Funding research diversity

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A report for Universities UK by Evidence Ltd
Foreword

The publication of the White Paper on 'The Future of Higher Education' has been followed by a lively debate about how to safeguard a thriving, innovative and inclusive higher education sector in the years and decades to come. In its response to the White Paper, Universities UK applauded the Government's commitment to the aims of high quality teaching and facilities, enhanced research capacity, fruitful relationships between universities and business and fair access.

However, despite this shared vision, there are considerable differences of view about how these outcomes can be achieved. In particular, the Government's proposals to enhance national research performance through a further concentration of research funding in top-ranking departments has met with widespread concern across the higher education sector.

The White Paper assumes that the concentration of research will drive up national research performance through better infrastructure, interdisciplinary synergies, and more attractive conditions for top researchers. It implies that the current landscape of 3, 4 and 5-rated departments engaged in research could endanger the UK's ability to keep up with its international competitors whereas fewer, larger units will produce higher quality output and bring the greatest net benefit to UK scholarship and long-term economic growth.

It is disturbing that considerations of such far-reaching importance should so far have been advanced with virtually no supporting evidence. Universities UK believes that any new policies with major repercussions should be based on a thorough examination of what the sector, and the country, stand to lose and to gain if fewer departments receive more research funding, and more departments receive none.

We have therefore commissioned Evidence Ltd to undertake this study of the impact of further concentration on university research performance and regional research capacity. Based on a careful and objective analysis of a range of sources, it addresses questions such as the international competitiveness of British research under the current system, the quality of research at 4-rated departments, and the implications of more selective research funding for the future of the regions.

We believe that this study will make a valuable contribution to the discussion of how best to support university research in the future and how to ensure that university research will continue to contribute to the economic dynamism, quality of life and cultural vitality of the UK.

Professor Ivor Crewe
President, Universities UK
October 2003
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This report is a summary with select data and is supported by a full Technical Report, which is available separately from Evidence Ltd, or on the Universities UK website at www.UniversitiesUK.ac.uk/diversity
This study contributes new and updated evidence to test some of the assumptions and implications of the UK Government’s White Paper proposals for university research funding. The policy would change the structure of the present research base by concentrating funding in the largest and most highly rated university units.

The case for further concentration of research funding is complex because the policy is likely to have unintended as well as intended consequences. We have addressed five principal questions, using a combination of data from the Research Assessment Exercise 2001, bibliometric indicators and a survey of Universities UK members. The answers lead to three key conclusions.

First, there is no evidence that there is a current problem with the performance of the UK research base that needs to be addressed, either overall or at the level of the units most likely to see a funding loss. Second, if there were an emerging problem, then there is no clear evidence that the UK’s research performance would benefit from further concentration of research funding. Third, there is evidence that research concentration as proposed would seriously exacerbate existing regional differences in research capacity and performance.

What is the comparative international performance of the UK?
Evidence shows that the research base as presently structured is working well. It has sustained the UK’s international research performance despite challenges from European neighbours and specialist research economies in Europe and the Asia-Pacific regions. The UK produces about 9 per cent of the world’s papers and receives about 10 per cent of the world’s citations. It usually ranks second to the USA in terms of volume and ranks second to the USA amongst G8 nations in terms of research quality in most subject areas. Its comparative international research performance appears actually to be improving.

What is the international standard of performance within the UK research base?
Bibliometric analyses confirm that the middle layers of the research base (graded 4 in research assessment) as well as the peak performers (graded 5 and 5*) contribute to overall UK performance. Specifically, science based grade 4 units generally perform above world average. These units have improved over the period of analysis and data indicate their potential for further improvement. The average UK grade 4 unit performs above world average in most disciplinary areas within the sciences and has improved over the period. Grade 3 units rising to grade 4 also show progressive improvement, so the funding at grade 4 provides an important bridge between national and international levels of research.
What is the relationship between diversity and development in the research base?
Innovative research of disciplinary, economic and social benefit may be at risk from a diminution of research funding for grade 4 units. A survey of institutional perceptions of the contribution made by these units to research capacity and diversity revealed their role across a wide range of regions and subjects. Institutions provided many examples of research from grade 4 units that was linked to regional and national governmental policy objectives. Grade 4 units contain individual researchers working at recognised levels of international excellence that benefit institutional missions.

What evidence is there about the benefits of research concentration?
There is no evidence that research concentration would necessarily create better research. Many relatively small research units bring in as much research funding per staff, produce relatively as many PhDs and papers, and have as high a research impact as larger units in their subject area. The statistical correlation between size and performance is mainly attributable to the fact that large units rarely have poor research. There is evidence that the only critical size threshold for research departments is at the smallest level, possibly equivalent to a single viable research group. This may confirm earlier suggestions regarding an optimal size for research groups.

How would funding concentration affect regional research profiles?
There is evidence that research concentration would have significant differences in effect at a regional level, with some regions potentially losing important areas of research and suffering substantial reductions in performance. We created a detailed database to model the regional impact of a national policy that increased differentials in funding between grade 4 and grade 5 units. The results suggest that shifts in funding and activity would be unevenly spread across the UK. They would actually increase existing regional disparities. The East Midlands and Wales appear to suffer the greatest losses. The three regions in the south-east quarter (South East, London, East) appear likely to gain the greatest benefits.
1 Aims of the study

The policy background
On the 22 January 2003 the Secretary of State for Education and Skills, Charles Clarke, announced publication of the White Paper “The Future of Higher Education”, which sets out the Government’s plans for radical reform and investment in universities and HE colleges. The aim of the work described in this report is to explore the possible costs and benefits of changes to research policy that the White Paper proposed.

At the heart of the Government’s proposals lies a belief that benefits will come from concentrating research in larger units. The expectation is that this might lead to better infrastructure, better collaboration within and between disciplines, easier development of research only posts and better pay for excellent researchers. It is argued that concentrating resources on the largest and most highly rated units at departmental and institutional level, whilst simultaneously encouraging and rewarding promising departments, will enable UK research to meet the increasing challenge of international competition. To achieve such concentration the Government wishes to focus resources on the best research performers and in larger units.

