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Predicting results of the Research Excellence Framework using departmental h-Index

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Received: 7 November 2014 / Accepted: date

Abstract We compare estimates for past institutional research performances coming from two bibliometric indicators to the results of the UK's Research Assessment Exercise which last took place in 2008. We demonstrate that a version of the departmental h-index is better correlated with the actual results of that peerreview exercise than a competing metric known as the normalised citation-based indicator. We then determine the corresponding h-indices for 2008–2013, the period examined in the UK's Research Excellence Framework (REF) 2014. We place herewith the resulting predictions on the arXiv in advance of the REF results being published (December 2014). These may be considered as unbiased predictions of relative performances in that exercise. We will revisit this paper after the REF results are available and comment on the reliability or otherwise of these bibliometrics as compared with peer review.

Keywords peer review \cdot Hirsch index \cdot normalised citation-based indicator \cdot Research Assessment Exercise (RAE) \cdot Research Excellence Framework (REF)

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Introduction and motivation

The Research Excellence Framework (REF) is a peer-review based exercise in which the quality of research emanating from universities and higher education institutes (HEI) in the UK is estimated. Such exercises take place every four to seven years. and are the bases on which governmental funding is directly allocated. They are also the primary source for research rankings and therefore contribute to the reputations of universities, departments and research institutes. In fact, such exercises are by far the most important funding- and reputation-related events for UK-based research groups and their managers in the academic calender.

The REF is, however, an expensive, time-consuming and disruptive exercise, as was its previous incarnation, the *Research Assessment Exercise* (RAE). For this reason, suggestions have been made to replace such peer-review systems by one based on scientometrics, or at least to include bibliometric based measures in the exercise. Such proposals have met with stout resistance from the academic community, so far with considerable success.

The results of the next evaluation exercise are due to be announced on 18 December 2014. Here, after comparing bibliometric-based measures with previous RAE outcomes, we use the best of these to predict some of the outcomes of REF.

In particular, we examine bibliometric indicators on an institutional basis for four subject areas: biology, chemistry, physics and sociology. We show that a certain version of the Hirsch index [1], known as the departmental h-index [2] has a better correlation with the results of RAE, compared with another citation-based indicator [3] for which a sophisticated normalization procedure was implemented. We then determine departmental h-indices for different HEI's based upon their outputs in these subject areas in the run up to REF 2014. We use this to rank universities in these subject areas. Since we generate our h-rankings before the 18 December 2014, they may be considered an unbiased prediction of the outcome of REF 2014. Our aim is to determine whether or not the h-index (at least in the form used here) could have been employed as a reasonable proxy for the REF.

The preprint of paper will appear in two versions. With the first version, we placed our predictions on the arXiv in **November 2014**, well after the peer reviews for REF have taken place but before the results are announced. After 18 December 2014 we will revisit the paper and comment on the accuracy or otherwise of the *h*-prediction.

1 Peer review versus scientometrics

Correlations between RAE scores and different citation based metrics were studied by many different authors and comentators, including in refs. [2,4,5,6,7]. While some claimed good correlations between the resultant rankings, others point to the futility of attempts to substitute peer review by any system based on citation counting, due to identified weaknesses of citation analysis. Recently, we also studied the correlation between the results of the most recent assessment procedure – RAE 2008 – and the so-called *normalized citation impact* (NCI) [8,9]. The latter is a measure provided by *Thomson Reuters Research Analytics* (previously known as *Evidence* [3]). We found that, for a number of disciplines, citation-based measures may inform, or serve as a proxy for, peer-review measures of the *total*

strengths of research groups. This means that the RAE 2008 scores scaled up to the actual size of a department correlate with the product of the NCI with the number of staff submitted to the exercise. The correlation is stronger in the hard sciences. However, if research quality is defined as strength per head, we also found that rankings based on the calculated citation impact differ significantly from the corresponding rankings based on the reported RAE 2008 scores. In other words, while the NCI might be a reasonable indicator of departmental strength, it is not a reliable measure of relative quality (which is strength per head).

Recently, however, Bishop reported interesting results claiming relatively good correlations between the RAE 2008 quality scores for psychology and the corresponding departmental Hirsch indices based on Web of Science data for the assessment period [2]. Therefore, the question of the potential suitability of citationbased metrics as a proxy for expert judgements of quality remains open. Here we expand upon the analysis of Ref. [2] for several other disciplines. We show that the departmental h-index is indeed superior to the NCI in that it is better correlated with the results of peer review, at least for RAE 2008. Having established the superiority of the h-index in this regard, we use it to predict quality rankings for the results of REF 2014. In doing so, we directly tackle two questions raised in Ref. [2]: how well the h-indices of university departments correlate with RAE outcomes for other subjects and whether it can predict results from submissions of research groups to the REF. We intend to revisit our predictions after the results of the REF become known to decide whether or not departmental h-indices can reasonably be used as part of, or as guidance for, the REF or as an inter-REF navigator.

