

Funding selectivity, concentration and excellence - how good is the UK's research?

Jonathan Adams and Karen Gurney

Introduction

1. This report assesses the strength of the UK's research base, and at a high level examines how that strength is distributed between institutions. It concludes that a very small number of institutions and individuals within them produce the truly exceptional research that puts the UK among the world's leaders in research, and that below those peaks of excellence performance is more evenly spread between institutions. Whereas the present policy of selectively funding excellent research wherever it is found has had the effect of concentrating research funds in a relatively small number of institutions, there is no general case for explicitly funding research according to historical institutional characteristics.
2. Government policy for research over the last two decades, since the introduction in 1986 of the Research Selectivity Exercise (the predecessor to the Research Assessment Exercise - the RAE), has been perceived to have been strongly selective, consequently driving a concentration of greater amounts of research activity into a progressively smaller number of institutions.¹
3. It was therefore of some surprise when the outcomes of RAE2008 produced profiles that suggested that high quality research was in fact widely distributed across the UK Higher Education sector.² It appears that the policy of selective funding, while leading to a fair degree of concentration of research funds, had not led to quite the concentration of research excellence that might have been expected.
4. It was not so much surprise as concern that was expressed by those institutions which held substantial research portfolios and whose strategies had evolved in a policy environment that directed funds selectively and in

¹ This report looks only at selectivity and concentration in the provision of QR money through the Research Assessment Exercise. This is one leg of the 'dual support' system of core (Funding Council) and project (Research Council) funding; although Research Council funding is not analysed here, it can be noted that Research Council funds are similarly concentrated in their allocation. In this report, selectivity is taken to mean the differential funding of research according to its quality, without regard to the institution in which it takes place. Concentration is taken to mean the explicit focusing of research funding on specific institutions, generally with regard to the intensity of research activity in those institutions. Concentration of funds may be an indirect consequence of a selective allocation process if quality is already co-located.

² RAE (2008). RAE 2008: the outcome. December 2008. Ref RAE 01/2008
<http://www.rae.ac.uk/pubs/2008/01/>

concentrated packages.³ The Higher Education Funding Council for England (HEFCE) produced a funding settlement that aimed to protect these institutions while still rewarding newly recognised excellence.

5. An immediate shift in the distribution of funding at institutional level was apparent. An additional 25 universities and colleges were now in receipt of core research funding. In terms of mainstream QR cash, in 2008-09 about 90 per cent of it was shared by 38 universities but from 2009 some 48 institutions were sharing this slice.⁴ There are two main reasons for this shift. First, under the previous scoring arrangements pockets of mediocre research might have become subsumed in an otherwise excellent and high-scoring department whilst, conversely, pockets of outstanding research might not have been recognised in a low-scoring department. Second, the weighting factors used in the 2009 funding formula provided a greater reward for moving from the modest plains of 2* research quality to 3* quality than from 3* to the far more challenging peak of 4* world-leading excellence, whereas in the previous scoring arrangements the step from a 4 to a 5 rating or from a 5 to a 5* rating provided a far greater reward than the step from a 3a to a 4.⁵ Arguably this would not only affect the balance of selectivity but could also contribute to a change in concentration of funding. The weightings associated with the different RAE scores have now been changed (announced in December 2009 to apply to funding from 2010-11), and the new weightings provide for greater relative reward for high RAE scores.

6. Both HEPI and Evidence have argued against undue concentration of resources and in favour of institutional, regional and national diversity.⁶ Indeed concentration as a policy cannot be right, if it means funding less good research

³ Arthur M (2009). A personal view - We need to keep some selectivity in funding to ensure a critical mass of 'world-leading' research in our universities. Times Higher Education, 15 January 2009. Curtis P (2009). There may be trouble ahead. Interview with the head of the Russell Group of research-based universities. Guardian, 24 February 2009.

⁴ Corbyn Z (2009). Reversal of fortunes. Times Higher Education, 5 March 2009. <http://www.timeshighereducation.co.uk/story.asp?storycode=405690>

⁵ In RAE2008, 4* is the top category of research defined as "Quality that is world-leading in terms of originality, significance and rigour" By contrast 3* is "Quality that is internationally excellent in terms of originality, significance and rigour but which nonetheless falls short of the highest standards of excellence." The 2* grade is for "Quality that is recognised internationally in terms of originality, significance and rigour." In the funding settlement, the weightings announced by HEFCE in January 2009 were 2* = 1, 3* = 3 and 4* = 7. Thus there was a threefold gain in rising from 2* to 3* and becoming excellent but a gain of only 2.3 in rising further to be world-leading. In February 2010, HEFCE announced changes that re-balanced the relative gains at 0:1:3:9 so that there was a three-fold gain between both 2* and 3* and between 3* and 4*.

⁶ Evidence (2003). Funding research diversity: the impact of further concentration on university research performance and regional research capacity, pp. 36. Universities UK, London. ISBN 1 84036 102 6

that happens to be conducted in a research intensive university, at the expense of better research in a university that is not marked out generally as research intensive. On the other hand any unintended diminution of the present balance of concentration might be of concern if it impacted on the overall performance of the system: presently, we just do not know whether this is the case. The 2009 outcome marked a change more profound than many will realise. There has never been enough money for the 'endless frontier' of research, so selectivity in allocation – and the consequent concentration – has a long history. It is undoubtedly the case that both the new RAE methodology and the HEFCE funding logic denoted a shift in direction: selectivity was maintained but concentration was not to be protected.

7. The weightings associated with the different RAE scores have now been changed (announced in December 2009 to apply to funding from 2010-11), and the new weightings provide for greater relative reward for high RAE scores. The effects of these changes are demonstrated and discussed below. Briefly, they have the effect of significantly increasing the concentration of funding in favour of the "Golden Triangle"⁷ of the five top performing institutions at the expense of most of the rest of the sector.