Before the 2001 Research Assessment Exercise (RAE) research funds in the UK were already distributed selectively (despite some differences in policy between the national funding councils). After RAE 2001, the Higher Education Funding Council for England (HEFCE) announced it would maintain funding levels for grade 5 units, but that grade 4s would be funded only from a residuum. However, there followed a period of uncertainty about the Government’s policy intentions in relation to future funding of grade 4 units. Subsequently, HEFCE announced it welcomed the Government’s decision to maintain the total grant for 4-rated departments and advised higher education institutions (HEIs) to plan on the basis of that grant being available through the period until the next RAE. Later the Minister for Higher Education modified this slightly in his speech to the Universities UK residential conference.

In real terms, whatever the actual details and timetable, this settlement represents a cut in funding to grade 4 units. The funding settlement still leaves in place, for English HEIs at least, fears about the long-term level and security of funding for grade 4s during the next RAE period.

Taken together the Government’s and HEFCE’s approaches to funding higher education research constitute a source of significant change for the present structure of higher education research. The consequences are not entirely clear. At the very least, they are likely to lead to a major redistribution of research activity and to bring about highly differential effects not just on institutional research profiles but on regional research capacity and diversity.
What questions does this study tackle?
This study addresses questions about the underlying assumptions and implications of the Government's proposals. The problem is complex because the policy of increased research concentration is likely to have unintended as well as intended consequences. The policy assumes that there is – or is likely to be – a problem with the present structure of the research base that funding concentration would help to solve. Since the White Paper refers to maintaining the UK's international research competitiveness, it must be assumed that the problem lies in that area.

The signal that resources will be redistributed (in England) away from grade 4 units to 5s implies a (negative) assessment of the relative contribution made by grade 4s to the performance of the research base at institutional, regional and national levels. A further assumption is, therefore, that although the ability of the ‘4’ units to maintain their research profile would have to be placed in doubt by reducing their funds, the concentration of funding elsewhere would produce an overall net benefit to the performance of the UK research base as a whole.

Universities UK commissioned Evidence Ltd to test the evidence that supports these assumptions. This study presents new and updated analyses of research performance that address five key questions.

• Internationally, how well does the UK perform against other countries? Is there evidence that the present structure is leading to a decline in the performance of the national research base?
• Nationally, within the UK research base, current funding council policy will concentrate resources in grade 5 units at the expense of grade 4 units. What has the comparative international research performance of grade 4 units been over the last decade? What other contribution do lower graded units make to the development of the research base?
• What evidence do universities have of the contribution made by research capacity and diversity to regional economic growth, national performance in major sectors, and the emergence of new research areas?
• The Government believes that greater concentration of research funding will enhance national research performance. What evidence is there for a link between research performance and the size of the research unit?
• Regionally, if grade 4 units had been funded at a lower level during 1996-2000 and if resources nationally had been more concentrated, what would the impact have been on the research performance of institutions at RAE2001 and how could this impact on regional research profiles?

This study explores the performance of the present UK research structure through a combination of quantitative and qualitative evidence, with a particular focus on the contribution of grade 4 units. It is the first study to delve into the question of regional research capacity and to model the possible impact of policy changes. Its findings and conclusions will be of interest to all those concerned with, or involved in, the operation and performance of the UK research system.
What is the purpose of this question?
Changes in research funding aimed at increasing the concentration of research resources will have effects on the structure and function of the research base. In other words, departments will gain and lose and whole institutions will gain and lose and the research landscape will change. To justify this change we might reasonably expect to find some evidence that there is an existing problem with the research base as presently structured. Specifically, since competing effectively with the world’s best is a stated objective, we might expect the UK’s comparative international research performance to show evidence of weakness.

With which countries is the UK compared?
The UK is a member of the G8 group of leading economies. It is usually considered a major research player. That is to say, it has a long history of supporting research, it spends a large amount on research in absolute terms and its researchers are acknowledged to be among the leaders in many fields.

For this study, we made comparisons between the UK and a group of other countries around the world. The group includes all the other members of the G8 (USA, Canada, France, Germany, Japan, Italy and Russia). The group also includes other European countries with strong research (Switzerland, the Netherlands, Belgium, Denmark, Finland and Sweden) and a select group of Asia-Pacific research economies (People’s Republic of China, Singapore, South Korea, and Taiwan).

The G8 collectively account for more than three-quarters of annual world research publications. These countries provide direct research competition to the UK in scale and performance. The smaller nations are those that have relatively strong performance for their size and some have niche strengths. Some of the Asia-Pacific countries are showing rapid growth in specialist areas.

What are the best indicators of comparative research status?
The research process consists of funding inputs, activity in terms of people and facilities, and knowledge outputs in the form of trained researchers, publications and patents. All of these contain information about a country’s research and, given time, a balanced analysis would draw on a balanced data spread.

Research publications are the most informative single indicator, if we wish to concentrate on a broad indication of research quality and if a rapid assessment is required. International publication databases contain data on all the countries in our comparator group and at a detailed level of research disciplines. The same databases include the citations to those publications, and citation counts are a generally accepted measure of influence in scientific research.
Citation indices therefore provide the single most general measure of research quality and enable us to plot trends in research performance as well as making comparisons between countries across a range of subject categories.

**What do bibliometric data indicate about the research status of the UK?**

The data show that the UK’s output of papers has increased continuously over a long period but is now showing some signs of reaching a plateau. The UK typically produces about 9% of the world’s papers recorded on ISI databases and receives about 10% of the world’s citations. It is usually second to the USA in terms of volume.

The UK’s share of world citations is second to the USA. It has increased over the recent past, despite the competitive performance of smaller nations. Germany is, however, now close behind. Switzerland and the Netherlands have particularly strong citation impact (calculated as average citations per paper) in certain areas of research but they have much less absolute capacity. The proportion of UK papers that remain uncited is falling in all research fields.

