wgong; Murd	ANU; UWA; Melbourne	77.9995	1

Source: Author's calculations based on the standardised data.

TABLE 5

Cluster Membership Based on Per Staff Research Output Measures

Department (1)	Two Clusters (2)	Three Clusters (3)	Four Clusters (4)
Melbourne	□	□	□
ANU	□	□	✞
UWA	□	□	✞
La Trobe	○	○	○
Adelaide	○	○	○
Tasmania	○	○	○
UNSW	○	○	○
New England	○	○	○
Sydney	○	○	○
Monash	○	○	○
Queensland	○	○	○
Newcastle	○	○	○
Murdoch	○	Δ	Δ
Wollongong	○	Δ	Δ
Canberra	○	Δ	Δ
Deakin	○	Δ	Δ
Macquarie	○	Δ	Δ
Curtin	○	Δ	Δ
Western Sydney	○	Δ	Δ
Griffith	○	Δ	Δ
Flinders	○	Δ	Δ
QUT	○	Δ	Δ
UTS	○	Δ	Δ
RMIT	○	Δ	Δ
Victoria	○	Δ	Δ
ADFA	○	Δ	Δ
Edith Cowan	○	Δ	Δ

Source: Authors' calculations based on the standardised data.

TABLE 6

Ranking of the Three Clusters of Economics Department using Factor Analysis

Total Research Output			Per Staff Research Output		
Department (1)	Cluster (2)	Factor Scores (3)	Department (4)	Cluster (5)	Factor Scores (6)
Melbourne	□	3.806	Melbourne	□	2.875
ANU	○	1.556	ANU	□	2.596
Monash	○	1.193	UWA	□	1.492
UNSW	○	1.087	La Trobe	○	0.646
Queensland	○	0.559	Adelaide	○	0.640
Sydney	○	0.410	Tasmania	○	0.558
New England	○	0.319	UNSW	○	0.492
UWA	○	0.315	New England	○	0.389
Adelaide	○	0.223	Sydney	○	0.162
La Trobe	○	0.165	Monash	○	0.083
Western Sydney	Δ	-0.326	Queensland	○	0.043
Curtin	Δ	-0.422	Newcastle	○	-0.135
Tasmania	Δ	-0.434	Murdoch	Δ	-0.170
UTS	Δ	-0.454	Wollongong	Δ	-0.425
Macquarie	Δ	-0.469	Canberra	Δ	-0.482
Wollongong	Δ	-0.478	Deakin	Δ	-0.555
Newcastle	Δ	-0.501	Macquarie	Δ	-0.571
QUT	Δ	-0.563	Curtin	Δ	-0.574
Murdoch	Δ	-0.563	Western Sydney	Δ	-0.595
Canberra	Δ	-0.601	Griffith	Δ	-0.609
Deakin	Δ	-0.615	Flinders	Δ	-0.639
Flinders	Δ	-0.633	QUT	Δ	-0.654
RMIT	Δ	-0.638	UTS	Δ	-0.749
Victoria	Δ	-0.646	RMIT	Δ	-0.876
Griffith	Δ	-0.689	Victoria	Δ	-0.931
ADFA	Δ	-0.770	ADFA	Δ	-0.938
Edith Cowan	Δ	-0.831	Edith Cowan	Δ	-1.071

Source: Authors calculations based on the standardised data.
Note: Both the Bartlett and regression methods generated similar factor scores.

Footnotes

[1] The four studies are Combes and Linnemer (2003); Coupe (2003); Kalaitzidakis, Mamuneas and Stengos (2003); and Lubrano, Bauwens, Kirman and Protopopescu (2003).

[2] There is evidence that research output by New Zealand academic economists is also highly skewed (Dalziel *et al.*, 2002) but whether the phenomenon occurs in other countries is unknown. No study has compared economics departments in more than one country according to research concentration although Scott and Mitias (1996) ranked 80 economics departments in the United States using Herfindahl indices and Neri and Rodgers (2005) ranked Australian economics departments using Gini coefficients.

[3] We thank Pomfret and Wang for allowing us to use their data.

[4] Not all reciprocal citations are problematic. They can reveal genuine academic communication among researchers. Clements and Wang (2003) examined the pattern of reciprocal citations among Australian universities using citations made by PhD students in papers presented at the annual conference for PhD students in economics and business from 1987 through 2000. The results revealed a low degree of communication among Australian economics departments in the 'group of eight' universities. It would be interesting to know whether the same would be observed in citations made by academic economists in published journal articles.

[5] The difference between the two Australian economics departments ranked third and fourth by Towe and Wright (1995) is 0.11 standard-size pages in Tiers 1-3 journals per person per six years. The differences between the three Australian economics departments that ranked second and third, and third and fourth, in Harris (1990) are both 0.1 citations per person per two years.

[6] The alternative, the 'flow' approach, assigns credit for published research to the department in which the research was done. The flow of research output per academic staff, per annum, is a measure of a department's productivity. A discussion of these issues can be found in Macri and Sinha (2005).

[7] The journals are the *Economic Record*, *Australian Economic Papers*, the *Australian Economic Review*, *Australian Economic History Review*, the *Australian Journal of Agricultural Economics* and the *Australian Journal of Agricultural and Resource Economics*. Publications, but not citations, were adjusted for the number of authors.

[8] It is common practice to standardise the variables in a cluster analysis in order to avoid bias resulting from variables having substantially different magnitudes or being measured in different units.

[9] The Cubic clustering criterion (CCC) available in SAS could have also been used as a stopping rule but this method has the tendency to indicate too many clusters.

[10] Only the first eigenvalue in each case exceeds unity and according to the scree plot – a test proposed by Cattell (1966) to determine the number of factors – only the first principal component is significant. Considering both total output and per staff output, we also observed that (a) Bartlett's test of sphericity was rejected at the one per cent level; (b) the Kaiser-Meyer-Olkin measure of sampling adequacy for total output and per staff output were 0.564 and 0.617, respectively; (c) all the elements on the diagonal of the Anti-image correlation matrix were at least 0.54; and (d) the lowest communality was 0.74.

[11] This does not necessarily imply that departments with large (small) numbers of academic staff have high (low) levels of research output per academic staff member. Some large departments, such as Victoria, have low levels of per staff research output and some small departments, such as Newcastle, have high levels of research output per staff. The simple correlation coefficient between the number of academic staff and the factor scores based on per staff output is 0.080, so there is no evidence of economies of scale in research production.