EVALUATING THE USAGE AND IMPACT OF E-JOURNALS IN THE UK

BIBLIOMETRIC INDICATORS FOR CASE STUDY INSTITUTIONS

CIBER WORKING PAPER 3

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The purpose of this paper

This paper sets out a range of bibliometric indicators that summarise the productivity and citation impact of the eleven case study institutions in five subject areas. The data will be used later in conjunction with information consumption profiles (derived from deep log analysis) to gain a deeper understanding between journal use and research outcomes.

Research method

Data on publication and citation patterns were collected online using Scopus in mid-September 2008. Scopus was selected as the data source in preference to Thomson ISI, the most commonly used reference point, for two reasons. The first and most important is that Scopus has made more progress than ISI in consolidating author addresses by institution (see Annex for a description of the codes used). This was a critical requirement. The second advantage of Scopus over ISI is that it draws a wider net over the literature, including document types such as patents and conference proceedings, thus offering a broader perspective on research outcomes. As agreed earlier, we define subject in this paper by Scopus subject code, not by Department within an institution. The data therefore reflect the whole output of an institution within a particular segment of the literature.

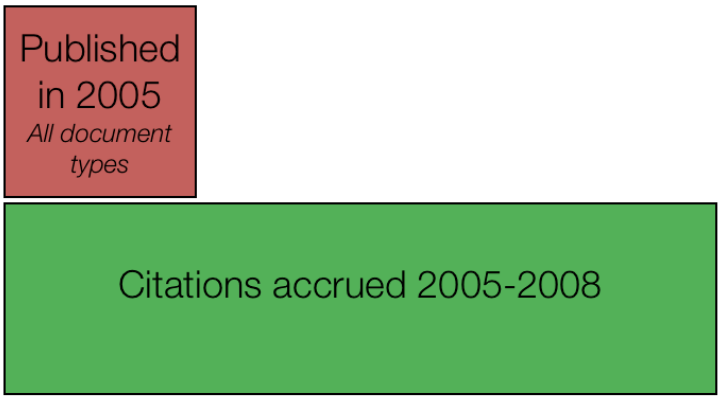
Interpreting the tables

In the pages that follow, four tables are given in each subject area. The notes below are a guide to how those tables were compiled and what they mean.

Table 1: Citations per paper

Table 1 offers a standard comparison between institutions, citations per paper, using a synchronous citation analysis method. This is explained in Figure 1 which shows that we are focusing attention on a single year of publication (2005) and counting all the citations to those papers from 2005 to the present.

Figure 1: Citations per paper explained



The table also gives a sense of the relative size of the outputs and their impact (i.e. total citations).

Table 2: Productivity and research outcomes

Table 2 contrasts two sets of indicators: a measure of institutional productivity (the `Hirsch index') and research quality as indicated by the peer review judgements made in the 2001 Research Assessment Exercise.

The Hirsch (or h-) index, was first introduced in 2005 as a measure of the productivity of individual researchers. Hirsch writes that:

> *A scientist has index h if h of his N_p papers have at least h citations each, and the other (N_p - h) papers have at most h citations each.*
>
> In other words, a scholar with an index of *h* has published *h* papers each of which has been cited by others at least *h* times. Thus, the *h*-index reflects both the number of publications and the number of citations per publication. The index is designed to improve upon simpler measures such as the total number of citations or publications. The index works properly only for comparing scientists working in the same field; citation conventions differ widely among different fields. (Hirsch, 2005).

In other words, a researcher with an h-index of eight must have published at least eight papers that have each attracted eight or more citations each. This is a tough composite measure of both production and quality since the scale is not linear: moving just one rung up this ladder means writing nine good papers (that are each cited at least nine times).

In this discussion paper, the h-index is applied at the institutional level for chemistry for a given time period, rather than for an individual over his or her career to date. The principle is the same though, it offers a comparative measure of the ability of the `department' to sustain productivity and high impact papers over the long haul.

Broadly speaking, there appears to be a correlation between the h-index and the judgements made in the 2001 RAE and this might well be worth further investigation. In fact, given what we know about the association between raw citation counts and RAE grades, it is possible that an institutional h-index might well offer a useful proxy for these peer-review judgements, although this does not seem yet to have been reported in the literature.