The citation impact of the UK is second only to the USA among G8 nations. Some close competitors, such as Germany, are clearly improving their performance relative to the UK in some areas but the UK has still improved against average global benchmarks.

**Does the UK perform well against international competition in all areas?**

If we analyse citation share at the level of research fields, then we can see that the UK is second to the USA and clearly ahead of competitors in almost all areas. The exceptions are mathematics, where it is third, and physical sciences and engineering, where it is fourth.

The UK has broad and sustained strengths across the natural sciences, particularly in the life sciences. There has also been strong recent development in the environmental sciences. UK engineering has also recently shown signs of improvement after a period of decline.

Some of the smaller nations, notably the Netherlands and Switzerland, rank higher then the UK on citation impact in some fields but the volume of their research is much smaller and the quality is less consistent. Nonetheless, the challenge from smaller nations is acute in these specific areas. Maintaining comparative research competitiveness will be increasingly difficult and require sustained resources.
What are the recent trends in comparative UK research performance?

Overall, the UK’s comparative international research performance improved progressively in terms of average research impact (citations per paper) over the last decade. The UK’s share of global citations is still increasing in all fields except social sciences and engineering. This improvement in the face of growing international competition is surprising given the UK’s previous strong position.

UK growth in terms of research publications has probably now peaked. The rate of growth has been similar to the rest of the G8 and does not seem to have been disproportionately driven by special factors such as the Research Assessment Exercise (RAE). There is a slight cyclical pattern to UK output associated with research assessment, however, and this may affect recent figures.

What related information is available from other recent studies?

Recent studies of research performance carried out by Evidence Ltd for the UK Office of Science and Technology have shown that the UK research base is highly productive. Its output, calculated in terms of PhD awards per researcher or of publications per researcher, is high compared to competitor nations. UK research is not only good but also relevant to research users. The UK attracts a relatively high level of business investment to public sector R&D.
3 What is the international standard of performance within the UK research base?

What is the purpose of this question?
The improvement in the relative international performance of the UK research base has been reflected in the changing spread of grades achieved in successive RAE cycles. There are now more units graded at the highest level and a higher proportion of university staff are in those units. That creates a resource allocation problem with too little differentiation at the high end. This is among the issues addressed by Sir Gareth Roberts in his review of the research assessment methodology.

It is conceivable that research is now so concentrated in the top graded units that the rest of the research base may no longer be making a significant contribution to performance. If this is true then a policy of increasing selectivity and concentration of funding in grade 5 units might be appropriate. If lower graded units contribute significantly to the overall capacity and performance and to the flexibility of the research base, however, then such concentration would also have a detrimental effect.

What is the significance of RAE grade 4 units?
Evidence Ltd described a peak and a platform in the research base, in a previous study, looking at the distribution of research performance across universities. The peak would be defined by any measure as research excellent in international terms. It is the group of laboratories and institutions to which researchers from institutions in other countries would immediately be attracted. In terms of the UK’s RAE outcomes, the peak is those units that receive a grade 5 or 5* rating. The peak does not work in isolation from the rest of the system. It is linked to a platform of other research, in grade 4 and grade 3 units. These units contribute to the success of the peak – and thus to national profile - by adding to the broader development of research, the generation of knowledge and the training of highly skilled people.

The RAE grading system is a ladder between units whose research does not attain even a national standard of quality and units where the research was predominantly international in character and standard. For example, grade 3 units are largely national in their level of achievement. Grade 5 units are those where quality equates to attainable levels of international excellence in up to half of the research submitted for assessment. In the funding formula used after the 1996 exercise, the basic funding quantum was fixed for 3b units with a progressive gain of 50 per cent at successive grades.

Grade 4 is the step between grade 3 research, which is generally of a national standard, and a predominantly international research standard. It is both a reputational and a funding step. As the standard of a unit’s research is raised, significant rewards became available when all research was of at least national standard and the possibility of reaching international standard at grade 5 had begun to be realised. Those rewards could provide the basis for further improvement.
Changing the height of the steps in the ladder will affect perceptions about the possibility of progression. The Higher Education Funding Council for England’s decision to maintain research funding levels for grade 5 units has led to the withdrawal of all research funding for grade 3s and the reduction in real terms of the funding for grade 4s. Now, the grade 4s receive a basic funding quantum while grade 5s receive about 2.8 times as much per unit activity. The funding step is thus that much better for the very best, but that much steeper for those seeking to achieve that standard.

What does grade 4 equate to in terms of national and international standards of excellence?

The RAE criteria define grade 4 research as “Quality that equates to attainable levels of national excellence in virtually all of the research activity submitted, showing some evidence of international excellence”14.

Grades depend on an assessment made by an expert panel. RAE panels take into account a wide range of data on funding, training, outputs and strategy as well as making judgments about reputation and achievement. Their judgment about how this equates to international standards is informed by their own experience and the additional moderating input of referees from outside the UK. RAE panels rightly avoid basing their decisions on simple quantitative indices. Their judgments involve the synthesis of a wide range of quantitative and qualitative material and the application of sound academic experience and good sense about the research culture in their field and the opportunities and influences that are pertinent to the community they assess.

How have grade 4 units performed against world average baselines?

Evidence Ltd does not have the resources to process the same volume of information as an RAE panel. It is possible for us, however, to create a much simpler assessment based on a select volume of bibliometric data that does allow direct comparison with international benchmarks (average citations per paper) in different fields. This is not intended to second-guess the assessment made by the RAE panels. They drew on data that were more relevant to performance than bibliometrics would have been in some fields, such as the arts. Nonetheless, we can make like-for-like comparisons and follow trends in relative international performance.

