Executive Summary

Research and regions: An overview of the distribution of research in UK regions, regional research capacity and links between strategic research partners

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1 This paper is concerned with regional aspects of the research structure of the UK. It considers the prospects for improving the transfer of knowledge from higher education to industry and increasing the economic development of less well-favoured regions through regional research funding.

2 Substantive sections of the paper report a quantitative, though preliminary, overview of the regional research profiles of the higher education and business sectors and the strategic cluster priorities of the Regional Development Agencies (RDAs). The policy and literature background is reviewed first, to set the scene for the quantitative analyses.

Policy alignment

3 Economic development of the regions via the exploitation of research brings into play a tension between two objectives. First, current UK Government policy favours selectivity and concentration of research funding (DfES, 2003) in a research base that has conventionally been conceived as a national (and international) entity rather than a regional one. This policy has potential regional impacts and the evidence is that the balance between concentration and diversity needs to be carefully struck if UK research excellence is to be maintained (Adams and Smith, 2003).

4 Second, since 1997 a central element in government policies for economic development, innovation and regeneration has been an enhanced role for regional government. The assumption has been that certain decisions, especially those with implications for regional prosperity and quality of life, are better devolved to the representatives of the regions involved. This philosophy has underpinned the creation of new regional bodies – RDAs,

Regional Assemblies, expanded Government Offices (GOs) and a central Regional Co-ordination Unit (RCU) – although there are different arrangements in place for the devolved nations.

5 The assumption is that RDAs (or the responsible devolved national bodies) have a legitimate interest in their regional universities and in stimulating university-industry partnerships. It is a logical step from this perspective to the view, recommended in the Lambert Review of Business-University Links (Lambert, 2003), that the delivery of RDA objectives might be better facilitated by direct regional control of a portion of the research funding hitherto distributed according to national benchmarks and assessments.

6 It is not always clear, however, that the emergent regional framework is consciously linked to pre-existing, and nationally oriented, policies and agents relevant to knowledge growth and exploitation. First, there is the research funding distributed by the national HE Funding Councils. Second, there is funding for specific research projects, functionally the responsibility of the Office for Science and Technology (OST) and distributed by the UK Research Councils (RCs). Third, there is DTI policy, where competition and technology are key aspects of the state's interest in stimulating innovation.

7 Consequently, it is in the region – spatially as much as culturally - that the questions addressed in this paper arise. They concern, on the one hand, the connectivity between university research activity and economic performance and, on the other, the importance of proximity to the transfer of research findings from discovery into application.

Dimensions of university research – literature review

8 Universities have diverse and pervasive impacts (Charles and Benneworth, 2001 and associated reports). They are significant economic entities: they are major employers, particularly of skilled people, and have a significant demand for goods and services. Research activity enhances those dimensions, adding to employment opportunities and increasing and diversifying demand for goods.

9 Universities import talented people to their regions. Graduates represent a skilled workforce of enormous economic value, many of whom choose to stay in the area where they graduated. Research adds to the experience of those students, but more importantly research leads to advanced research training and the output of more highly skilled people with research experience and the ability to transfer knowledge and know-how to companies.

10 Universities produce knowledge and innovative ideas. These are made available as tacit knowledge, through consultancy and the movement of people, as intellectual property 'close to market' that can be licensed and exploited, and as codified knowledge emerging from basic research and particularly in the form of journal articles.

11 Universities also offer consultancy, instrumentation and high-tech research services, short courses and industrial research training, and advanced and complex facilities for testing, imaging, and modelling.

12 Cities benefit from the presence of a university and research excellence boosts awareness and reputation (Goddard et al., 1994). Cities with universities may also be better places to live because they lower stress levels by contributing to economic stability (news item in Science 2004,

vol 303, 463) as well as employment and culture. Universities are key players in innovative clusters, which we discuss in more detail below.

13 To summarise, many studies have demonstrated the wide range of economic and cultural contributions that Universities make. Only some of these are directly related to research but most of them benefit from research activity generally and research excellence in particular.

Economic benefits of research – literature review

14 Economic and policy studies have in the past sought to quantify the widespread assumption that basic research fuels a stronger economy. Recent syntheses have emphasised the more diverse benefits of research investment, affecting labour and capital.

15 Governments fund research for many reasons, none of them disinterested, but perhaps most readily summarised under the headings of 'wealth creation' and the 'quality of life'. Basic research represents an economic good and thereby justifies public support. The outcomes of public research are made available without restriction to users, because application is both uncertain and potentially pervasive. The United Nations has recently endorsed the view that developing countries would benefit if they boost their R&D base (news item in Nature 2004, vol 427, 577).