8. Can it reasonably be argued that a change in resource distribution might affect the performance of the UK national research base? History provides some pointers. In 1986, selectivity in the distribution of HE research funds changed from an underlying principle to an overt methodology. Research was to be funded differentially, based on quality wherever it was located, but this selectivity was to be exercised at roughly the level of the discipline or department.⁸ There was no overt policy to concentrate research funding at institution level. However, because a relatively small number of universities contained a large number of units judged to do outstanding research, the policy of selectivity had as a consequence the concentration of research funds in these universities. Around the same period, the UK's comparative international research impact changed trajectory from a downward to an upward gradient, and then continued a sustained rise against growing competition.⁹ There is a plausible argument suggesting causation as well as correlation in this relationship, but whether it was the policy of selective funding that underpinned

⁷ Oxford, Cambridge, Imperial, the London School of Economics and University College London.

⁸ 'Roughly' because such divisions do not apply to interdisciplinary research. Department is a convenient shorthand for the roughly 60-70 groupings of assessment units to which submissions are made and in which assessments are carried out.

⁹ We present additional data on this improvement in this report, but we have discussed this pattern in several previous reports.

this improvement or the consequential concentration of research funding is not known. The latter seems unlikely, but cannot be discounted¹⁰.

9. A policy change today might, by extension of the argument, affect the ability of the present system to maintain that competitiveness. The management problem is that the system is complex and zero-sum funding pots create multiple interdependencies. Each correction produces new risks and challenges. Thus, an announcement in January 2010 that the funding formula used in England would indeed be adjusted to increase the degree of selectivity appeared to benefit the excellent, but at the expense of the good. The anticipated gains and losses were not described.

10. To understand better the system, and the effect of change, we need to establish where we currently stand, so that we can monitor change and so that any debate can be based on firm evidence. In this report, we start by recalling some way-markers in the history of UK research support and note the dynamic balance between the forces of selectivity and redistribution. We then explore two questions. One we can answer with numbers: how concentrated is the UK research base in terms of broadly-defined criteria for international excellence? The other is one on which we can only speculate: given the pattern on the ground, what consequences arise from changes in policy?

Origins of selectivity

11. In 1889, HM Treasury established an ad hoc Committee on Grants to distribute £15,000 it had set aside for eleven university colleges. At the end of 1916, the government created the Department for Scientific and Industrial Research (DSIR) to support civil science and to co-ordinate and commission its own research.¹¹ In this small 'dual support' system, the University Grants Committee (UGC) (created in 1919) block grant paid for salaries and preliminary investigations while the DSIR gave funds to university scientists to carry out specific research. Selectivity was unimportant. In 1917, for example, there were only 24 DSIR funded university postgraduate research studentships and this number had grown to no more than 81 by 1938.

12. After 1945, the UGC moved to the Board of Education with new terms of reference that required it to take a more active stance on university policy. The numbers of trained research professionals in universities doubled during the 1950s, science research spend in 1962 was at least tenfold that in 1945 and

¹⁰ It has been argued, for example, that there may be "trickle across" that is to say a virtuous circle induced by improved reputation, and – maybe – the benefits for interdisciplinary research of having excellence in several/many fields in one University.

¹¹ Varcoe, I (1974). Organizing for science in Britain. Oxford University Press, Oxford. ISBN 0 19 858319 2

real-terms expenditure on conventional science had at least doubled.¹² From this point the UGC seems always to have operated some level of selective funding, mediated partly through subject-based, expert sub-committees and partly through policy. For example, within the 1947-1967 quinquennial cycles, it responded to needs identified by Government (pace the origins of Foresight and its priorities) through earmarked grants amounting to about 30 per cent of total recurrent funds.¹³

13. Selectivity mechanisms developed through the 1960s. For example, there was the so-called take-over exercise: "the continued financing of research projects, hitherto funded by the Research Councils, which it was agreed should be continued as part of the normal activities of the universities."¹⁴ For take-overs, the UGC made earmarked increases to the block grants of selected institutions, identified as about £1.8M per year in a total grant for 1966-67 of about £134M.¹⁵ Success in attracting research grants was a factor in the UGC's methodology.¹⁶ Special factors seemed to include a scale effect ("an increasing payment per student in respect of non-teaching functions as universities get larger") and "an unusually high level of support for certain privileged areas".¹⁷

14. The UGC's quinquennial cycle ended in 1976-77. Despite cuts, the UGC selectively allocated £500k to enable 11 institutions to work in stated areas of high priority. The Annual Survey for 1979-80¹⁸ announced that "the current distribution of equipment grant (£72M for 1980/81 cf. recurrent grant of £987M) takes into account each university's past record of attracting outside research grants and thus provides a slightly better equipment base for those with a proven research capability".

¹² Wilkie, T (1991). *British science and politics since 1945*. Blackwell, Oxford.

¹³ Shattock, M (1994). *The UGC and the management of British universities*. Buckingham: Society for Research into Higher Education & Open University Press. Wilkie, T. (1991). *Op. cit*

¹⁴ UGC (1966). *University Grants Committee, Annual Survey for the academic year 1965-1966*. Cmnd 3192, HMSO.

¹⁵ UGC (1967). *University Grants Committee, Annual Survey for the academic year 1966-1967*. Cmnd 3120, HMSO.

¹⁶ UGC (1984). *A strategy for higher education into the 1990s; the University Grants Committee's advice*. HMSO.

¹⁷ Cook W R (1976). How the University Grants Committee determines allocations of recurrent grants - a curious correlation. *Journal of the Royal Statistical Society (A)*, 139, 374-384. Cook W R (1977). Curious correlations - a reply. *Journal of the Royal Statistical Society (A)*, 140, 511-513. Dainton F (1977). Comments on "How the UGC determines allocations of recurrent grants - a curious correlation". *Journal of the Royal Statistical Society (A)*, 140, 199.

¹⁸ UGC (1985). *A strategy for higher education into the 1990s; the University Grants Committee's advice*. HMSO.