Bibliometrics work best for broad based science and poorly for broad based arts subjects. Our previous study of units15 in science and technology UoAs that received a grade 4 in the 1996 RAE indicated that at that time the average performance of such units was above world average. The world average itself is dominated by data for the G8 countries and is therefore a very competitive benchmark.
Our analysis of the performance of the units at grade 4 for RAE2001 was less clear than the 1996 analysis, and showed an apparent dip towards the end. While this might indicate a shift of more top level research into grade 5, we found that it was at least partly due to increased variance between subjects. A general ‘science and technology’ analysis was now too inclusive. Performance was increasing steeply compared to world average in some areas, while in other areas it was not increasing at all or was very volatile. The different rates at which citations were being acquired also created ‘noise’ in the overall data profile.

A simpler picture emerged when we looked only at core natural sciences and medicine (illustrated here). It now reflects the same progressive improvement we had seen in the 1996 data. That progressive change continued through to the last year in the dataset. It started below world average in 1992, climbed past that benchmark in the middle of the decade and was well above it by 2000. The average performance of grade 4 units is still below the UK average, but this is dominated by the performance of the grade 5 units.

**Are there performance differences between subject areas?**

Grade 4 units have continued to improve in the life sciences and clinical medicine. This seems also to have been the case in environmental sciences, although the disparity between grade 4s and UK average was greater in 2000 than in earlier years. The profile in physical sciences is variable for grade 4s whereas there is progressive improvement overall. For mathematics, the picture generally is rather more volatile.

The simpler picture that we developed for the bibliometric analysis required the separation of engineering and environment from other science based units. We had already separated social sciences and humanities because bibliometrics are a poorer guide to research excellence in those areas.
Engineering is a complex area for research performance analysis and the Royal Academy of Engineering has recommended a multi-factor approach to assessment, with which we concur. Furthermore, by no means all key engineering outputs are disseminated through journal publications. The bibliometric spread of engineering departments is therefore wider and, while peak units are internationally excellent on many criteria, it is evident in separate analyses that the bibliometric performance of grade 4 units in engineering is below world average.

In social sciences and arts, there is still some bibliometric separation between the UK average including grade 5s and the performance of grade 4s alone. On bibliometric criteria, the 4s sit just below the national average but (in apparent contradiction) are often above world average. Further analysis of bibliometric data in isolation is inappropriate in these disciplines.

**Are there performance differences between established grade 4 units and newly promoted grade 4s?**

We found that established grade 4 units, those that were graded at 4 in 1996 and remained at that grade in 2001, were ahead of those that rose up from grade 3 to 4 in 2001 on average in terms of average bibliometric performance. Units that remained at grade 4 in 1996 and 2001 were slightly lower in average performance than those that rose from grade 4 in 1996 to grade 5 in 2001.

The units climbing from grade 3 were generally well below world average in 1992 but followed the general trend and were achieving around world average standard in terms of output quality by the end of the decade.

At a subject level, there was less differentiation between old and new grade 4s in the biomedical sciences. The distinction was clearer in environmental and physical sciences.
Conclusions on grade 4 performance
The overall bibliometric pattern within and between RAE grades is in broad agreement with the RAE panel judgments in terms of relativities in impact. Our analysis demonstrates that all the units associated with grade 4 have improved, that units promoted from grade 4 to grade 5 were performing better than average and that units promoted from grade 3 had hauled themselves up to performing at a standard that equates to a world average dominated by research in G8 nations.

The grade 4 units appear to be competitive in international terms and continue to make a substantive contribution to the UK’s overall research performance. There has been a dynamic aspect to the performance of this research platform that must contribute to the overall strength and diversity of the UK research base. Grade 3s have evolved into grade 4s while the best grades 4s have evolved into grade 5s. It seems inevitable that the withdrawal of or reduction in funding from these areas would affect future research competitiveness.
What is the purpose of this question?

Bibliometric indicators alone do not reveal the different contributions of each grade of units to the future development of the research base. The research performed by grade 4 units may also be important because it contributes to other related aspects of institutional mission or to the development of ideas and techniques in new and emerging areas of research. The contribution made by grade 4 should also be seen in terms of the broader economic, social and cultural impacts of research activity.

To address this question, we analysed the responses to a Universities UK survey of UK higher education institutions (HEIs) to explore the range of contributions that they identified that had been made by grade 4 units to institutional research vitality and the broader community of research users.

After RAE2001, there were 664 grade 4 units in the UK accounting for 25% of research active staff and located in 121 universities and colleges. Grade 4 units therefore constitute a major part of the intellectual and spatial diversity of the research base. They are invariably co-located with other, often higher graded, academic units and working together or independently these academic centres may have close ties with local regional or national economies.

How important are RAE funding incentives to improved research performance?

Maintaining the existence of a vibrant research culture is a key part of institutional research management. HEIs are clear that this task requires appropriate incentives and that the quality related (QR) funding derived from successive RAEs has been instrumental in driving up research performance. HEIs expressed concern that reductions in funding for units rated 4 and below would heavily influence future research capacity and diversity. The results show that:

- Long-term improvement in research performance across a wide range of subjects and units is attributed to the incentive effect of additional funding associated with grade gain
- QR funding forms part of a block grant that has traditionally carried with it the benefit of autonomy for institutions in making investment decisions to respond to new and emerging areas of research
- Areas of research graded 4 in RAE 2001 have already been de-incentivised by reductions in funding in England and in some units are at risk of being closed as key staff leave
How do grade 4 units contribute to institutional diversity and mission?

Over time the incentive effect of RAE funding, together with investment autonomy associated with it, has enabled progressive grade improvement. Many of today’s grade 5 and 5* units have risen from relatively low RAE grades during successive cycles of the RAE. Researchers in new or improving units, which at some time will have been 4-rated, contribute expertise not just to the emerging area of research but to broader institutional life. Researchers frequently work in teams and groups that cross unit boundaries and researchers in 4-rated units frequently work with colleagues in higher (and lower) rated units.