2 The RAE, the REF and citation metrics

Since 1986, the distribution of funds for research in the United Kingdom is heavily based on the results of peer-review based assessment procedures – first the RAE and more recently the REF. The results of the last RAE were published in 2008 [10] and those of the REF will be announced in December 2014 [11]. At RAE 2008, academic disciplines were divided into 67 categories called units of assessment (UoA). Higher education institutes were invited to submit researchers to any of these categories for examination by expert panels. For REF 2014 only 37 UoA's are used. In each assessment however, biology, chemistry, physics and sociology were included in the list of UoA's, so it is reasonable to examine these in both exercises.

For the RAE, as for the REF, the most important consideration is the quality of selected research outputs (usually in the form of published academic papers). RAE and REF submissions can involve research groups or centres, which are not always identical with university departments and not all members of a group have to be submitted. Moreover, while individuals submitted to RAE/REF have to be university employees on a given census date, their submitted papers may have been published while at a previous institution, so long as the dates of publication fall inside the given RAE/REF window. Four outputs per submitted individual were subject for evaluation, with allowances made for part-time staff and staff with career breaks. The RAE and REF have extensive guidelines on how to deal with matters such as collaborative research. Publications resulting from collaborations

between universities could usually be submitted by each institution. The rules for publications involving different authors within a university depended upon whether co-authors belong to the same, or different, departments and varied considerably across disciplines (see also [9]).

In addition to the quality of research outputs, the RAE sought to measure aspects of the environment and esteem associated with submitting departments and institutes. The REF is also interested in research environments but the esteem element has been replaced by measures of impact outside academia (e.g., onto industry or the public at large). For RAE 2008 and for REF 2014, the outcome of the process was a graded profile for each submitted department or research group. These quantify the proportion of work which falls into each of five quality bands [10]. The highest is denoted 4* and represents world-leading research. The remaining bands are graded through 3*, 2* and 1* with the lowest quality level termed "Unclassified" [12]. Governmental quality-related funding is then determined by combining the profiles in a weighted manner [8].

To determine the funding allocated to each university for their various submissions, a formula is used to convert the weighted profile into a single number s, which may be considered as representing a measure of overall quality of the group. If the size of a research group, measured by the number of submitted staff, is denoted by N, its overall strength is then S=sN and the amount of quality-related funding allocated to each group is proportional to this number. The quality formula was subject to regional and temporal variation post RAE 2008. However, immediately after the RAE 2008 results were announced, the funding formula used by the Higher Education Funding Council for England (HEFCE) was [13]

$$s = p_{4*} + \frac{3}{7}p_{3*} + \frac{1}{7}p_{2*}, \tag{1}$$

where p_{n*} represents the percentage of a group's research which was rated n*. Political pressure and lobbying resulted in a change to Eq.(1) in an attempt to concentrate funding in the best performing universities. This resulted in usage of the alternative formula

$$s' = p_{4*} + \frac{1}{3}p_{3*}. (2)$$

Here, as in ref. [8], we consider s, as defined in Eq.(1), as a good representation of the peer-review measure of the quality of a research group. This is also the measure considered by Bishop in Ref. [2]. However, in order to test the importance of the different weighting procedures, we also consider s' in what follows. (However, since s' came about after political lobbying, and since it values 2^* research as equal to unclassified research, we view s' as a less fair and less useful measure than the original quantity s – see also Ref. [14].)

We wish to compare s and s' to two citation-based metrics h and i which we explain below. Since h and i are based entirely on the citations and, therefore, on research outputs (normally publications), they do not contain a direct measure of estimates of environment esteem or non-academic impact unlike s and s'. For this reason we also use s_{output} which is determined using equation (1) but taking into account only the output sub-profile (i.e., discarding the environment and esteem elements).

The normalized citation impact (NCI), denoted by i here, is a citation-based indicator developed by Thomson Reuters Research Analytics as a measure of departmental academic impact in a given discipline. In refs. [8,9] i was compared

to the results of expert assessments. NCI values were determined for various universities using Web of Knowledge citation data [15,16]. To compare sensibly with the UK's peer-review mechanism, only the four papers per individual which were submitted to RAE 2008 were taken into account in order to determine the average NCI for various research groups [16]. An advantage of the NCI is in the non-trivial normalization (so-called "rebasing") which takes into account the different citation patterns between different academic disciplines [16]. The NCI is a relative measure (see, e.g., [17]), since it is calculated by comparing to a mean or expected citation rate. It is also a specific measure of academic citation impact because it is averaged over the entire research group.