Reference

Hirsch, J.E. (2005). An index to quantify an individual's scientific research output, *Proceedings of the National Academy of Sciences,*102(46):16,569-16,572.

Table 3: Virtual impact factors

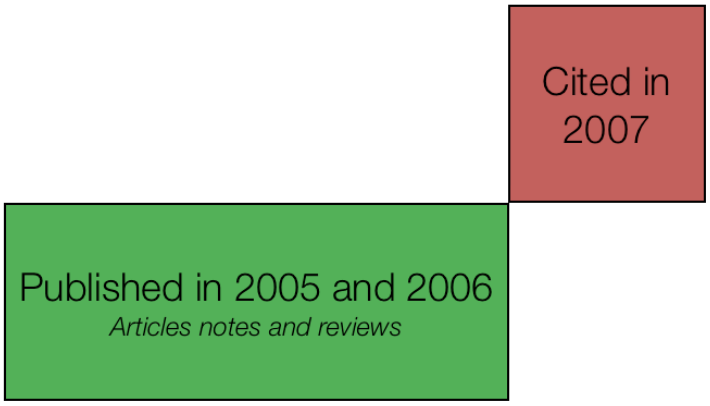
In this Table we attempt a first. The notion of a journal impact factor is very widely accepted and influential in academic circles: it is shorthand for the citation impact of a given title: the average citedness of recent articles.

CIBER has developed a methodology for applying this concept to research groups rather than journal titles. In other words, if we treat the combined output of say, Edinburgh, in chemistry *as though it were a journal in its own right* ("Edinburgh Transactions in Chemistry") then we have a

new and powerful way both to compare university `departments' with one another and with the rest of the world.

Table 4 shows these `virtual impact factors' for our case study institutions. The data come from SCOPUS *and not therefore directly comparable with published ISI impact factors,* but they are constructed in exactly the same way, as visualized in Figure 2.

Figure 2: Virtual impact factor explained



The impact factor is a simple ratio. The denominator is the number of `citable' papers (research articles, reviews and notes) published in a two-year window. Other document types, such as editorial matter and letters are excluded, so that we focus on serious research findings. The numerator is the number of citations received during the following year to that recent set of research papers.

Since we can also provide a virtual impact factor for the performance of the whole world[1] in a given discipline (final row of Table 3), we can benchmark the performance of each institution with global norms for that discipline, in the final column.

Table 4: Patents awarded

Table 4 offers a different perspective on research outcomes: numbers of successful papetnt applications. The sources included in this analysis are: the European Patent Office, the UK and US Patent Offices, and the World Intellectual Property Organisation. This could be thought of as a crude indicator of `third-stream' commercial application of knowledge.

[1] The figures presented in Table 3 for World impact (last row) are provisional estimates. Scopus only allows the automatic processing of up to 2,000 documents online, so these estimates are based on very small samples of the total population. They are roughly in line with the equivalent ISI averages for equivalent subject fields but they should be treated with caution.

The tables

Agriculture and biological sciences

Table 1a: Citations per paper: 2005 papers (all document types) cited 2005-2008
Numbers and ratios
Ranked by citations per publication

	Publications (2005)	Citations (2005-2008)	Citations / publication
Manchester	**199**	**3,506**	**17.62**
Edinburgh	337	5,004	14.85
UCL	350	5,074	14.50
Rothamsted	209	2,516	12.04
CEH	137	1,334	9.74
Strathclyde	39	363	9.31
Cambridge	511	4,715	9.23
Swansea	57	519	9.11
King's London	110	995	9.05
Aberdeen	214	1,774	8.29
Bangor	119	927	7.79
Total / mean	**2,282**	**26,727**	**11.71**

Table 2a: Hirsh index scores and RAE_{2001} outcomes: all document types, 2005-2008
Hirsch indexes, RAE 2001 grades and research active staff FTEs
Ranked by Hirsch index

	Hirsch index	2001 RAE†
UCL	**42**	**5**
Edinburgh	37	5
Cambridge	35	5* A (58.4)
Manchester	32	5* B (68.0)
Aberdeen	27	5 C (19.0)
Rothamsted	27	n/a
CEH	23	n/a
King's London	22	3a C (34.5)
Swansea	16	3a A (36.0)
Bangor	15	4 A (29.3)
Strathclyde	14	n/a

†Unit of Assessment 14: Biological sciences
Note: Cambridge made five submissions under this UoA, the results shown are those for Zoology.