Universities identified grade 4 research as pivotal to three aspects of institutional mission:

• Learning and teaching initiatives that derive knowledge and expertise directly and indirectly from the development of new and emerging areas of research
• The development of cross-institutional research culture and achievement, particularly in fields requiring multi-disciplinary approaches to solve problems
• The effects of achieving improved status and funding associated with promotion to grade 4 in galvanising morale and in providing the impetus to drive change throughout an institution’s culture

How important is the contribution of grade 4 units to the emergence of new research specialisms?

New areas of research may initially have a relatively low profile in RAE terms. A low grade may reflect as much on the immaturity of the area as the quality of the research submitted. It can also be the case that pockets of exciting and higher quality research in novel areas take place in units that are undergoing transition. The bridging role of the grade 4 is particularly important in this context. HEIs emphasised the time-cycle associated with the maturity and development of new research fields. The longer-term trajectory of growth and improvement is reflected in progressive RAE grade improvements. In addition, new research is increasingly multi- and inter-disciplinary. Many research questions require the mobilisation of an array of disciplinary skills and methods and, in some cases, the development of wholly new inter-disciplinary approaches if they are to be tackled effectively. In this context, universities indicate that:

• Expertise is distributed widely across the research base
• Grade 4 units include highly skilled researchers operating at the highest international levels
• Grade 4 activity supports research performance in other units, including those rated 5 and 5*
• There are synergies of expertise across related areas that would be at risk if grade 4 funding is cut
How would the potential loss of research activity in grade 4s impact on regional capacity?

A study by the AUT18 has revealed the risk that, if funding reductions lead to the loss of grade 4 units, then there will be a significant reduction in regional research diversity. In order to further examine this, we analysed the complete grid of universities grouped by region with a view to identifying regional grade 4 clusters at the level of our Super-UoAs, the Faculty groups of cognate subjects. Such linked clusters would increase the threat to regional diversity or richness unless there was also an abundance of similar research at grade 5. Our analysis was selective rather than comprehensive but we found:

- Most regions have clusters of grade 4 units and would therefore have research areas at risk
- Clusters in Engineering, Physical Science, Social Science, Medicine and Environment stand out as most at risk compared with other subject groupings
- Some regions are more exposed than others
- East Midlands has clusters in Medicine, Physical Sciences, Engineering, Social Sciences and Humanities involving a total of 51 grade 4 units; Scotland has clusters across all subjects involving 98 grade 4 units
- Eastern region, by contrast, has only one cluster of 9 grade 4s (all at one HEI) and is less at risk
- Some individual HEIs are particularly exposed – in London, King’s College has 10 grade 4 units; in the South West Exeter has 16; in Scotland Aberdeen, Glasgow and Strathclyde between them have a total of 54 units, grouped across a scatter of subject areas

What type of links with regional and national research users are at risk from any diminution of research diversity and capacity?

HEIs submitted a wide range of exemplars to illustrate the nature of the risk to research users should diversity and capacity be affected by funding changes. These focused on five broad areas:

- **Science and technology interactions** - the Structures and Materials Group at University D19 carries out research in composite materials technology with aerospace applications. Its partners include Airbus UK, Rolls Royce, Agusta Westland and Dowty Propellers, BAE Systems, Bombardier Shorts, NEG Micon;
- **Healthcare interactions** - University T cited its Centre for Rehabilitation Sciences and Health Promotion and Public Health as the only RAE graded (3a) research cluster in the region. It is involved in a Cochrane Collaboration Review Group and the NHS is a major user of its research expertise;
• **Community and social exclusion focused interactions** - University V’s Institute for Social, Cultural and Policy Research carries out community focused research and has developed in conjunction with partners a new model financial institution dedicated to combating financial exclusion among lower economic groups. Interactions with business organisations include Lloyds TSB, Barclays and Natwest;

• **Culture and the arts interactions** - University K has a unit researching the emerging research field of Dance, its research outputs serve a broad arts public including specialist arts organisations such as the Royal Ballet;

• **Quality of life interactions** - University B provided the exemplar of its Centre for the Study of Violent Crime which collaborates with statutory bodies such as the Scottish Executive, the Prison Service, the NHS and Social Services to provide a valuable contribution to quality of life.
5 What evidence is there about the benefits of research concentration?

What is the purpose of this question?
There is no apparent problem in the present comparative international research performance of the UK, and the grade 4 units that would suffer if funding were more concentrated appear to be making a substantial contribution to the national profile. Nonetheless, it is possible that the Government has identified the possibility of emerging problems due to increased international competition for which increased concentration might provide an answer. The question is therefore about the evidence that concentration of resources produces better research performance.

What are selectivity, concentration and critical mass in research policy?
There is a long history to policy proposals for increased concentration of research in the UK and some selectivity in earmarking funding was applied by the University Grants Committee in quinquennial cycles from 1947-20. The UK system is arguably as concentrated as that of the USA. Given that arguments in favour of increasing the concentration of research funding have been going on for nearly half a century one is tempted to suggest that some other process embedded in the research structure must continually oppose this drive.

Selectivity is an active process, of choosing between higher and lower priorities or raising the barrier above which funding allocations are made. Concentration is the outcome of selectivity. When funds are distributed more selectively, then more will go to the highest rated (by whatever criteria) researchers. Core funds, grants and studentships will become concentrated in a smaller number of departments and perhaps in a smaller number of institutions, or the difference between the poorer and the better funded will increase.

There are arguments in favour of both selectivity and concentration, and they are not the same. The argument in favour of selectivity is that money spent on less excellent research is money wasted and that it is better to focus on the very best. When funds are scarcer than opportunities this argument usually makes good sense but there may be a balance between excellence and diversity. The argument in favour of concentration is that bigger units would deliver more or better research than spending the same money in several smaller units.

Critical mass is strictly used to imply that there is a threshold value for size. In its strict sense, it implies that there is a size (perhaps staff numbers) below which the research unit is not viable but above which research performance can rapidly and markedly improved. The term is misused in many research policy discussions as a code for size generally.
Why might bigger units perform better research?