15. Selectivity was endorsed by all sides of the research support system, including the UGC, the Advisory Board for the Research Councils (ABRC) and the Advisory Committee for Applied Research and Development (ACARD).

- The joint UGC/ABRC Merrison Committee concluded "that whatever research is done should be of high quality and properly supported" and "universities will need to concentrate research funds into selected areas".¹⁹
- The ABRC's Morris Report also supported selectivity. "Each university, through its research committee, will have to choose which of its staff to support and which not to".²⁰
- The Joint Report of the Chairmen of the ABRC and ACARD proposed that there should be national and overt policy of selectivity among research objectives.
- 'A Strategy for Higher Education into the 1990s' suggested (at par. 5.14) a "more selective allocation of research support among universities".²¹

16. In 1985, the UGC told universities that the distribution of research funds would take account of work of special strength and promise, so as to maintain quality. In 1986, it operated the first Research Selectivity Exercise, applying the ratings to the selective allocation of part of the research resource.

17. Selectivity was strategic as well as formulaic. In 1987, the ABRC's 'Strategy for the Science Base' (ABRC, 1987) recognised that "selectivity and more directive management ... can be seen as the inevitable response to the challenge of managing science within finite resources". It expressed support (par. 1.21) for the Oxburgh review on the Earth Sciences, which concluded that resources for that subject were over-dispersed. More radically, it suggested (par. 1.25) that the allocation of Research Council grants to scientists in below average departments was "not conducive to the concentration of effort that we believe generally to be in the national interest".²²

18. The ABRC concluded that policies then in place would not lead quickly enough to the degree of concentration required to maintain the international competitiveness of university research (then, among just 60 institutions, not the

¹⁹ ABRC/UGC (1982). Report of a joint working party on the support of University scientific research. Cmnd 8567, HMSO. (The Merrison Report).

²⁰ ABRC (1983). The support given by Research Councils for in-house and university research. (The Morris Report).

²¹ UGC (1985). Op.cit.

²² ABRC (1987). A strategy for the science base. A discussion document prepared for the Secretary of State for Education and Science by the Advisory Board for the Research Councils. HMSO, London. ISBN 0 11 270627 4

120-odd of 2010). The proposal that emerged was for an R-T-X (Research, Teaching and Hybrid) system of institutions differentiated according to the pervasiveness and breadth of their research strength, with just 15 institutions in the top R category of substantial international research across most fields. This was a new kind of selectivity, with the express purpose of concentrating funding to create centres of excellence.

19. UK research funding policy has thus regularly invoked: selective resource allocation among disciplines, particularly through pro-active initiatives; selective allocation among researchers, mainly through peer review; selective distribution among departments, by internal management and some external judgment; and selective distribution across institutions, sometimes via obscure committee decisions.

How can we measure the concentration of excellence?

20. So much for policy and history: how concentrated has the system become?

Bibliometrics as indicators of quality

21. To measure concentration, what can we use as a broadly-defined criterion for international excellence? We are interested in the quality of research activity. If it is high then we might reasonably expect output to lead to beneficial outcomes. But we cannot directly measure the quality of research activity. Although peer experts can usually establish fairly quickly whether a laboratory or group in their field is any good or not, that perception does not translate into an objective measure. So we have used as a proxy an indicator related to the value placed by other academics upon the direct, published outputs of research.

22. The citation counts in Thomson Reuters' databases provide us with our proxy for excellence.²³ They do not of course directly measure excellence, nor are they an infallible measure of excellence. And they are a much more powerful tool in the STEM subjects – where publication in influential journals is the most common means of scholarly communication – than in the humanities and (to a lesser extent) the social sciences. But in general citations are widely regarded as a reasonable approximation. If we take into account the year and field of publication for each UK-authored article, then we can compare observed citation counts with the global average, an 'expected' value for the discipline. The ratio

²³ Thomson Reuters holds a database of journal publications and citations initiated in the 1960s by Eugene Garfield. It has a well-developed data structure based around that part of the serial literature most widely used by researchers. It covers many fields in a similar way and enables some degree of comparability. It covers many countries. It is a successful commercial operation because it indexes that part of the literature which researchers most often wish to search, and will pay to do so.

of observed to 'expected' would be a measure of academic 'impact' and give some indication of how well the research is seen by the wider community.²⁴ By counting output volumes and comparing impact between institutions, we can determine how concentrated the excellence of the UK research base has become.

23. The arithmetical average of citation impact, referred to by some analysts as a 'crown indicator', is a weak indicator of the distribution of excellence.²⁵ Most research data are skewed: there are many low-index data points and a few very high-index outliers. This applies to funding (per person or per unit) and it applies to citations per paper.²⁶ These positively skewed distributions typically have a mean (average) that is much greater than their median (central point).²⁷ It is therefore useful to transform indicators to produce a more accessible presentation and analysis.²⁸

24. We have chosen to look at the distribution of more and less well cited - that is to say higher or lower impact, papers within institutions. We are interested in the spread of the output that is contributing to the highest levels of excellence, not the average. Graphical profiles make the naturally skewed distribution of citation data more accessible by sorting the data into 'bins' relative to the world average.²⁹

Compartmentalizing the higher education sector

25. We have made use of conventional groupings of institutions.

- The sector as a whole includes every institution funded for research in 2007-08 by one of the regional Higher Education Funding Councils (HEFCs).

²⁴ Garfield E (1955). Citation Indexes for Science: a new dimension in documentation through association of ideas. *Science*, 122, 108-111

²⁵ Lundberg J (2007). Lifting the crown: the citation z-score. *Journal of Informetrics*, 1, 145-154; Opthof T and Leydesdorff L (2010). Caveats for the journal and field normalizations in the CWTS ("Leiden") evaluations of research performance. *Journal of Informetrics* (in press).

²⁶ Seglen P O. (1992). The skewness of science. *Journal of the American Society for Information Science* 43(9): 628-638.

²⁷ For example, analyzing UK physics after ten year's citation accumulation, we find that most papers are cited less often than world average although the UK average is above the median and the world average.