Table 3a: Citation impact in 2007: virtual impact factors
Numbers, virtual impact factors and relative world impact
Ranked by virtual impact factor

	Papers (2005-2006)	Citations (2007)	Virtual IF	Global impact
CEH	**137**	**1,334**	**9.74**	**477**
Cambridge	883	5,513	6.24	306
UCL	516	3,131	6.07	298
Edinburgh	528	2,794	5.29	259
Manchester	345	1,512	4.38	215
King's London	155	567	3.66	179
Rothamsted	365	1,273	3.49	171
Strathclyde	87	292	3.36	165
Aberdeen	426	1,349	3.17	155
Swansea	110	329	2.99	147
Bangor	237	570	2.41	118
World	**204,959**	**418,320***	**2.04***	**100**

†Citations received in 2007 to 2005 and 2006 articles, notes and reviews.
*Estimated.

Table 4a: Patents awarded, 2005-2008
Numbers of patents†

	Patents
UCL	**28**
Cambridge	26
Manchester	26
Edinburgh	25
King's London	24
Rothamsted	15
Strathclyde	14
Aberdeen	8
Bangor	4
CEH	2
Swansea	0
Total	**172**

†Scope: European Patent Office, UK Patent Office, US Patent Office and World Intellectual Property Organisation (WIPO).

Chemistry and chemical engineering

Table 1b: Citations per paper: 2005 papers (all document types) cited 2005-2008
Numbers and ratios
Ranked by citations per publication

	Publications (2005)	Citations (2005-2008)	Citations / publication
CEH	**11**	**312**	**28.36**
Rothamsted	16	451	28.19
Cambridge	712	11,467	16.11
Edinburgh	243	3650	15.02
Manchester	512	5,978	11.68
Bangor	22	254	11.55
UCL	411	4,733	11.52
King's London	109	916	8.40
Aberdeen	87	709	8.15
Strathclyde	149	1,107	7.43
Swansea	51	375	7.35
Total / mean	**2,323**	**29,952**	***12.89***

Table 2b: Hirsh index scores and RAE_{2001} outcomes: all document types, 2005-2008
Hirsch indexes, RAE 2001 grades and research active staff FTEs
Ranked by Hirsch index

	Hirsch index	2001 RAE†
Cambridge	**58**	**5* A (68.0)**
UCL	40	5* B (31.8)
Manchester	38	5 B (32.2)
Edinburgh	36	5 A (43.0)
King's London	20	4 B (22.0)
Aberdeen	19	3a C (13.2)
Strathclyde	19	4 A (43.0)
CEH	13	n/a
Rothamsted	13	n/a
Swansea	11	4 A (12.0)
Bangor	9	3a A (12.3)

†Unit of Assessment 18: Chemistry

Table 3b: Citation impact in 2007: virtual impact factors
Numbers, virtual impact factors and relative world impact
Ranked by virtual impact factor

	Papers (2005-2006)	Citations (2007)	Virtual IF	Global impact
CEH	**18**	**181**	**10.06**	**359**
Aberdeen	164	1,248	7.61	272
Rothamsted	32	219	6.84	244
Cambridge	1,239	7,060	5.70	204
Edinburgh	429	2,276	5.31	190
UCL	722	3,462	4.80	171
Manchester	946	3,911	4.13	148
King's London	181	665	3.67	131
Strathclyde	272	825	3.03	108
Bangor	49	131	2.67	95
Swansea	101	228	2.26	81
World	**304,685**	**853,971***	**2.80***	**100**

†Citations received in 2007 to 2005 and 2006 articles, notes and reviews.
*Estimated.

Table 4b: Patents awarded, 2005-2008
Numbers of patents†

	Patents
Manchester	**110**
Strathclyde	98
Cambridge	62
King's London	24
Edinburgh	22
UCL	17
Bangor	14
Swansea	6
Aberdeen	4
Rothamsted Research	1
CEH	0

†Scope: European Patent Office, UK Patent Office, US Patent Office and World Intellectual Property Organisation (WIPO).