Here, as in [2], a departmental h-index of n means that n papers, authored by staff from a given department, and in a given subject area, were cited n times or more in a given time period. Therefore all researchers (not only those submitted to RAE or REF) publishing in a given subject area can, in principle, contribute to the departmental h-index. Moreover, so long as a paper is published inside the RAE/REF window, the author address at the time of publication – not at the REF census dated – determines which to HEI a given output is allocated for the purpose of determination of the departmental h-index. We calculate departmental Hirsch indices h for groups which submitted to RAE 2008 within the selected disciplines of biology, chemistry, physics and sociology. The citation data is taken from the Scopus database [18]. In order to roughly calculate h the following steps were performed to filter the documents: (i) only publications which correspond to United Kingdom were considered; (ii) to compare with RAE 2008, the publication period was limited to 2001–2007; (iii) the following subject areas were chosen using Scopus subject categories which are closest to the RAE 2008's definition of the corresponding UoAs. For the biological sciences, we combine the Scopus subject categories 'Biochemistry, Genetics and Molecular Biology', 'Agricultural and Biological Sciences' and 'Immunology and Microbiology'. The categories 'Chemistry' and 'Chemical Engineering' are deemed to correspond to the RAE/REF chemistry UoA. Similarly 'Physics and Astronomy' corresponds to the physics UoA and 'Social Sciences' to the sociology UoA. (iv) only publications, affiliated to a particular HEI were taken into account. Regarding the last step, some HEI's submitted to a particular unit of assessment of RAE 2008 are sometimes absent in the Scopus 'Affiliation' list. For these the values of h-indices can not be determined and, therefore, the numbers of HEI's in section 3 (Table 1 and Figs. 1–3) are slightly different from numbers of HEI's in section 4 (Tables 2–5). To give an example, at the moment of data collecting the Scopus citation data for Open University was available only for papers published between 2001 and 2007, and unavailable for papers published between 2008 and 2013. Therefore, the Open University is included into the figures as well as into Table 1, but excluded from the list in the

The RAE 2008 covered research generated in the time-window 2001 and 2007. We define h_{2008} to be the value of the h-index measured at beginning of 2008. We call this the *immediate h-index* since it is calculated immediately after the RAE submission deadline and only takes into account publications within the previous seven years. The relevance of the publication window and its effect on the h-index was discussed in Ref. [19]. Here we compare the metric to i, s, s' and s_{output} . If the h-index were to be a useful proxy for, or guide to, peer review, one would require the immediate h-index to deliver useful information. However, we also consider

 h_{2009} (based on the citations made to the end of 2008), h_{2010} and so on in order to determine the effects of time lags.

3 Correlations between scientometrics and results of RAE 2008

We therefore have at our disposal five measures: $s, s', s_{\text{output}}, i$ and $h_{20\text{xx}}$, where 20xx refers to the years 2008-2014. The first set of three scientometrics are based on peer review, accepted as the "gold standard" in the research community. They apply to the research submitted to RAE or REF. The second set, containing the last two measures, are citation-based bibliometrics. They apply to research emanating from HEI's in certain Scopus-defined subject categories. Although the research outputs are not necessarily identical with the those submitted to RAE/REF, one may reasonably expect some overlap. Our objective is to compare between and within the two sets.

The results are summarised in Table 1 where Pearson's correlation coefficients and Spearman's rank correlation coefficients for various combinations are listed. The first observation is that, although even the highest value in the table does not exceed 0.8, i is consistently less well correlated with the various peer-review-based scores than is the Hirsch index. Since the normalization encoded in i is expected to reduce the imperfections of citation counting, its poor performance is perhaps unexpected. This surprise is compounded by the fact that i determined by taking into account the actual papers which were submitted to RAE 2008, while the filtering of publications used to calculate h_{2008} less resembles the RAE. The second observation is the relatively good correlations achieved by the departmental h-index. This is also surprising because the Hirsch index, unlike quality measures s, s' and s_{output} , is a priori not expected to be intensive or specific.

Visual representations of the correlations between the various s-type indices and h_{2008} are given in Fig. 1. We also observe that, while the relatively good correlations between the group h-index and the various peer-review metrics are quite similar to each other, the best match is between s and h_{2008} . Therefore, we agree with the remark by Bishop in Ref. [2] that "the resulting h-index predicted the RAE results remarkably well".

A common objection to the usage of citation-based metrics is that, presumably unlike peer review, it takes a certain amount of time for citations to accumulate. Presumably also, the time lapse is discipline dependent. If this were to have a significant effect, one may expect increasing reliability of citation-based metrics

Table 1 The values of Pearson coefficients r and Spearman's rank correlation coefficients ρ , calculated for different disciplines for different pairs of measures. All values are statistically significant at the level $\alpha=0.05$. The numbers of HEI's for each discipline are given in parentheses.