16 One evident association between research and the quality of life is through improved health, social and living conditions. Even so, benefit measurement for health services remains a real challenge for those seeking to determine how NHS R&D should be used. Furthermore, the volume growth of activity in biology has been measurably greater (doubling every 10 years) than the rate of return in new discoveries (doubling every 50 years for biology generally and every 22.5 years for genetics this century:

Glass, 1979). Such statistics are a characteristic of every research field and the consequence is that the productivity of publicly funded research becomes a matter for enquiry.

17 Arguments asserting the benefits of research have tended to rely on studies using data for a particular industry or innovation that is readily susceptible to analysis, while other studies have emphasised the importance of the spillover effects of research (that is, the many-to-many relationship between research fields and industrial sectors) (see e.g. Pavitt, 1985; Martin et al, 1996; Salter and Martin, 2001).

18 The spillover effect makes simple analysis of research-economy linkage a challenge. If research investment results in diverse outcomes, it is difficult to develop a single, consistent model of economic benefit. For example, while case studies on biotechnology and optical communications show a clear and direct impact of investment in basic research, there is uncertainty about the importance and utility of discovery in other disciplines (Sornette and Zajdenweber, 1999) and thus an early DES analysis of the impacts of research on the semi-conductor industry came to few clear conclusions (Byatt and Cohen, 1969).

19 Cross-sectoral studies in the USA measuring State and Government returns for research funding and returns for R&D spend by commercial organisations indicate positive net outcomes. In a study of 883 companies, Grilisches (1980) found a consistent positive relationship between company productivity and investment in R&D with high private rates of return. Mansfield (1998) looked at 77 major firms and estimated that over 10% of the new products and processes introduced in those industries could not have been developed in the absence of recent academic research. Additionally, a reducing time lag between research and product innovation

(from around 7 to 6 years) indicated accelerating cycles of knowledge exchange.

20 Generally, studies find that the impact of research investment is often both fuzzy and delayed in time. Estimates may consequently seem to be unstable and, although illuminating, "at best a very crude beginning" (Mansfield, 1992). Summarising past work, Martin et al (1996) pointed to evidence of different forms of economic benefit. They argue that basic research must be seen as not only a source of useful codified information but also of wider benefits such as trained researchers, improved instrumentation and methods, tacit knowledge, and membership of national and international networks. Martin and Trudeau (1998) similarly note that traditional economic impact studies sought only to assess how spending on research affects the rest of the economy: "they do not describe its underlying, dynamic impact on the two primary factors of production, labour and capital". Furthermore, after graduating, "students become a primary source of innovation in the organisations they join".

21 To summarise, while there are sound examples of good rates of return for specific research investment in some sectors, such as pharmaceuticals, these are not readily generalised. In many fields, such as chemical engineering, the returns are less readily quantified because of spillover between discoveries and innovations. Although the generic benefit of research becomes diffuse, it nonetheless has measurable and pervasive impact mediated particularly by skilled labour.

Clusters and scales – literature review

22 The analysis of research and policy documents concerning national and regional economic development is made more difficult by conceptual

confusion. This applies particularly to the term ‘cluster’ and to the use of ‘region’ as an indicator of geographical scale.

23 The modern concept of ‘clusters’ (local aggregations of interdependent manufacturing and service companies) as economic entities that exhibit particularly effective rates of innovation and growth, and thereby enhance competitiveness, is associated with Michael Porter (e.g. Porter, 1990). The importance claimed for clusters is that proximity (usually in space but sometimes also in sector) enables a level of interaction that adds to the inherent growth potential of each member. Universities can be important players in such clusters because they are a source of knowledge and of skilled people, but such interaction between companies themselves is thought to be equally important.

24 This makes clusters a focus for policy. It is assumed that stimulating cluster development should add to economic growth generally but could boost it further through better knowledge transfer between the research base and users. Not surprisingly, there have been extensive studies on cluster formation, structure and distribution.

25 The problem is that ‘cluster’ is variably interpreted. While original studies of clusters have usually been fairly specific about both scale and scope, this has not always been true when such material is adopted by policy makers. Thus examples relating to Silicon Valley in the USA (principally a localised IT cluster with good research links), carpet-making in Belgium (a widespread ribbon of related companies with less research), aerospace-defence in the UK (a set of distant locations linked by a common sector and a diffuse research base) and the Cambridge phenomenon (a localised IT and biotechnology development and an excellent but loosely connected research companion) are cited as if they refer to essentially the same thing.