Earth, planetary and environmental sciences

Table 1c: Citations per paper: 2005 papers (all document types) cited 2005-2008
Numbers and ratios
Ranked by citations per publication

	Publications (2005)	Citations (2005-2008)	Citations / publication
Edinburgh	**406**	**7,134**	**17.57**
Strathclyde	56	963	17.20
Rothamsted	55	884	16.07
Cambridge	770	10,811	14.04
UCL	570	6,819	11.96
Bangor	98	916	9.35
CEH	318	2,953	9.29
Manchester	563	5,206	9.25
Aberdeen	202	1,724	8.53
Swansea	63	524	8.32
King's London	77	556	7.22
Total / mean	**3,020**	**37,188**	***12.31***

Table 2c: Hirsh index scores and RAE_{2001} outcomes: all document types, 2005-2008
Hirsch indexes, RAE 2001 grades and research active staff FTEs
Ranked by Hirsch index

	Hirsch index	2001 RAE
Cambridge	**56**	**5* A (56.7) †**
UCL	45	5 B (33.3) †
Edinburgh	43	5 A (52.7) †
Manchester	37	5 B (26.6) †
CEH	28	n/a
Aberdeen	24	4 C (14.2) †
King's London	18	n/a
Rothamsted	18	n/a
Swansea	17	n/a
Strathclyde	16	n/a
Bangor	15	4 A (34.0)*

†Unit of Assessment 20: Earth sciences
*Unit of Assessment 21: Environmental sciences

Table 3c: Citation impact in 2007: virtual impact factors
Numbers, virtual impact factors and relative world impact
Ranked by virtual impact factor

	Papers (2005-2006)	Citations (2007)	Virtual IF	Global impact
King's London	**146**	**1,045**	**7.16**	**363**
Edinburgh	767	4,370	5.70	289
Cambridge	1,477	7,957	5.39	274
Manchester	703	3,407	4.85	246
UCL	1,063	4,710	4.43	225
Rothamsted	107	460	4.30	218
CEH	415	1,489	3.59	182
Aberdeen	401	1,320	3.29	167
Strathclyde	116	366	3.16	160
Swansea	134	414	3.09	157
Bangor	187	506	2.71	138
World	**228,628**	**450,923***	**1.97***	**100**

†Citations received in 2007 to 2005 and 2006 articles, notes and reviews.
*Estimated.

Table 4c: Patents awarded, 2005-2008
Numbers of patents†

	Patents
Cambridge	**8**
Manchester	7
CEH	4
Strathclyde	4
King's London	3
UCL	2
Aberdeen	2
Rothamsted	1
Bangor	0
Edinburgh	0
Swansea	0

†Scope: European Patent Office, UK Patent Office, US Patent Office and World Intellectual Property Organisation (WIPO).

Economics, econometrics and finance

Table 1d: Citations per paper: 2005 papers (all document types) cited 2005-2008
Numbers and ratios
Ranked by citations per publication

	Publications (2005)	Citations (2005-2008)	Citations / publication
Cambridge	**249**	**6,198**	**24.89**
Edinburgh	99	2,319	23.42
Bangor	8	174	21.75
Manchester	160	2,767	17.29
UCL	161	2,698	16.76
Aberdeen	44	422	9.59
King's London	41	286	6.98
Strathclyde	30	167	5.57
Swansea	15	81	5.40
CEH	n/a	n/a	n/a
Rothamsted	n/a	n/a	n/a
Total / mean	**965**	**16,414**	***17.01***

Table 2d: Hirsh index scores and RAE_{2001} outcomes: all document types, 2005-2008
Hirsch indexes, RAE 2001 grades and research active staff FTEs
Ranked by Hirsch index

	Hirsch index	2001 RAE†
Cambridge	**49**	**5 B (44.9)**
UCL	39	5* A (30.5)
Edinburgh	32	4 B (13.0)
Manchester	28	4 B (34.0)
Aberdeen	18	3a A (16.0)
King's London	17	n/a
Strathclyde	11	4 C (18.0)
Bangor	6	n/a
Swansea	6	4 A (16.0)
CEH	n/a	n/a
Rothamsted	n/a	n/a

†Unit of Assessment 38: Economics and econometrics

Table 3d: Citation impact in 2007: virtual impact factors
Numbers, virtual impact factors and relative world impact
Ranked by virtual impact factor