	$s \text{ vs. } h_{2008}$		s' vs. h_{2008}		s_{output} vs. h_{2008}		s vs. i	
	r	ρ	r	ρ	r	ρ	r	ρ
Biology (39)	0.74	0.78	0.74	0.79	0.65	0.71	0.67	0.62
Chemistry (29)	0.80	0.83	0.79	0.83	0.74	0.71	0.58	0.59
Physics (34)	0.55	0.58	0.57	0.59	0.44	0.49	0.37	0.47
Sociology (38)	0.62	0.58	0.61	0.58	0.5 7	0.53	0.51	0.49

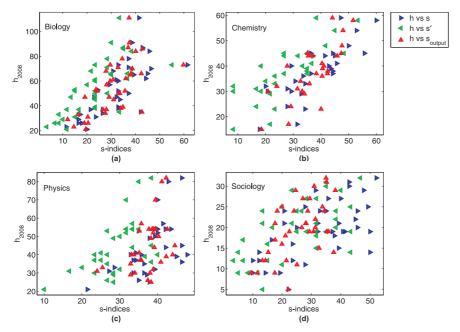


Fig. 1 Correlations between h_{2008} and the peer-review based measures s, s' s_{output} for research from different HEI's in (a) biology; (b) chemistry; (c) physics and (d) sociology.

with time elapsed since the publication window. (We are not referring about the effects of delayed recognition here since this is rather a different phenomenon.) To check this at the level of departments and research groups, we calculate h-indices based on different time lapses: h_{2008} , h_{2009} , h_{2010} , h_{2011} , h_{2012} , h_{2013} and h_{2014} . We then plot these in Fig. 2 to track the evolutions of departmental h-indices with time. While the values of the h-indices grow gradually and more or less linearly with time, the ranks of the various institutions do not change significantly.

The dynamics of the calculated values of Pearson and Spearman coefficients are shown in Fig. 3. One sees that the correlations between the h- and s-values do not become noticeably stronger with time. Moreover, the correlations between h and s are consistently better than those between i and s for all disciplines studied. This reinforces our earlier conclusion that RAE 2008 scores, as well as ratings built on this basis, are better correlated with departmental h-indices than with the normalized citations impact i. Moreover, and importantly, it is reasonable to use the immediate h-index, which can be calculated right away after the end of the fixed publication period — one does not have to wait years for citations to accumulate, at least when dealing with departments rather than individuals.

4 Predictions for REF 2014

We next use the procedure described above to estimate group h-indices corresponding to REF 2014. Since these are based on the REF 2014 publication period, namely from 2008 until the end of 2013, we employ the new notation \hat{h} to distin-

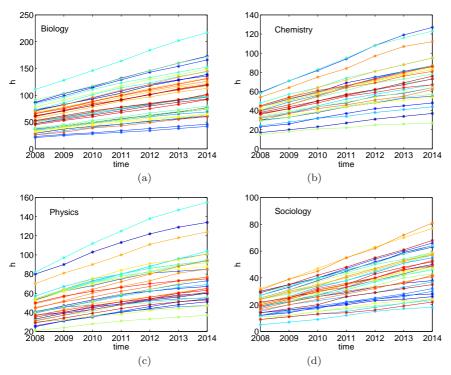


Fig. 2 The evolution of the group h-indices in time $(h_{2008}, h_{2009} \dots h_{2014})$ for (a) biology; (b) chemistry; (c) physics and (d) sociology. Different colours represent the data for different universities

guish the next results from the results for RAE 2008 data. We use the same list of higher education institutes as was used in RAE 2008, although that is sure to change to some degree for REF 2014. Using the departmental h-indices as proxies, we build ranked lists of universities for the four disciplines examined. These are listed in Tables 2, 3, 4 and 5. It is interesting to compare the forecasted ranks with the previous ones based on RAE 2008, but already a weak correlation between s and h-indices can cause the differences between two lists itself. Therefore, we compare rather the ranked lists of HEI's based on the h_{2008} and on the \hat{h}_{2014} – two indices, which were obtained by the same tools. The arrows in the third columns (\hat{h}_{2014}) indicate the group h-index predictions for the direction of movement of the various HEI's at REF 2014 relative to their ranked positions based on their h_{2008} values.