Rather obviously they do not and their sectoral and structural differences seem likely to be important.

26 The concept of region is bound up in this. The region affected by Cambridge is the area around the city, not the East of England. Other clusters, such as European textiles, link regions that spread across national boundaries. Again, while original research recognises these differences and sometimes supplies reference typologies (Trends Business Research, 2001), secondary documents sometimes fail to preserve those distinctions and risk basing policy on shaky evidential foundations.

27 It remains unclear whether there are regional dimensions to the suite of University research services that could be distinguished from the local (city) scale and the wider (national) scale. Goddard et al (1994) suggest that local research contracts are usually few and small whereas inter-regional links are more substantial. Instrument testing and consultancy may be more local, while IP exploitation tends not be local because of the need for a good match with the user.

28 To summarise, there is little doubt that 'clusters' involving HE can be powerful promoters of innovation and can have profound economic effects on their locale. However, the fudging of distinctions of both structure and scale weakens the evidence base for policy development and gives room for scepticism - perhaps inappropriate - about whether some phenomena are as widespread or general as claimed.

<u>What do companies want from higher education?</u>

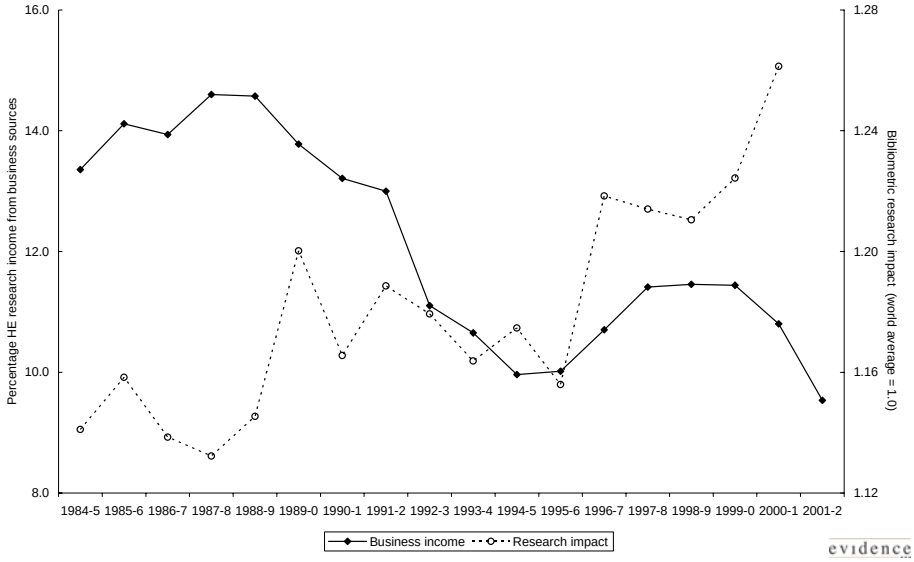
29 As noted above, research is not the only way in which universities can have an economic impact. In fact, a detailed study carried out for the Council for Industry and Higher Education showed that more than half the financial

input to universities from industry is related to teaching (White and Horton, 1991) and there is also significant spend on industrial short courses.

30 Data from the DTI R&D Scoreboard and from university statistical returns show that over 98% of the £16 Billion annual industrial R&D spend in the UK is either 'in house' or contract research placed with other companies. Only about £250 million[1] goes into university research.

31 Although there has been a cash increase, in relative terms there has been a decline in industrial investment in university contract research from about 14% to less than 10% of the HE sector's R&D income over the last twenty years. The consequence is that, although there is extensive evidence that the international excellence of the UK research base has improved (May, 1997; Adams, 1998, 2002), the industrial share of support for the research base has not kept pace with either UK public support or the growth of European funding (Figure 1).

Figure 1 Research contract income from industry and commerce as a proportion of total project based research grant and contract income to UK universities (data from HESA) and the bibliometric impact (citations per paper, data from Thomson ISI®) of UK research compared to world averages



[1] HEFCE figures for 2002 suggest that this may have risen to about £328 million, calculated on a slightly different basis, This is good news, although it would not significantly affect the ratio between total BERD and business spend in HE.

32 To summarise, industry invests less in research than in teaching and, although universities do more and better research, industrial research support is now a relatively smaller part of universities' research funding than in the past.

The regional distribution of research

33 A number of observations are possible based on an analysis of the distribution of UK research. First, the development of the present UK research structure from the early 20th century established a strong concentration of major research facilities along the London-Bristol corridor prior to the development of the university research base or the modern industrial R&D base.