	Papers (2005-2006)	Citations (2007)	Virtual IF	Global impact
Edinburgh	**145**	**1,217**	**8.39**	**831**
Cambridge	434	3,571	8.23	815
UCL	300	2,161	7.20	713
Manchester	279	1,676	6.01	595
Bangor	16	83	5.19	514
Aberdeen	94	398	4.23	419
King's London	69	290	4.20	416
Strathclyde	56	168	3.00	297
Swansea	34	51	1.50	149
CEH	n/a	n/a	n/a	n/a
Rothamsted	n/a	n/a	n/a	n/a
World	**33,556**	**33,626***	**1.01***	**100**

†Citations received in 2007 to 2005 and 2006 articles, notes and reviews.
*Estimated.

Table 4d: Patents awarded, 2005-2008
Numbers of patents†

	Patents
Cambridge	**2**
Strathclyde	2
Aberdeen	1
Bangor	0
Edinburgh	0
King's London	0
Manchester	0
Swansea	0
UCL	0
CEH	n/a
Rothamsted	n/a

†Scope: European Patent Office, UK Patent Office, US Patent Office and World Intellectual Property Organisation (WIPO).

Physics and astronomy

Table 1e: Citations per paper: 2005 papers (all document types) cited 2005-2008
Numbers and ratios
Ranked by citations per publication

	Publications (2005)	Citations (2005-2008)	Citations / publication
Manchester	**512**	**5,978**	**11.68**
Edinburgh	392	4,146	10.58
UCL	562	5,236	9.32
Bangor	37	307	8.30
Cambridge	1,439	11,453	7.96
King's London	156	1,006	6.45
Swansea	90	556	6.18
Aberdeen	138	692	5.01
Strathclyde	267	841	3.15
CEH	n/a	n/a	n/a
Rothamsted	n/a	n/a	n/a
Total / mean	**3,593**	**30,215**	***8.41***

Table 23: Hirsh index scores and RAE_{2001} outcomes: all document types, 2005-2008
Hirsch indexes, RAE 2001 grades and research active staff FTEs
Ranked by Hirsch index

	Hirsch index	2001 RAE†
Cambridge	**60**	**5* A (138.9)**
UCL	42	5 B (84.4)
Manchester	34	5 A (59.0)
Edinburgh	35	5 B (64.8)
King's London	22	4 B (16.5)
Aberdeen	18	n/a
Strathclyde	16	4 A (45.7)
Swansea	14	5 A (11.6)
Bangor	9	n/a
CEH	n/a	n/a
Rothamsted	n/a	n/a

†Unit of Assessment 19: Physics

Table 3e: Citation impact in 2007: virtual impact factors
Numbers, virtual impact factors and relative world impact
Ranked by virtual impact factor

	Papers (2005-2006)	Citations (2007)	Virtual IF	Global impact
CEH	**18**	**184**	**10.22**	**396**
Rothamsted	21	182	8.67	336
Manchester	946	3,911	4.13	160
UCL	980	3,331	3.40	132
Edinburgh	656	2,196	3.35	130
Cambridge	2,320	7,300	3.15	122
Aberdeen	965	2,798	2.90	112
King's London	278	794	2.86	111
Bangor	60	155	2.58	100
Swansea	149	249	1.67	65
Strathclyde	400	598	1.50	58
World	**269,095**	**693,206***	**2.58***	**100**

†Citations received in 2007 to 2005 and 2006 articles, notes and reviews.
*Estimated.

Table 4e: Patents awarded, 2005-2008
Numbers of patents†

	Patents
Strathclyde	**55**
Manchester	45
Cambridge	41
UCL	7
Edinburgh	6
King's London	4
Aberdeen	3
Bangor	2
CEH	0
Rothamsted	0
Swansea	0

†Scope: European Patent Office, UK Patent Office, US Patent Office and World Intellectual Property Organisation (WIPO).

Ranking universities

Table 5a offers a summary of the previous Tables for the biological sciences, with the data replaced by ranks.