5 Conclusions

There are persistent suggestions, primarily by research managers and policy makers, to replace or inform national peer-review research evaluation exercises by a simple system based on bibliometrics or scientometrics. Such a set-up would have the advantage of being more cost effective and less invasive. However, to convince the academic research community of the reasonableness of such a system,

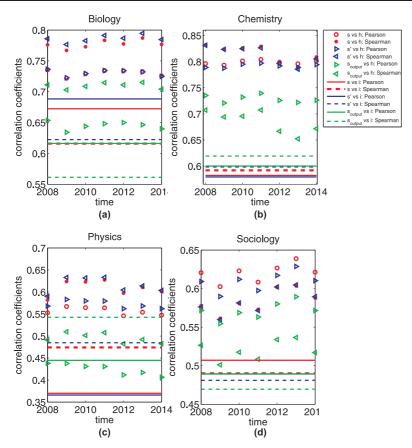


Fig. 3 Pearson and Spearman correlation coefficient values between s, s' and s_{output} vs h-indices calculated for different years for research groups from different HEI's: (a) biology, (b) chemistry, (c) physics and (d) sociology. The corresponding values for s, s' and s_{output} vs. i, as calculated for RAE 2008 data, are shown by lines.

it would need to have a proven high degree of accuracy relative to peer review because, besides its importance for funding purposes, such exercises – and the inevitable rankings that follow them – have predominant effects on institutional and departmental reputations. One objection, frequently made about citation-based measures, is that they require a significant period of time to allow citations to accrue and thus every national evaluation would necessarily be "historical".

Here we have studied the correlations between two departmental quality metrics and the scores from RAE 2008. Of the two, the h- index performs better in terms of its similarity to that peer-review exercise. At first sight, this is a surprising result because the h-index is not an extensive or specific index (see, e.g., [20]). Moreover and also contrary to expectation, it is not required to wait a long time to collect sufficient numbers of citations – the h-index calculated immediately after the specified publication period is as well correlated as that evaluated years later. On the other hand, at least a part of the data which contribute to the immediate

Table 2 The list of British HEI's in **Biology**, ranked by RAE 2008-scores s, h_{2008} and by \hat{h}_{2014} (the corresponding values of h-indices are shown in parentheses). Scopus data were not available for some HEI's due to technical reasons and these are omitted from the corresponding lists. The "up" and "down" arrows show the direction of shift within the 3rd column relative to the 2nd. The word 'University' is omitted in the 2nd and the 3rd columns to save space.

HEI, ranked by s	HEI, ranked by h_{2008}	HEI, ranked by h_{2014}
1. Institute of Cancer Research (ICR)	1. Cambridge (111)	1. Cambridge (143)
2. University of Manchester	2. Edinburgh (91)	2. KCL ↑ (120)
3. University of Dundee	3. ICL (87)	3. ICL London (109)
4. University of Sheffield	4. KCL (86)	4. Edinburgh \downarrow (107)
5. University of York	5. Dundee (84)	5. Manchester \uparrow (105)
6. Imperial College London (ICL)	6. Glasgow (78)	6. Leeds ↑ (92)
6. Kings College London (KCL)	7. ICR (73)	7. Newcastle, Faculty
8. Royal Holloway,	7. Birmingham (73)	of Medicine ↑ (89)
University of London	9. Cardiff (71)	8. ICR ↓ (88)
9. University of Cambridge	10. Manchester (70)	9. Dundee ↓ (83)
10. University of Leeds	11. Leicester (68)	10. Glasgow ↓ (82)
11. University of Edinburgh	12. Newcastle upon Tyne	11. Birmingham ↓ (80)
11. University of Newcastle	(66)	12. Cardiff \downarrow (79)
upon Tyne	12. Sheffield (66)	12. Sheffield (79)
13. Cardiff University	14. Leeds (65)	14. Leicester \downarrow (77)
13. University of Aberdeen	15. York (62)	14. Nottingham ↑ (77)
13. University of Glasgow	16. Southampton (61)	16. Southampton (72)
16. University of St. Andrews	17. Nottingham (60)	17. Liverpool ↑ (68)
17. University of Bath	18. Liverpool (57)	18. Aberdeen ↑ (66)
17. University of Birmingham	19. Sussex (53)	19. York \downarrow (64)
17. University of Durham	20. Bath (52)	20. East Anglia ↑ (60)
17. University of East Anglia	20. Reading (52)	21. Queens Belfast ↑ (59)
17. University of Exeter	22. Aberdeen (50)	21. Exeter \(\gamma\) (59)
17. University of Nottingham	22. East Anglia (50)	21. Warwick ↑ (59)
23. University of Southampton	24. Queens Belfast (47)	24. Queen Mary ↑ (57)
23. University of Warwick	24. Warwick (47)	25. St. Andrews \uparrow (56)
25. University of Leicester	26. St. Andrews (45)	26. Sussex \downarrow (53)
26. University of Liverpool	27. Durham (39)	27. Reading \downarrow (52)
27. Queen Mary, University of London	28. Exeter (38)	28. Bath \downarrow (50)
27. University of Essex	29. Bangor (37)	$29.\text{Durham} \downarrow (46)$
29. University of Reading	29. Queen Mary (37)	30. Bangor \downarrow (45)
29. University of Sussex	31. Royal Holloway (35)	31. Plymouth \uparrow (41)
31. University of Kent	32. Essex (34)	32. Swansea ↑ (38)
32. Queens University Belfast	33. Hull (33)	32. Essex (38)
33. Bangor University	34. Kent (31)	34. Royal Holloway ↓ (37)
34. University of Plymouth	35. Cranfield (29)	35. Hull \downarrow (36)
35. University of Hull	36. Swansea (26)	36. Cranfield \downarrow (34)
36. Cranfield University	36. Plymouth (26)	37. John Moores ↑ (32)
36. Swansea University	38. John Moores (23)	38. Kent \downarrow (31)
38. Liverpool John Moores University		