34 Second, staff, funding, PhD awards and research publications are highly concentrated in the three regions in the south east quarter of England. This area accounts for about half of England's research, or about 40% of UK research staff and a rather greater percentage of funding and publications (Table 1). There is a concentration of research excellence. On the whole, contrasting diversity in subject coverage or specialism between regions is less marked than differences in capacity and performance. Because of relative concentration, however, the south east has an exceptional level of biological and medical research while there is strong engineering and physical sciences in some other regions.

Table 1 University summary research data aggregated by regional groups (HESA data)

% of research activity by regional group	Research Active staff	Research grant and contract income	Industrial research contract income	PhD awards	ISI research journal papers

London, East and South East	40.1	46.8	43.9	40.5	45.5
Rest of England	40.2	34.8	38.2	41.8	36.1
N Ireland, Scotland, Wales	19.7	18.4	17.9	17.7	18.3

35 Third, an analysis has been carried out of data relating to the 700 companies on the DTI R&D Scoreboard to map the distribution of industrial R&D. Company names are linked to addresses for research publications and these are used to link both R&D spend and research articles to regions. The evidence again shows a concentration of R&D in south eastern England, and it is even more concentrated than public sector research. The three regions in the south east account for 60% of company R&D spend and 75% of company research publications (Table 2). While there is an apparent clustering effect, such clusters spread across regional boundaries as defined by RDAs.

Table 2 Regional distribution of R&D spend and research publications by top 200 companies in DTI R&D Scoreboard (data from DTI and from Thomson SI®)

Regional group	R&D spend		Publications on ISI database	
	£m	% UK	Count	% UK
London, East and South East	37027.7	61.9	13092.0	74.5
Rest of England	20528.8	34.3	4035.0	23.0
N Ireland, Scotland, Wales	2280.2	3.8	445.0	2.5

36 Most of the companies that produce research publications (a significant proportion are in the biotechnology-pharmaceuticals sector) are in the top 200 of the DTI Scoreboard. These spend £15 Bn of the UK's £16 Bn annual industrial R&D. Publications tend to indicate the support of research that is less near-market. There is a correlation between the volumes of expenditure and publication. In other words, overall commitment to R&D is reflected in engagement in collaborative research that is less near-market.

37 The combined picture is really rather stark. There are regional concentrations of public and private sector research and they are co-located around London and in the south east. The concentration of bio-pharma activity is most marked, in both sectors. Research output is more concentrated than expenditure in both sectors. And that part of industrial R&D that is most likely to engage with the research base, through collaboration and publication, is at the heart of the concentration. It is difficult to see how such a national concentration of infrastructure and activity could be re-balanced by regional strategies, even if it were desirable to do so.

38 The relatively undifferentiated spread of regional specialisms might suggest a lack of tuning to regional economies, but it is argued elsewhere that it may be beneficial to have regional research that is as diverse as the national research base (Adams and Smith, 2003). Rather than fitting closely to current industrial peaks, diversity offers a range of research support and innovation interaction across sectors and time.

39 To summarise, most regions reflect the national research base in diversity but the playing field for both university and industrial research is heavily tilted towards south eastern England. Research-intensive industry,

particularly in pharmaceuticals, seemingly has too little incentive to locate to other regions given the present balance.

The regional distribution of research collaboration

40 Many studies assert that for industry 'proximity matters' when it comes to research collaboration and knowledge transfer. The evidence on co-location of public and private sector research concentration seems to support this. In an era of global competitiveness and on-line knowledge bases, however, it is a legitimate question to ask to what it is that proximity matters.

41 Studies of research collaboration have shown that the average distance between collaborators has increased over time (Smith and Katz, 2000). An analysis of the university and public contacts of UK chemical firms shows that most research links are inter-regional (Charles and Howells, 1992).

42 For this paper, information about research publications authored by UK companies were analysed to determine which were co-authored with a UK university, what was the regional distribution of those co-authors and how many of the papers were co-authored with an overseas institution. Publication is an effective mode of engagement in research networks, is now more common among R&D active companies and signals research that is less near to market. On the other hand, culture plays a role: biotechnology tends to use journals to communicate more than does engineering which prefers conference proceedings.

43 The outcome is quite clear. R&D intensive companies collaborate with a wide network: these are the major publishers and the major R&D spenders. It is equally clear that these companies have much overseas collaboration. Proximity does not seem to be a constraint for such businesses. Does this

signal indicate that proximity is more important for some firms, or sectors, or types of company than for others? Or does it indicate that proximity is more important for some types of research interaction than it is for others?