²⁸ See Leydesdorff L and Bensman S (2006). Classification and Powerlaws: The Logarithmic Transformation. *Journal of the American Society of Information Scientists and Technologists*, 57, 1470-1486.

²⁹ Adams J, Gurney K and Marshall S (2007) Profiling citation impact: a new methodology, *Scientometrics*, 72, 325-344.

- Five internationally familiar members of the Russell Group are located in a well-established golden triangle around the SE quarter of England: University of Oxford, University of Cambridge, University College London, Imperial College London, and the London School of Economics.
- The Russell Group is an association of 20 research-intensive universities, mostly founded prior to 1960. The Group formed in 1994 at a meeting convened in the Russell Hotel.³⁰ We have analysed activity for both the Russell Group as a whole and a variant group without the five golden triangle HEIs which we refer to as “RG-5”.
- The 1994 Group is an association of 19 universities, some of which were parts of the University of London and others of which were part of the 1960s Robbins expansion.³¹
- Specialist Colleges are those institutions, generally in the creative arts but also in bio-medical and agro-veterinary sciences, which have a specific, disciplinary mission and portfolio.
- An ‘artificial group’ of Other HEIs, which is the UK higher education research base after the 1994 and Russell Groups have been taken out.

26. Note that our analyses are inclusive. That is to say, unless otherwise stated, the 1994 Group includes all activity linked to the group whether solely attributable to them or collaborative with others. RG-5 removes activity attributable solely to the golden triangle, but golden triangle papers co-authored with other Russell Group members are retained.

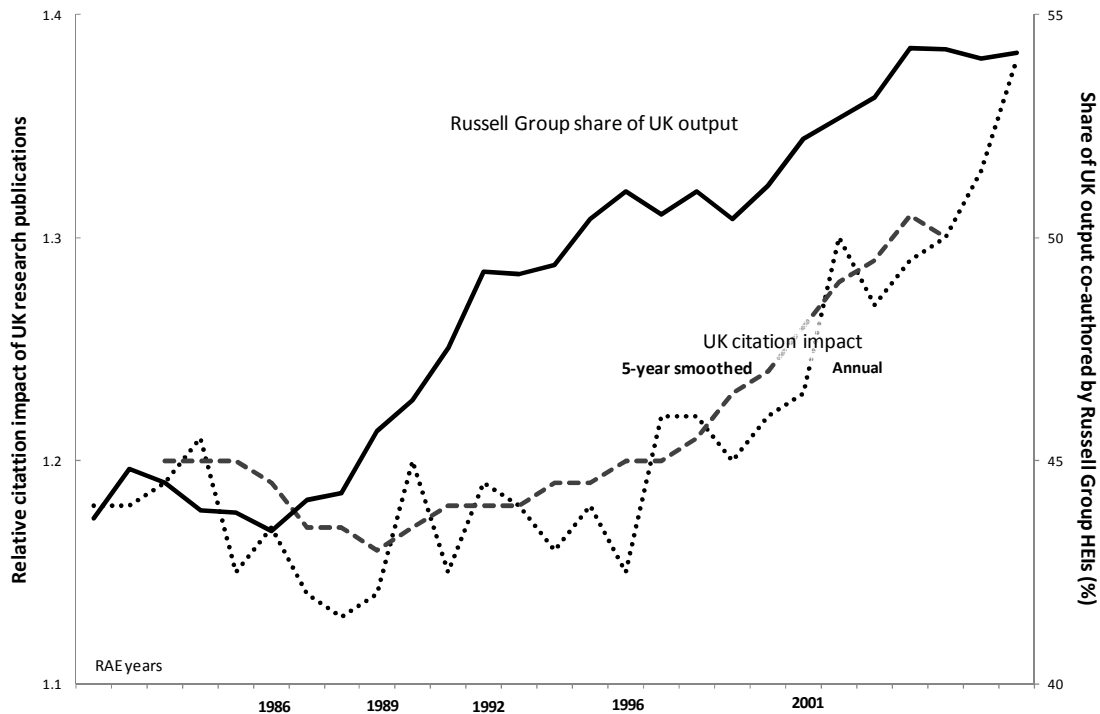
The competitiveness of the UK research base

27. Is there any evidence that 25 years of overt selectivity, and the consequent concentration of research funding, has had an effect on international competitiveness? We noted that there is bibliometric evidence of an improvement in the UK’s position over the period, which we can compare with the changing level of research concentration within the HE sector.

³⁰ For more about the Russell Group and its members see <http://www.russellgroup.ac.uk/>

³¹ For more about the 1994 Group and its members see <http://www.1994group.ac.uk/>

Figure 1: The relative³² citation impact of the UK research base (1981-2007)



28. Figure 1 shows the relative citation impact of the UK research base as annual figures and as five-year moving windows (dotted and dashed lines – left-hand axis); the RAE years are indicated. Plotted on the same time frame is the share of UK journal outputs (including articles, reviews and other material) that had at least one author from one of the Russell Group institutions (continuous line – right-hand axis). Figure 1 shows that, in the early 1980s UK research impact was in the doldrums or in real decline compared to the rest of the world. From the late 1980s, there was a change in trajectory and a gradual increase in relative impact that accelerated into the late 1990s. Whether this should be accounted a consequence of the introduction of the RAE or simply a correlative outcome of the policy and management environment in which the RAE has operated is open to debate, as we noted. And even if it were the consequence of the introduction of the RAE – which seems reasonable to conclude – whether this outcome was the consequence of selectivity in funding or the concentration of research resources in a relatively small number of universities is another question.

³² Relative = relative to world average. 1.0 = world average, and anything above that is above and anything below that below world average.

29. The distribution of activity changed over the same period. Prior to the RAE, the share of publications co-authored by the Russell Group was static, perhaps declining, but it took off in 1986 and grew sharply to 1992, continuing on a steady but still markedly upward path to 2005. A separate analysis of the golden triangle institutions shows a concurrent concentration increase within the Russell Group, with a rising golden triangle share between 1981 (about 40 per cent of Russell Group) and 1996 (about 44 per cent of Russell Group).