ate h-values has 7-years time spans, so many papers have past the peak of their citation record. This may account for the stability of the results.

Based on these empirical findings, we then use the departmental h-index to make predictions for the rankings of universities in four different subject areas for REF 2014. If the simple citation-based metric can, indeed, be used as some sort of proxy for the peer-review-based assessments, one would expect it to be able to predict the outcome, or some aspects of the outcomes, of REF 2014. Even a

Table 3 As in Table 2 but for Chemistry.

HEI, ranked by s	HEI, ranked by h_{2008}	HEI, ranked by h_{2014}
1. University of Cambridge	1. ICL (59)	1. ICL (84)
2. University of Nottingham	2. Cambridge (58)	1. Cambridge ↑ (84)
3. University of Oxford	3. Oxford (54)	3. Oxford (74)
4. University of Bristol	4. Bristol (48)	4. Manchester \uparrow (66)
5. Imperial College London	5. Manchester (45)	5. Liverpool \uparrow (57)
6. University of Leeds	5. Nottingham (45)	6. UCL ↑ (55)
7. University of Liverpool	5. Southampton (45)	7. Bristol \downarrow (52)
8. University of Manchester	8. Cardiff (44)	7. Leeds ↑ (52)
8. University of York	8. UCL (44)	9. Durham ↑ (51)
8. University of Warwick	8. Liverpool (44)	9. Nottingham ↓ (51)
11. University of Durham	11. Leeds (41)	9. Warwick ↑ (51)
12. University of Sheffield	12. Queens Belfast (40)	12. Southampton \downarrow (50)
13. University College London	12. Sheffield (40)	13. Cardiff ↓ (49)
14. Cardiff University	14. Durham (39)	14. Bath \uparrow (48)
15. University of Southampton	15. Warwick (38)	15. York ↑ (46)
15. University of Birmingham	16. Birmingham (37)	16. Birmingham (45)
17. University of Bath	16. York (37)	17. Sheffield \downarrow (44)
17. Heriot-Watt University	18. Sussex (36)	18. Queens Belfast ↓ (43)
19. University of Sussex	19. Hull (34)	19. Newcastle ↑
20. University of East Anglia	20. Bath (33)	20. Heriot-Watt ↑ (36)
21. Bangor University	21. Reading (32)	21. Reading (35)
22. University of Hull	22. Leicester (31)	22. East Anglia ↑ (34)
23. Queens University Belfast	22. Loughborough (30)	23. Loughborough \downarrow (33)
23. University of Newcastle	24. Newcastle (30)	24. Aberdeen ↑ (32)
upon Tyne	25. East Anglia (29)	25. Hull ↓ (29)
25. University of Leicester	26. Aberdeen (24)	26. Leicester \downarrow (26)
25. University of Aberdeen	27. Heriot-Watt (23)	27. Sussex \downarrow (25)
27. Loughborough University	28. Bangor (17)	28. Bangor (20)
28. University of Reading	29. Huddersfield (15)	28. Huddersfield \uparrow (20)
29. University of Huddersfield	` ′	

limited degree of success may suggest that this metric could serve at least as a "navigator" for research institutes in between the massive expert exercises.

Here we delivered h-index predictions in advance of the outcomes of REF 2014. We place the paper on the arXiv for the record and we will revisit it after the REF results are published to decide whether or not there is any hope that a useful metric of this type could be developed, even as a "navigator" for managers and policy makers.

Acknowledgements

This work was supported by the 7th FP, IRSES project No. 269139 "Dynamics and cooperative phenomena in complex physical and biological environments" and IRSES project No. 295302 "Statistical physics in diverse realizations".

References

 Hirsch J.E., An index to quantify an individual's scientific research output. P. Nat. Acad. Sci. USA, 2005, 102, No. 46, 16569–16572.