The term ‘unit’ in the context of the research process needs to be defined each time it is used. Earlier in this document we referred specifically to academic departments, but research units may be teams, laboratories, departments, schools or institutions. Because these different kinds of units may bring research together in different ways their scale relationship with research performance should be studied separately. For example, a team is made up of various numbers of individuals, a department consists of individuals in one or more teams and a university is home to many people in a smaller or larger number of departments. If we considered scale factors solely in relation to staff FTE across these different organisational layers then we would be obscuring essential structural information.

The general arguments concerning research and scale that lie in the background of policy proposals were usefully summarised in a 1987 report by the University Grants Committee\(^1\). First, the intellectual environment created by a larger group of researchers may add to overall vitality, through the opportunity to exchange and develop ideas and to be spurred by visible achievement. Second, the per capita marginal costs of research (administration, clerical support, etc) could be reduced. Third, this could be accentuated by the scale of cost of major equipment and facilities in the natural sciences. Fourth, larger groups might make possible the simultaneous and parallel development of research themes, leading to an overall acceleration. Larger group size might also contribute to diversity of thought and of sub-discipline, increasing intellectual spillover and cross-fertilisation. Finally, larger groups of research students may provide a supportive atmosphere for research training. The realisation of such potential benefits would depend, however, on appropriate management.

Work carried out by Evidence suggested that bigger universities often host better research than smaller universities. However, bigger universities also tend to be older universities with a long history of research investment leading to a wealth of capital resources. These universities often also have a great diversity of departments and diversity itself may be an important factor in research performance\(^2\).

For this study, the unit is the departmental level of structure. The data used in the analysis are drawn from the RAE database for 2001. The unit is therefore actually not necessarily an academic department but is the group of staff submitted by a university to an RAE Unit of Assessment. These will usually be from one academic resource centre (department or school) but they may include cognate researchers from other schools and one school may be split into two or more UoAs.
Do bigger units perform better research?

It is important to distinguish between research quantity and quality when considering size effects. We are not asking whether big, excellent units could do even more research but whether they could do even better research. Larger departments usually (not universally) attract more funding, have more students and produce more papers. They do this because they have, by definition, more staff. They may not necessarily attract more funding per capita, however, nor train more students per supervisor nor produce more papers per FTE. Thus, to test our question about size and quality, we indexed research quality across a range of departmental sizes by considering not only bibliometric impact factors but also looking at per FTE data on grant income, research students and publications.

We found that most big units do indeed perform above average research but it was equally clear from our data that small units can also be excellent.

Our analyses in 1999 showed that there was a statistically significant correlation between unit size and research performance measured by average citations per paper. Our analyses now, expanded to consider research income per staff FTE, PhD awards per staff FTE and publication output per staff FTE as well as research impact, confirm this broad pattern across a wide range of disciplines not only in the sciences but also in the arts and humanities.

The simple conclusion that might be made from the above statement is only partially right. The more informed conclusion is that size alone is not a barrier to performance and there is no universal pattern in our data that links better research with bigger units. Big units on average carry out better research than smaller units, but the average for small units includes some that perform at a standard comparable with the largest. To put it another way, some small units carry out only a modest amount of research while there are very few large units without a large research profile.

Are there differences between subject areas in the relationship between unit size and performance?

The relationship between the size of staff groups in UoAs and research activity per FTE is recorded in Table 4 in the Technical Report. The results are inevitably complex. Income per FTE is significantly well correlated (P < 0.01) for 16 UoAs in the natural and social sciences and more weakly (P < 0.05) for a further 10 including some humanities. PhD awards per FTE is well correlated for 33 UoAs across a wide range of subjects and weakly for a further 10 UoAs. This covers over 60% of UoAs. Articles per FTE is significantly correlated in 11 UoAs, but these are mostly in the social sciences and include History.
These results are interesting in that they show that the underlying scale pattern is not confined to the sciences. It is usually asserted that while size may be a factor benefiting research in science, because of team and equipment factors, the lone scholar is still the paradigm elsewhere. If this is true, then this is a further indication that apparent departmental size factors may not be causative even if they are statistically correlated.

**Are there any discernible patterns in the relationship between unit size and performance?**

To understand the results from our analyses, we need to look at the spread of data as well as examining statistical coefficients. Given time, since we only looked at simple linear models, we should also develop more sophisticated statistical models to discern the characteristics of the functional relationship between size and performance.

The statistical outcome ignores the underlying spread of performance among smaller units. The data scatter does not suggest that there is any reason why small units cannot attract high levels of funding, attract and train students and produce significant volumes of excellent research. There are, however, many small units that do not perform at this standard. A sophisticated conclusion might be that small units that become good at research acquire the resources to become large units. Conversely, large units that do badly at research lose resources and decline in size as well.

Two patterns seemed to emerge when we plotted data for each UoA. In the Technical Report these are shown in Figure 8. By far the most common pattern is that while very few large units have average research performance below the median for their UoA there is, by contrast, great variation in performance of small units.

This common pattern is seen in the figures on research income per FTE for UoA14 Biology (illustrated here) and Electrical Engineering, citation impact for Physics, or publications per FTE for Philosophy.
Less commonly, large units more consistently perform better than small units. This is seen in the figures on research income per FTE in Sociology (illustrated here) and Chemistry and publications per FTE in Psychology.

We would need to look in much more detail at other factors associated with the larger and smaller units submitted in each of these UoAs to be able to develop a general explanation for the observed outcomes.

We conclude that there are size factors associated with research performance and they evidently occur across many disciplines but causation, correlation or consequence cannot be determined at this stage. Nonetheless, there is no general evidence to support the widely held supposition that bigger units necessarily do better research.