Analysing the recent spread of citation impact

30. The UK higher education research base produced 306,661 research articles and reviews in the five year period 2002-2006. Of these, 204,307 (about two-thirds) had at least one author from an institution in the Russell Group. And of these, some 87,157 items (about 43 per cent of the Russell Group) had at least one author from one of the five golden triangle institutions. Over the same period there were 58,083 papers associated with the 1994 Group and 69,756 papers with authors from other HEIs.

31. So, there is some degree of concentration of excellence. More than two-fifths of the output of twenty large institutions has a co-author from just five - by no means all among the largest - and those twenty themselves can claim a share in two-thirds of the output of more than 100 research active HE organisations.

32. Quantity is nothing without quality. The distribution of more or less frequently cited papers across the UK research base and its compartments is shown in Figure 2 below.

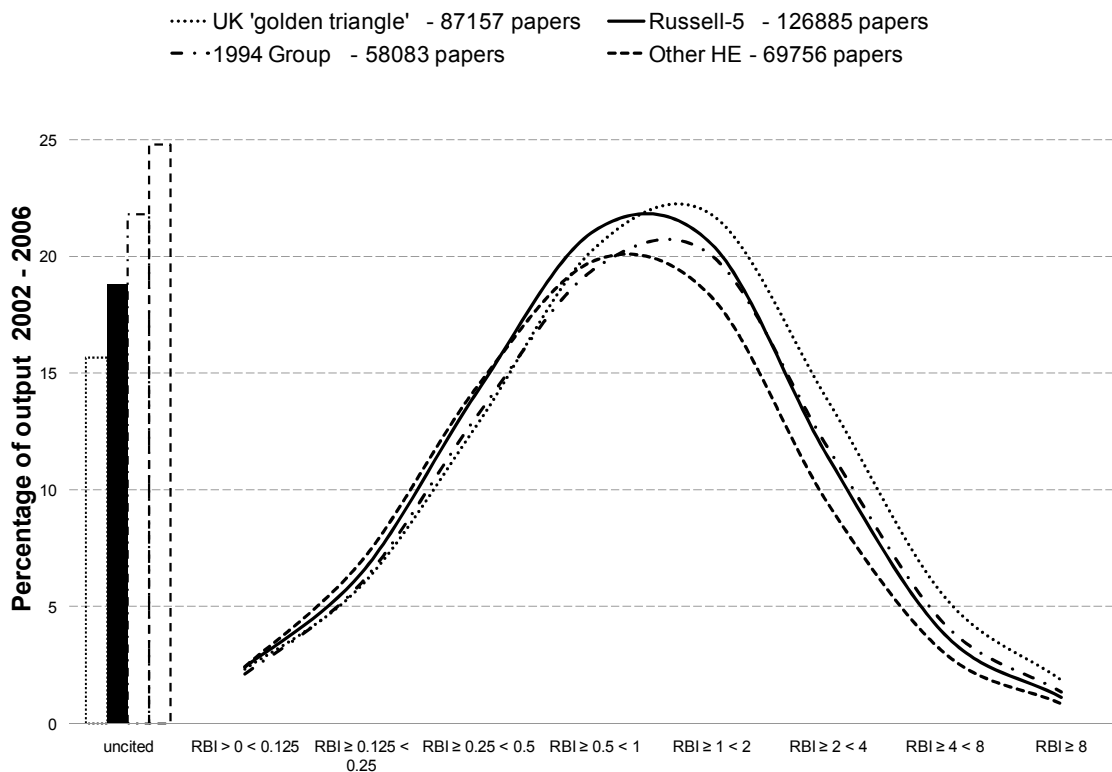
- UK addresses on Thomson Reuters papers were traced to verify where the author was associated with an HE institution. Where there was more than one HE address, the papers were associated with each institution recorded. This produced institutional datasets.
- Citations were counted for each of these HEI papers.
- The actual citation count was compared with the average that would be expected for other papers in the same journal category and published in the same year. This is the normalised or rebased impact (RBI)³³.
- Cited papers were allotted by RBI (i.e. impact relative to world average = 1.0) to one of eight bins, four either side of world average and bounded by

³³ It should be noted that the data on which Table 1 is based world average in all subjects without differentiating between subjects. RBI refines this to take account of different citation patterns in different subjects.

doubling or halving the threshold impact (i.e. $RBI=0.5-1.0$, $1.0-2.0$ etc). We set aside uncited papers.

- Aggregate groups were created. These are inclusive, e.g. the 1994 Group includes papers co-authored by 1994 Group institutions with Russell Group institutions.
- Duplicate papers are removed from aggregate totals for groups (e.g. if Birmingham and Leeds co-author then each joint paper counts only once to the RG-5 curve).
- The outcome is then displayed as a percentage of the total output for the group.

Figure 2: The distribution of citation impact relative to world average for research publications by the UK higher education sector, 2002-2006



33. Impact indices have been calculated to account for citation variation by year and field of publication. Each curve shows the percentage of papers that fall into a particular impact category for that institutional group. The bottom axis shows the range of impact categories ($RBI = 1.0$ is the world average). Uncited papers are shown separately on the left while the most frequently cited papers are in the impact bins on the right, which are 4-8 and > 8 times world average.

34. Figure 2 above shows that the Impact Profile®, the curve of excellence, is progressively shifted to the right, towards the high impact end, as we shift the grouping to the golden triangle from other institutions. In concordance with this, as the curve shifts left so the associated proportion of uncited papers rises.