Table 5a: Summary of bibliometric rankings in biological sciences, 2005-2008
Rankings

	Cites / paper	Hirsch index	Virtual impact	Patents
Aberdeen	10	5	9	8
Bangor	11	10	11	9
Cambridge	7	3	2	2
CEH	5	7	1	10
Edinburgh	2	2	4	4
King's London	9	8	6	5
Manchester	1	4	5	3
Rothamsted	4	6	7	6
Strathclyde	6	11	8	7
Swansea	8	9	10	11
UCL	3	1	3	1

In Table 5b, we can see more clearly that there is little consistency in the ranking obtained for a given university on the four measures reported. In the worst case, the Centre for Hydrology & Ecology shifts by nine ranks (final column).

Table 5b : Summary of bibliometric rankings in biological sciences, 2005-2008
Mean rankings and range

	Mean ranking	Range
UCL	2.0	2
Edinburgh	3.0	2
Manchester	3.3	4
Cambridge	3.5	5
CEH	5.8	9
Rothamsted	5.8	3
King's London	7.0	4
Aberdeen	8.0	5
Strathclyde	8.0	5
Swansea	9.5	3
Bangor	10.3	3

Methodological notes

The data in this paper were collected online over the period 13-15 September 2008 using the subject codes indicated in Table 5.

Table 5: Scopus subject codes

	SCOPUS search codes
Agriculture and biological sciences	AGRI
Chemistry and chemical engineering	CHEM *OR* CENG
Earth, planetary and environmental sciences	EART *OR* ENVI
Economics, econometrics and finance	ECON
Physics and astronomy	PHYS

As previously mentioned, Scopus has developed a fairly sophisticated algorithm for resolving author addresses to a smaller number of institutional codes. Those used in this analysis are shown in Table 6.

The algorithm is by no means perfect and there is a further challenge, especially in the case of large universities like Cambridge, as to which codes to include or exclude.

Table 6: Scopus affiliations and codes

	SCOPUS affiliations and codes
Aberdeen	"University of Aberdeen" 60015875 "University of Aberdeen School of Medicine" 60011032
Bangor	"University of Wales Bangor" 60025779
Cambridge	"University of Cambridge" 60031101 "Bullard Laboratories" 60008160 "Girton College" 60023413 "Homerton College" 60014514 "University of Cambridge Institute of Public Health" 60009587 "University of Cambridge Interdisciplinary Research Centre in Superconductivity" 60025925 "University Museum of Zoology Cambridge" 60032641 "University of Cambridge School of Clinical Medicine" 60025649
CEH	"Centre for Ecology & Hydrology" 60004708
Edinburgh	"University of Edinburgh" 60027272 "University of Edinburgh College of Medicine & Veterinary Sciences" 60010973
King's London	"King's College London" 60028215 "King's College London Institute of Psychology" 60011520 "King's College London School of Medicine & Dentistry" 60008115
Manchester	"Manchester Business School" 60026051 "Turner Dental School" 60025230 "University of Manchester" 60003771

	"University of Manchester School of Medicine" 60016726
Rothamsted	"Rothamsted Research" 6000279
Strathclyde	"University of Strathclyde" 60024724
Swansea	"Swansea University" 60004572
UCL	"Glynn Laboratory of Bioenergetics in the Department of Biology at UCL" 60019568 "Great Ormand Street Hospital for Children NHS Trust and UCL Institute of Child Health" 60018207 "UCL" 60022148 "UCL Ear Institute" 60011326 "UCL Eastman Dental Institute" 60013985 "UCL Institute of Child Health" 60012662

Limitations

Two limitations should be borne in mind when examining the data in this report.

The first regards institutional-level analysis. Many research papers are collaborations between more than one university or laboratory but this is not reflected here: a integer count is used, either an institution's name appears in the list of corporate sources or it doesn't. It is not possible, using Scopus, to easily identify which authors belong to which institution, and so there will be cases here where Aberdeen, for instance, is attributed a full paper in which it may have played only a small part.

The second limitation is that it is very difficult to establish a definitive list of research-active staff by subject area for each institution (as we found during the earlier background information collection exercise for each case study). This is exacerbated by the new focus of this study: where we define papers by their subject content rather than by their departmental affliation. For these reasons, analysis at the researcher level, perhaps showing trends in numbers of papers per author, are not practicable within the limited scope of this exercise.

However, the purpose of this exercise is not a detailed bibliometric evaluation of the case study institutions. It is to present data that will later be juxtaposed against user behaviour profiles, so we perhaps do not need to worry unduly about the wrinkles.

History is outside the scope of Scopus indexing.