Other studies suggest that there may be an optimal size for research units at the level of teams and an optimal group size around 5-8 may be common. This optimal group size appears to hold for a very wide range of information processing systems including ecological and economic as well as social communities. If so, this could be a component in determining the overall pattern seen in the general data. There do seem to be very few departments much below that size. If departments that fell below the optimal group size were non-functional then this would represent a true critical mass threshold for a research department.

It is worth noting that larger departments may be constituted of many small and optimally sized teams. If this is so, then peak performance would not necessarily increase with departmental size although diversity and its possible benefits might do so. Diversity could also be maintained, however, by managing better cross-departmental links.
6 How would regional research profiles be affected by further concentration of funding?

What is the purpose of this question?
One of the aims of this study was to explore the possible local and regional impacts of the policy changes implemented by the HEFCE and those proposed in the 2003 White Paper. This is the counterpart to the Government’s underlying policy intention, which is to improve the overall national performance of the UK research system. There is a value judgment to be made about the net effect of possible national benefits and regional costs.

We have tried to address this issue by making an initial and hypothetical quantification of policy-driven changes in the research profile for each region. To do this, we made a series of predictive assumptions about relative performance and the potential effects of funding change on performance even to develop a simple model. Real changes in research behaviours and outcomes will be contingent on a range of factors, only one of which (although possibly the most important) is funding.

What does the model assume?
To model the consequences of making research funding more selective, we developed an argument about the likely impact of reduced resources on the research performance of grade 4 units. In fact, because we wished to use historical data rather than projections, we created a scenario in which their funding was cut earlier, in 1996. We assumed that the same grade 4 units continued to exist but that the level of their research performance was reduced.

For modelling purposes, we assumed that other system factors – numbers of research active staff for instance – would have remained unchanged. In practice, a migration of staff from grade 4 to grade 5 units is likely as people move to richer resource bases for their research. We cannot calculate other contingent effects – for example, the effect of morale deficit on performance. Again, it is reasonable to suppose this would further depress performance, so our calculations of performance change are likely to err on the conservative side.

The Government’s policy intention is to sustain the performance of grade 5 units, whether or not grade 4s decline. We know we cannot predict with any accuracy the effects of shifting resources to grade 5 units because we have already shown that funding concentration alone is unlikely to improve performance for units that already perform well. Although it may affect training and output volume, we cannot be certain that funding gains would result in those units attracting more research students or increasing their research output. We can only make hypothetical assumptions about possible improvements in performance of grade 5s.
Our core assumptions are that

- Lower funding and altered differentials in 1996 would have resulted in a drop in the activity of those units that actually achieved grade 4 in 2001 because there were both fewer resources and fewer incentives
- The nearest relevant approximation for which we have historical data is the average for grade 3 units
- The loss to regions over the 1996-2001 period would have been the difference between what grade 4s actually delivered and what grade 3 look-alikes would have delivered
- The main beneficiaries of the shift in funding and activity would have been the grade 5 units

The net change in research profile for each region will therefore depend on the balance of grade 4 and grade 5 departments.

**Are there existing regional disparities in research capacity and performance?**

We grouped our data to fit the regional boundaries adopted for the UK’s regional development agencies. Some regions have more HE institutions and this affects research diversity as well as capacity, thus we do not start with a level playing field. In fact, our analyses here show that they also have different relative capacity in units graded 3, 4 and 5 at the 2001 Research Assessment Exercise. Furthermore, they vary in the distribution of staff across departments, and resources are therefore affected by the balance of science and technology compared to social sciences and humanities.

It seems likely that this regional distribution of research activity is affected less by recent research performance and much more by historical factors. Other studies have shown that there is a relative concentration of research facilities and institutes in the south-east quarter of the UK, which includes the East, London and South East regions, particularly along the London-Bristol corridor. We found in this study that the gross average bibliometric impact of the south east quarter is also higher than for any other regions, although the average for all UK regions except Wales and Northern Ireland exceeds world benchmarks.

**How would research policy affect the regional distribution of research staff and activity?**

National policy interacts with existing regional differences to produce a spread of local impacts. If all regions had similar proportions of 4 and 5 graded staff and units, and similar distributions by subject then policy changes would be balanced by pro rata losses and gains. Because this is not true, selectivity and concentration will inevitably favour those that already have a relatively high number and proportion of research excellent staff and units.
- Regions with a relatively high proportion of 4-units and a high proportion of staff in such units will lose relatively more of their capacity if funding is reduced for 4 graded units.

- Regions with a high proportion of 5-units will make a relative gain if funding is more selectively concentrated on the highest performing units.

Nationally, a high proportion of those staff who are in grade 5 departments are in the three regions in the south east quarter of England (East, London, South East). This is not just a consequence of concentration of university research. The same regions also have a high relative proportion of their staff who are in grade 5 departments.

**Which regions would be winners and losers in any redistribution of activity?**

It is clear from what we have said above that any model of change in the research landscape will show that some regions will gain more and others will lose more. What the calculations actually show in terms of losses and gains rapidly becomes complex as we consider more factors at disaggregated subject levels. It is tempting to seek to simplify the picture and to produce quick answers by averaging across indicators. Such averages become increasingly contentious, however, when the application of possible weighting factors would depend on untested assumptions. More analysis is thus required to determine the detailed outcomes.

The balance of absolute volume in grade 4 and grade 5 staff is the key factor in this model or any related calculation. What this means is, for example, that the North East will suffer few losses because it has fewer grade 4 staff but the scale of its gain will also be small and below average because it has half the grade 5 staff of the East, and a quarter the grade 5 staff of London or the South East.

In summary, we calculated from our model that

- The three regions in the south east quarter (South East, London, East) appear likely to gain most. For example, the South East would show only lower than average losses on grade 4s and greater than average gains on grade 5s.

- The West Midlands would have lower than average losses but make lower than average gains as well, as would the North East.