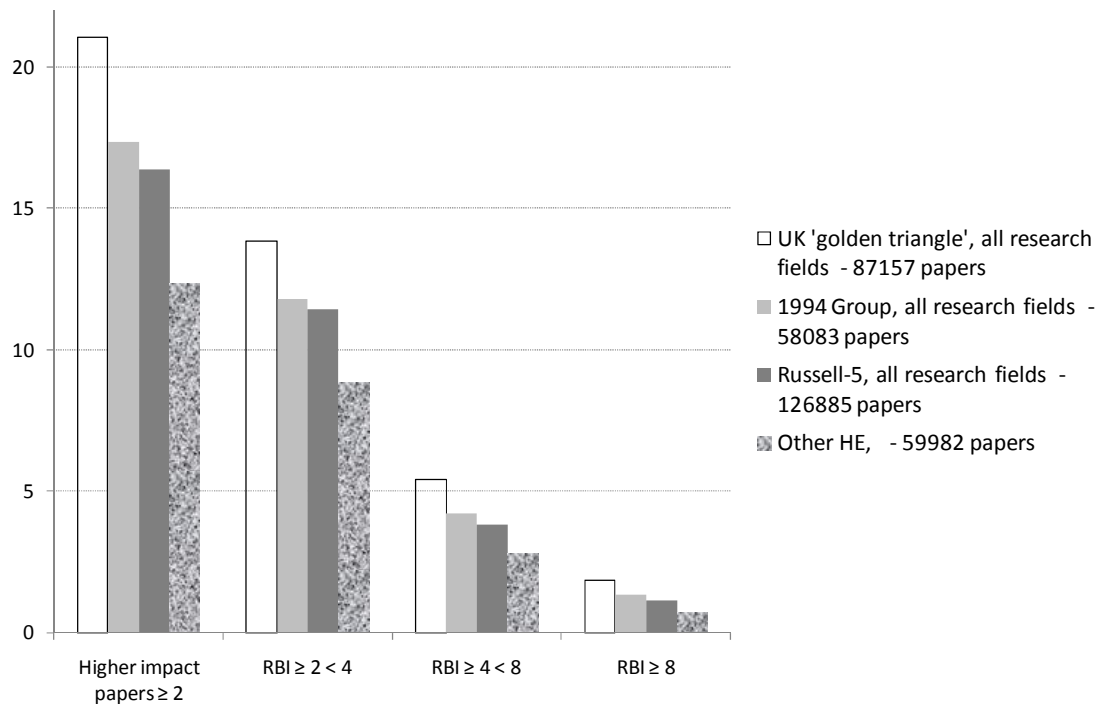
35. But the differences are not as great as might have been imagined, given the differences in the amount of funding. A substantial proportion (nearly half) of Russell Group output has impact below world average, and in the highest impact categories the percentage of RG-5 papers without a golden triangle co-author is less than for the 1994 Group curve. The overall performance of not just the Russell Group but of the entire UK research base is driven to a significant extent by the impact of papers from a small number of leading institutions.

36. The golden triangle institutions have a lower proportion of uncited papers than for the other groups, as well as a lower proportion of papers in all impact categories below world average and a higher proportion of papers across all impact categories above world average. It should not be thought that these golden triangle papers do not have other co-authors: many are collaborative with a network of HEIs and research organisations in the UK and overseas. But those papers by other (including Russell Group) institutions include golden triangle co-authors and yet their Impact Profile® is clearly left-shifted. Note also that, while the golden triangle sub-sample reflects excellent performance, not everything is exceptional since over 15 per cent of golden triangle research receives no citations at all. Nearly 20 per cent of RG-5 research is uncited, compared to about 25 per cent of the sector as a whole.³⁴

37. On the right of the figure are those impact categories above two times, above four times and above eight times) world average. For the golden triangle institutions, some 7.24 per cent of output is in these categories, compared to 5.24 per cent of the UK HE research base overall and less than 4 per cent for 'other HEIs'. In numbers, the UK HE sector produced about 16,000 papers that exceeded the '4 times world' threshold impact over the five-year period and authorship of these is most concentrated. About 73 per cent had a Russell Group co-author and 39 per cent had a golden triangle co-author (Table 1 below): more than half of the highly cited papers from the Russell Group had a golden triangle co-author compared to around two-fifths of the Russell Group's overall output.

³⁴ The comparable data for the world as a whole are difficult to assess because the analyses we produce are created at the level of individual publication records whereas those for global databases are aggregated. About 1,000,000 papers are published globally every year. The rate at which these generally receive citations is slower than that for the UK-specific part. Articles from the UK, USA and Germany generally start to get cited at about the same time and rate. All these countries are ahead of the world generally but behind some research-excellent nations such as The Netherlands.

Figure 3: The distribution of publications in the higher impact categories above twice world average citation impact, by category and in total



38. Figure 3 above focuses on just these high end papers, summing everything with a greater impact than twice world average. The separation may not seem great but the overall extent to which the golden triangle exceeds others in its production of papers of relatively high impact is a major part of the UK's total research strength. Figure 3 shows, for example, that over 20 per cent of all research produced in golden triangle institutions has an impact over twice world average.

Table 1. Summary distribution of UK higher education research output by institutional sub-sector and impact category

	Total articles and reviews, 2002-2006	Papers above world average impact	Papers with impact exceeding four times world average
Papers with at least one co-author from the UK higher education research base	306,661	112,358 37% of sample total	16,060 5.2% of sample
Papers with at least one co-author from the Russell Group	204,307 66% of UK HEIs' total	79,505 70% of UK HEIs 39% of sample	11,734 73% of UK HEIs 5.7% of sample
Papers with at least one co-author from the five golden triangle institutions	87,157 28% of UK HEIs' total	37,370 33% of UK HEIs 43% of sample	6,308 39% of UK HEIs 7.2% of sample

39. The peak of performance does not exist in isolation. We cannot truncate the spread of UK research activity and expect the rest to survive. But it is arguable that research with great academic impact is also likely to contribute to exceptional social and economic impact. If this argument is accepted, then it should also be noted that the very highest category of impact, above 8 times world average, represents less than 2 per cent of UK total output. Within this top slice of 3,715 papers, the five golden triangle institutions are co-authors on 1,600 or around 43 per cent. Just the University of Cambridge alone counts as a co-author on 15 per cent of the UK total.