 ${\bf Table\ 4\ As\ in\ Table\ 2\ but\ for\ \bf Physics}$

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HEI, ranked by s	HEI, ranked by h_{2008}	HEI, ranked by h_{2014}
1. Lancaster University	1. Cambridge (82)	1. Cambridge (98)
2. University of Cambridge	2. ICL (80)	2. Oxford ↑ (95)
2. University of Nottingham	3. Oxford (70)	3. ICL ↓ (94)
2. University of St. Andrews	4. Birmingham (57)	4. Manchester ↑ (84)
5. University of Bath	5. UCL (54)	5. UCL (78)
6. University of Edinburgh	5. Bristol (54)	6. Durham ↓ (73)
7. Imperial College London (ICL)	5. Durham (54)	6. Edinburgh \downarrow (73)
8. University College London (UCL)	5. Edinburgh (54)	8. Glasgow \downarrow (70)
8. University of Durham	5. Glasgow (54)	9. Bristol ↓ (68)
8. University of Glasgow	5. Manchester (54)	9. Liverpool ↑ (68)
8. University of Sheffield	11. Queen Mary (53)	9. Southampton ↑ (68)
12. University of Birmingham	12. Liverpool (52)	12. Birmingham \downarrow (66)
13. University of Oxford	13. Sussex (50)	13. Queen Mary↓ (63)
13. University of Bristol	14. Southampton (49)	14. St. Andrews ↑ (61)
13. University of Liverpool	15. St. Andrews (45)	15. Warwick ↑ (57)
16. University of Manchester	16. Sheffield (44)	16. Cardiff ↑ (56)
16. University of Exeter	17. Lancaster (40)	16. Nottingham ↑ (56)
16. University of Sussex	17. Queens Belfast (40)	18. Sheffield \downarrow (55)
19. University of Southampton	17. Leeds (40)	19. Sussex \downarrow (54)
19. Heriot-Watt University	20. Bath (39)	20. Lancaster \downarrow (53)
21. University of York	21. KCL (37)	21. Leeds \downarrow (50)
22. University of Warwick	21. Surrey (37)	21. Leicester \uparrow (50)
22. University of Leicester	23. Nottingham (36)	23. Queens Belfast ↓ (48)
24. University of Leeds	24. Warwick (35)	24. Exeter ↑ (44)
25. Queen Mary, University of London	25. Cardiff (33)	24. Strathclyde \uparrow (44)
25. Loughborough University	26. Exeter (32)	26. Loughborough ↑ (36)
27. University of Surrey	27. Strathclyde (31)	26. Bath \downarrow (36)
28. Swansea University	28. Swansea (30)	28. KCL \downarrow (35)
28. Kings College London (KCL)	28. Leicester (30)	29. Heriot-Watt ↑ (34)
30. Queens University Belfast	30. York (29)	30. York (33)
31. Cardiff University	31. Loughborough (26)	31. Surrey \downarrow (32)
32. University of Strathclyde	32. Heriot-Watt (25)	32. Swansea ↓ (30)

- 2. Bishop D., Bishop Blog. http://deevybee.blogspot.co.at/2013/01/an-alternative-to-ref 2014.html Accessed 7 November 2014.
- 3. Research Analytics, http://www.evidence.co.uk. Accessed 31 October 2014.
- 4. MacRoberts M.H., MacRoberts B.R., Problems of citation analysis: a critical review. J. Am. Soc. Inform. Sci., 1989, **40(5)**, 342–349.
- 5. Oppenheim Ch., Do citations count? Citation indexing and the Research Assessment Exercise (RAE), Serials: The Journal for the Serials Community, 1996, 9, No. 2, 155–161.
- 6. Holmes A., Oppenheim C., Use of citation analysis to predict the outcome of the 2001 Research Assessment Exercise for unit of assessment (UoA) 61: library and information management. Inform. Res., 2001, 6(2). Retrieved from http://informationr.net/ir/6-2/paper103.html Accessed 31 October 2014.
- 7. Van Raan A.F.J., Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment for 147 chemistry research groups, Scientometrics, 2006, **67**, No. 3, 491–502.
- Mryglod O., Kenna R., Holovatch Yu., Berche B., Absolute and specific measures of research group excellence, Scientometrics, 2013, 95(1), 115–127. DOI 10.1007/s11192-012-0874-7.
- 9. Mryglod O., Kenna R., Holovatch Yu., Berche B., Comparison of a citation-based indicator and peer review for absolute and specific measures of research-group excellence, Scientometrics, 2013, **97**, 767–777. DOI 10.1007/s11192-013-1058-9.

Table 5 As in Table 2 but for Sociology.