- Wales and the East Midlands are projected to have both higher than average losses and lower than average gains.
There is a series of maps in the Technical Report that summarise these data and the results. The following map (Map 4 in the Technical Report) shows the pattern of predicted change in model activity compared to real activity during the RAE census period. In the data boxes\textsuperscript{26}, red italic type indicates above average loss and below average gain. Green bold type indicates lower losses and greater gains. The boxes show the percentage change in the following factors for the period 1996-2000: research grant and contract income; the numbers of PhDs awarded; and the numbers of articles in ISI journals. The grade 5 staff are shown as a percentage of all staff for the region compared to national averages. The revised impact is a preliminary estimate of the possible change in research performance due to reduced capacity and the opportunity for others to capitalise on these gaps.
30 Funding research diversity – Summary report • Universities UK
7 What conclusions can be drawn about the further concentration of research funding?

International research comparisons do not suggest that there is at present any problem with the performance of the UK research base. Not only is it second to the USA on many indicators and in most fields but it has sustained that position over the last decade and has actually improved on its own performance relative to world averages. There is evidence that competition is increasing globally and it seems reasonable to suppose that sustained investment will be required to maintain the UK’s position in the future.

Our analysis of the relative performance of grade 4 units indicates that they make a substantial contribution in two regards. First, their performance is itself at or above world average, so they make an important volume addition to research at this standard. Second, the funding and reputational step represented by grade 4 appears to have been a factor in enabling new research to move up from national to international standards, so they may make an important contribution to maintaining capacity and diversity.

There are a wide range of institutional examples to illustrate the contributions made by grade 4 units to their mission and diversity and to both regional and national research users. These users include Government policy makers as well as industry. Innovative and interdisciplinary research is identified as important to maintaining research effectiveness. Institutions asserted that the research diversity of their grade 4 units was vital to the health of this new research.

We found that there was no clear evidence that the concentration of resources in larger units would universally produce a gain in research performance. In most subject areas, there are small units that perform at a high level. There is a statistical association between size and performance, but this is frequently driven by the number of small units that have a poorer research performance. There may be a critical mass threshold but this could be related to the size of a viable research group and not the size of departments.

At a regional level, there are existing disparities in research capacity and performance. Some regions not only have more research activity but also have a relatively greater proportion of their research in higher-grade units. These existing differences are likely to become accentuated by a policy of research concentration. There would be substantial losses in some regions and an overall shift towards the south-east quarter, but it is difficult to quantify possible gains. It is important to restate the obvious consequence of these shifts, alluded to in the section on research diversity and development, that reduced regional research capacity will have knock-on consequences for regional economic performance and the capacity for technology innovation.
Overall, we found no clear evidence that there is a problem in UK national research performance that needs to be addressed by structural change. If such a problem were to emerge, there is no clear evidence that research concentration would prove to be the best way of addressing it. It is evident, however, that the further concentration of research funding would carry with it the risk of reduced research capacity for some regions, the failure to achieve some institutional missions and an overall reduction in the diversity of the UK’s research base.
Notes


2 “… funding for 4-rated departments will be maintained at current levels (£118million) until the next RAE”. HEFCE Press Release quoting Rama Thiruchandraman, HEFCE Director of Research and Knowledge Transfer, 13 August 2003

3 HEFCE 2003/38 para 22.


5 The same policy has not been adopted in Scotland. In Wales, the Higher Education Funding Council for Wales announced in September 2003 that it would maintain funding for a wider range of departments and that it recognises a wider definition of high-quality research than only 5 and 5* units.

6 The Web of Science databases held by Thomson ISI® cover over 3500 leading research journals worldwide.

7 Each publication refers to, or ‘cites’, earlier work. Publications that receive many citations are therefore seen to be those that have had a particular influence on their field. High average indices of citations per paper are taken as a measure of excellence of an institution or country’s research. Citation rates vary between fields and corrections need to be made to account for this.

8 The discipline categories in this study were grouped Units of Assessment as used the UK Research Assessment Exercise (RAE). There are 68 UoAs and they were grouped by Evidence into 12 Super-UoAs after carrying out a frequency analysis of their publication similarity. The methodology is explained in J Adams et al (1998) Benchmarking of the international standing of research in England, CPSE, Leeds.

9 The RAE has been run in 1986, 1989, 1992, 1996 and 2001. The format has developed over those cycles. Earlier cycles took publication volume into account and were blamed for a supposed UK tendency to produce quantity at the expense of quality.

10 The OST is responsible for the £2.4 billion UK Science Budget and for funding directed through the Research Councils, the Royal Society and the Royal Academy of Engineering. OST is headed by the Chief Scientific Adviser who provides research advice to Government.

11 The four UK funding bodies (HEFCE, SHEFC, HEFCW and DEL NI) commissioned Sir Gareth Roberts to lead a review into the means by which research at UK higher education institutions is assessed. The final report was published in May 2003. Further information is available from [http://www.rareview.ac.uk/](http://www.rareview.ac.uk/)


13 The 1997 research activity weighting factor was 3a = 1.5, 4 = 2.25, 5 = 3.375.
The term “unit” is used here to indicate the units submitted to the RAE, which are usually university departments but may include a wider grouping within the institution.

Measuring excellence in engineering research (January 2000), Royal Academy of Engineering

QR is one of the components of the block grant allocated to universities by the funding councils. The block grant is available to the university to allocate internally as it sees fit. More information about block grant funding is available from e.g. HEFCE guide 02/18 ‘How the HEFCE allocates its funds’.

The risk to research in higher education in England (June, 2003), AUT, London.

We have used arbitrary codes here and in the technical report to preserve institutional anonymity.


These data are drawn from the HERO database for RAE2001 using staff FTE numbers from RA1, research income from RA4, and research student data from RA3. Data on publications and citations are taken from Thomson ISI® databases address reconciled by Evidence Ltd to UK universities and mapped to UoAs using a methodology developed from a frequency analysis of the RA2 output database.


J Adams and B Shorrocks, Competing species come in sevens (1985) New Scientist, 1465, 41-44

Data are taken from Thomson ISI® databases and the RAE2001 database on the HERO website.
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