40. For the avoidance of doubt, if we drill down into the data, to various levels of discipline, then we find that the pattern is repeated. So, a high proportion of the UK's exceptional academic research is strongly associated with a relatively small number of institutions (Table 1, Figures 2 and 3). Whatever the broader mapping of archipelagos of excellence, and the curve of relative excellence extends across the full range of categories for all institutional groups (Figure 2), as this concentration has grown there has been a correlated - if not consequential - change in the concentration and impact of the UK research base (Figure 1).

41. On the other hand, over 20 per cent of the UK's research output is uncited, and as much as 15 per cent of research done in the golden triangle institutions is uncited. It seems that a significant amount of the research done even in golden triangle institutions might be considered to be not very good at all, and that the money provided for such research could be better - or at least as well - spent elsewhere. At the very least this suggests that care should be exercised in pursuing a general policy of increased concentration as distinct from selectivity based on merit. The evidence presented in this report confirms the

outcomes of the RAE2008 profiling, that research quality is far more widely spread than might previously have been thought, and shows that much of the research produced in institutions where research funds have been concentrated is not of particularly high quality. Evaluation to stimulate institutional management to improve this balance must continue, and allocation by historical precedents will not do that.

Recent changes in selectivity

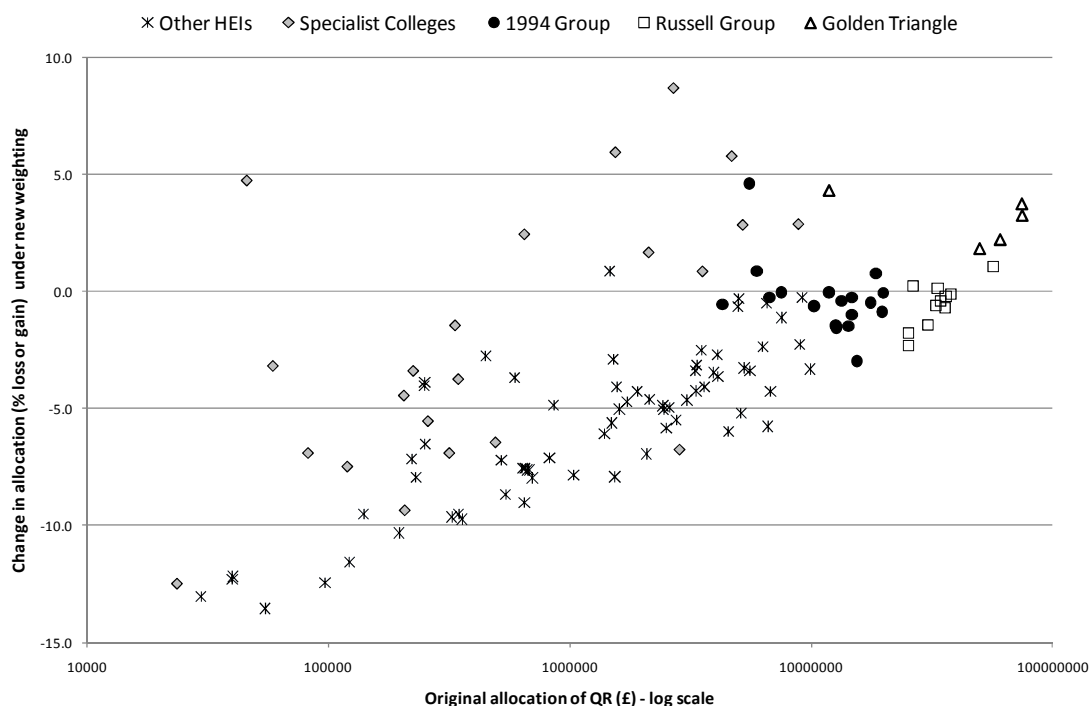
42. On 1 February 2010, HEFCE announced changes to its research funding formula for 2010. To correct the more dispersed allocations made post-RAE2008, it said that it would use revised weighting factors to shift the balance across 1*/2*/3*/4* units from 0/1/3/7 to 0/1/3/9. This increases the concentration of resources towards the research in each Unit of Assessment of the highest quality.³⁵ How will this affect funding at the institutional level and what consequences might arise?

43. To illustrate this, we examined the implications for the different parts of the system of applying the 2010 funding formulae to the 2009 pot of money and (with the same grade weightings across subjects and institutions) and comparing that with the 2009 outcomes. The results are shown in Figure 4 below.

44. As might be expected, there is a shift of resources towards golden triangle institutions where the high impact captured in Figure 2 above is reflected in a high density of 4* activity assessed by RAE peer review panels. But this is a fixed pot of resource, so from where is that increase in concentration drawn? It comes from a wide spread of institutions, as Figure 4 reveals.

³⁵ See <http://www.hefce.ac.uk/news/hefce/2010/grant1011/>

Figure 4: The hypothetical gains and losses of QR funding that would have occurred had HEFCE's 2010 corrections to grade-related weightings been applied to the 2009 HEI allocations



45. Data are displayed to show where the sub-sector groupings described elsewhere in this report would fall in the overall spectrum. Note in Figure 4 that the horizontal axis is scaled logarithmically, so the absolute gains and losses to the right-hand institutions are much greater than to the left-hand.

46. The total budget is over £1 billion whilst we calculate that the total gains (or total losses) from the revised formula are more in the order of £10 million. Thus no more than 1 per cent of total research funding would have moved from some institutions and towards some others. The spread of different institutional groups in this graph is, however, clearly not even and this is as would be expected.

47. It must be understood that this is *not* the actual change in funding that institutions will actually see in 2010. That is because there is a general uplift to the system of about 2 per cent in cash (not real) terms, because the changes to weightings will be associated with some changes to subject pools and also because there are some other agreed changes to specific subjects. This analysis is simply a broad indication of what the 2009 allocations would have been like with a different formula. So, at an aggregate level, what would that scenario have looked like? Table 2 below shows the gains and losses for some of the broad sector groupings, and shows the extent to which the new formula will lead to gains for golden triangle institutions at the expense of the rest.