HEI, ranked by s	HEI, ranked by h_{2008}	HEI, ranked by h_{2014}
1. University of Manchester	1. Manchester (32)	1. Oxford ↑ (41)
2. University of Essex	2. Oxford (31)	2. Cambridge ↑ (36)
2. Goldsmiths College,	3. Cardiff (30)	3. LSEPS ↑ (35)
University of London	4. Bristol (29)	3. Edinburgh \uparrow (35)
4. Lancaster University	4. York (29)	3. Manchester \downarrow (35)
5. University of York	6. LSEPS (27)	6. Nottingham ↑ (34)
6. University of Edinburgh	6. Cambridge (27)	7. Cardiff \downarrow (31)
6. University of Surrey	8. Lancaster (25)	7. Sussex \uparrow (31)
8. University of Warwick	8. Glasgow (25)	9. Lancaster \downarrow (30)
9. Cardiff University	10. Birmingham (24)	9. Birmingham \uparrow (30)
9. University of Oxford	10. Edinburgh (24)	9. Exeter \(\gamma(30)\)
11. University of Sussex	10. Newcastle (24)	12. Open Uni. ↑ (29)
12. University of Exeter	10. Nottingham (24)	12. York \downarrow (29)
13. University of Cambridge	14. Warwick (22)	14. Bristol \downarrow (28)
14. Open University	15. Brunel (21)	14. Glasgow \downarrow (28)
14. Queens University Belfast	15. Open Uni. (21)	16. Brunel \downarrow (27)
16. Loughborough University	15. Liverpool (21)	16. Newcastle ↓
17. University of Aberdeen	18. Leicester (20)	16. Warwick \downarrow (27)
18. London School of Economics	18. Surrey (20)	19. Loughborough \uparrow (26)
and Political Science (LSEPS)	20. CUL (19)	19. Aberdeen ↑ (26)
19. University of Newcastle	20. Aberdeen (19)	21. Leicester \downarrow (25)
upon Tyne	20. Essex (19)	21. Liverpool \downarrow (25)
20. University of Nottingham	20. Exeter (19)	23. Surrey \downarrow (24)
21. City University, London (CUL)	20. Sussex (19)	24. Essex \downarrow (23)
21. Brunel University	25. Loughborough (18)	24. Plymouth \uparrow (23)
23. University of Bristol	26. Strathclyde (17)	26. Strathclyde (21)
24. University of East London	27. Plymouth (16)	27. Queens Belfast ↑ (20)
24. University of Glasgow	28. Queens Belfast (15)	28. West of England,
26. University of Leicester	29. Goldsmiths College	Bristol \uparrow (19)
27. University of Plymouth	(14)	29. CUL ↓ (18)
27. Manchester Metropolitan	29. West of England,	30. Manchester
University	Bristol (14)	Metropolitan ↑ (17)
29. Roehampton University	31. Glasgow Caledonian	31. Glasgow Caledonian
30. University of Liverpool	(12)	(16)
30. University of Birmingham	31. Manchester	32. Goldsmiths College ↓
32. University of Teesside	Metropolitan (12)	32. Roehampton ↑ (14)
33. University of Strathclyde	31. Napier (12)	34. Huddersfield ↑ (13)
34. University of Huddersfield	34. East London (11)	35. Napier \((12)
35. University of the West of England,	35. Robert Gordon (9)	35. East London ↓ (12)
Bristol	35. Huddersfield (9)	35. Teesside (12)
35. Glasgow Caledonian University	35. Teesside (9)	38. Robert Gordon \downarrow (9)
37. Napier University	38. Roehampton (5)	
37. Robert Gordon University		

- 10. RAE 2008: Research Assessment Exercise,
 http://www.rae.ac.uk/ Accessed 31 October 2014.
- 11. REF 2014: Research Excellence Framework, http://www.ref.ac.uk/ Accessed 31 October 2014.
- 12. RAE 2008. The panel criteria and working methods. Panel E. (2006). http://www.rae.ac.uk/pubs/2006/01/docs/eall.pdf. Accessed 31 October 2014.
- 13. Higher Education Funding Council for England: http://www.hefce.ac.uk/ Accessed 31 October 2014.
- 14. Enderby J. Thick or thin? the funding dilemma. Editorial in the Journal of the Foundation for Science and Technology, 2011, 20, No. 6, 3–4.

15. The future of the UK university research base. Evidence (a Thomson Reuters business) report, July 2010.

- 16. Funding research excellence: research group size, critical mass & performance. A University Alliance report, July 2011.
- 17. Schubert A., Braun T., Cross-field normalization of scientometric indicators, Scientometrics, 1996, 36, No. 3, 311-324.
- Scopus, http://www.scopus.com/. Accessed 31 October 2014.
 Schreiber M., A variant of the h-index to measure recent performance, arXiv preprint arXiv:1409.3379 (2014).
- 20. Molinari J.-F., Molinari A., A new methodology for ranking scientific institutions, Scientometrics, 2008, 75, No. 1, 163–174.