Table 2: The hypothetical gains and losses of QR funding that would have occurred had HEFCE's 2010 corrections to grade-related weightings been applied to the 2009 HEI allocations

Sub-sector group	Extent of hypothetical loss or gain
Golden Triangle	Gain = £7,953, 000
Russell Group – 5	Loss = £1,483,000
1994 Group	Loss = £1,237,000
Specialist colleges (creative arts, business schools, medical, agricultural and veterinary)	Gain = £777,000
Other HE institutions	Loss = £6,011,000

Data are aggregated to the sub-sector groupings described elsewhere in this report.

48. In the last group, of other HEIs, only one of some 60 institutions actually benefits while the others would see larger or smaller losses compared to the funds they were actually allocated.

49. There are some marked gains for the specialist colleges (Figure 4, Table 2). This is to some extent driven by the relatively high proportion of 4* activity identified in those UoAs in which they were active at RAE2008. This shift in resources might now be seen as an unexpected and unintended consequence of that outcome, and might invoke some need for review and standardisation of criteria across broad subject areas.

50. To what extent are the new weightings a sufficient response to the need to protect the UK's peak of international competitiveness? Getting the concentration balance right is a challenge that policy makers are expected to anticipate and regulate in a timely fashion; managers are there to manage. The additional funds directed towards the golden triangle should be of value: they amount to 2-3 per cent of institutional core QR. But this is a small part of the total funding to those institutions and may have little evident impact. The change has been achieved at significant cost to other institutions where losses in some cases amount to more than 5 per cent, even 10 per cent, of institutional core QR. Entire sub-sectors will see this as a raid; some of those sub-sectors are contributing research of considerable value to the UK, as Figure 2 shows. Would an analysis of the relationship between input and likely outcomes confirm that the net losses will be outweighed by the net gains?

Conclusions and policy consequences

51. We have argued elsewhere that there would be a danger in over-concentration of the UK research base, that it is healthy because of its regional structure and diversity.³⁶ The peak of research is supported by a platform that feeds highly trained people, excellent ideas and corroborative data to the wider

³⁶ See: Evidence (2003). Op.cit.

system.³⁷ Ideas are explored, details are illuminated, regional industry is advised - and that allows enterprise to thrive. Moreover, it is apparent that there is good research throughout the system, and there is also modest - even poor - research in all types of institution.

52. Nonetheless, as described, the UK research base has been subject to a long period of selective funding allocations and a consequent concentration of research resources and activity. This has been accompanied by a simultaneous period of improvement in the UK's relative international impact, which should not be taken in any sense as a 'given'. There has been a huge rise in R&D expenditure in many jurisdictions as governments focus on the value of a 'knowledge economy'. The phenomenal research expansion of China³⁸ is reflected in other parts of south-east Asia, in Brazil³⁹ and increasingly in India.⁴⁰ To maintain share in such a competitive environment would be a good achievement, and it would be one in which the USA has not succeeded: the USA's share was around 38-39 per cent of world output in the 1990s, fell to 34 per cent by 2000 and dropped further to 31.5 per cent by 2007. The impact of its research (measured by citation analysis) showed a less dramatic but nonetheless evident decline. To have improved impact and increased its share of world research excellence, as the UK has done, is extraordinary.⁴¹

53. The data in this report show that this exceptional achievement is in significant part the result of the outstanding performance of a very small number of individuals in an even smaller number of institutions. The majority of the research done in this country - throughout the sector, from the most exalted institutions to the least, and from those that have received the most research funds to the least - is very much more modest, although this would be true of a profile for any other country.

³⁷ Evidence (2002). Maintaining research excellence and volume. A report for the Higher Education Funding Councils for England, Scotland and Wales and for Universities UK, pp. 118. http://www.hefce.ac.uk/pubs/rdreports/2002/rd08_02/

³⁸ Adams J, King C and Ma N (2009). China: research and collaboration in the new geography of science. Global Research Report, November 2009. Thomson Reuters, London. ISBN 1 904431 22 4

³⁹ Adams J and King C (2009). Brazil: research and collaboration in the new geography of science. Global Research Report, June 2009. Thomson Reuters, London. ISBN 1 904431 20 8

⁴⁰ Adams, J, King C and Singh V (2009). India: research and collaboration in the new geography of science. Global Research Report, October 2009. Thomson Reuters, London. ISBN 1 904431 21 6

⁴¹ Evidence (2008). International comparative performance of the UK research base, pp 113. A report to the Department of Innovation, Universities and Skills. http://www.dius.gov.uk/science/science_funding/science_budget/uk_research_base

54. Although after the 2008 RAE funding was more widely spread, in recognition of the fact that research excellence was found to be widely spread, the new arrangements due to be implemented from 2010-11 will have the effect of focusing funding even more on the very small number of institutions with a concentration of truly outstanding international excellence in research, and at the expense of the generality of universities, including those that have traditionally received the most research funds. That would be consistent with the evidence in this report that suggests that there may be an argument for more selective funding to the rare peaks of internationally outstanding excellence; and of course funding for expensive, specialised and shared facilities needs separately to be considered. That is a real dilemma for policy makers. What seems clear, though, is that there is no case for a general and wider policy to concentrate funding based on historical characteristics.

55. It is highly desirable that the checks and balances that have allowed the system to continue to bear fruit over a century of growth and fluctuating resource levels should continue. Policy through the 1990s has not just maintained this balance but has sustained the UK research base against increasingly challenging and well-funded competition. The present level of concentration – however it has evolved – supports research that gains global recognition. We disrupt it at our peril and we should expect to see sound analysis underpinning any change in policy or practice. It remains to be seen whether recent policy perturbations will deliver the most effective outcome for UK research competitiveness.