44 To summarise, the signals on collaboration and on concentration (see above) should be read together. The companies that are co-located with the concentrated research base are also collaborating with universities all over the country and with other institutions outside the UK. This must lead to a re-consideration of the report by Goddard et al (1994) and his distinction between those research services that have a strong local base and those that do not. In other words, knowledge transfer activity is not all the same.

Regional economies and regional research policy

45 The significance of clusters to the innovation process has been acknowledged. The final pieces of evidence introduce analyses of the main sectors (clusters) of employment in each region and the cluster priorities of the Regional Development Agencies (RDAs).

46 Work for DTI by Trends Business Research (2001) demonstrates the spread of principal concentrations of employment (clusters) in each region. There is some differentiation between regions and the clusters in the south east seem to match the R&D base better than those in other regions, although there is some symbiosis in the East Midlands which has strength in engineering.

47 A review and analysis of the RDA web-sites leads to the overwhelming impression that RDA cluster priorities have a great deal of similarity. It was found that there is a particular focus on biotechnology-pharmaceuticals, communications and IT, leisure and media, advanced

engineering and tourism (Table 3). These are also common to many national strategies on economic competitiveness in other parts of the world.

Table 3 Priority cluster areas identified on web-sites of English RDAs and Scottish Enterprise

Cluster subject	S	NE	Y&H	EM	E	L	SE	SW	WM	NW
Health and medicine		X		X					X	
Biotechnology	X	X	X		X	X	X	X	X	X
Food and agriculture	X		X	X	X			X	X	X
Creative	X	X		X	X	X		X	X	X
I&CT	X	X	X		X	X	X	X	X	X
Environment	X			X		X	X	X	X	X
Advanced engineering	X	X	X	X	X	X	X	X		X
Tourism and leisure	X				X	X	X	X	X	X
Chemicals	X	X	X							X
Energy	X			X						X
Textiles	X			X						X
Finance	X				X	X			X	X
Manufacturing					X		X		X	
Transport					X		X		X	
Building							X		X	X
Marine							X	X		X

Data from surveys of RDA web-sites

48 While there is some overlap between employment clusters and RDA priorities, the employment clusters tend to relate to mature industries while RDA priorities tilt towards the R&D and innovation agenda of new industry.

49 The conclusion is, therefore, that, despite distinctions related to historic employment sectors, RDAs are relatively undifferentiated in their plans for innovative research clusters.

What are the implications for Government and RDA policy?

50 Universities provide many benefits to the economy, some of which are research based and others - like graduates - get added value from research. The balance of evidence confirms that R&D investment provides real returns in commercial innovation and competitiveness, and that clusters create good conditions for bringing producers and users of knowledge together. The regional dimension is unproven, but it seems reasonable to suppose that the development of appropriate clusters would promote regional economic development and would also further business-university links at a city level that might then benefit the wider region.

51 However, the literature review and analyses reported here suggest that funding more collaborative research is not the most likely route to increase the transfer of knowledge from universities to industry. Furthermore, it also seems unlikely that a regionally-based research strategy could significantly affect economic development without some more fundamental rebalancing of national research disparities.

52 The evidence in this report suggests that the problem for many RDAs will be that their industrial R&D base is weak, is not engaged with the research base and has little capacity to develop that engagement. In addition, the HE research base is strongest in the south-east alongside the most substantial R&D. For many of the companies in the other regions, finding money for collaborative research is unlikely to be the most congenial route forward, although it could be for newer businesses that have emerged from a research background.

53 The RDAs will also need to consider the challenge for the universities, which have seen a relative decline in industrial research support, which can see significant costs in working with companies with low research capacity

and, by the same token, which will see only low rewards a long way off in any new ventures. They will need significant persuasion and support to engage in this mission.

54 Because public support must not be linked to near-market research, that will also restrict the range of companies that can benefit from regional collaborative research funding. In fact, the greatest beneficiaries could be those who are already most closely engaged with the research base, publish widely and collaboratively and need least encouragement to maintain those links.

55 RDAs will also need to consider the wisdom of chasing the same opportunities. Their cluster priorities are both sensible and problematic. It is universally agreed that these areas are where great opportunities lie and where huge economic benefits might be found, yet it seems unrealistic to suppose that each region in the UK can possibly develop critical mass in all sectors. It seems even more unrealistic when the existing playing field in the key sectors is tilted so steeply towards one corner. RDAs should also apply a wary eye to the structure, scale and reality of the clusters in which they propose to invest and they should test the match between evidence and policy.

56 Research strategy and funding is currently organised at national level, and there are potential risks to be considered if this were to change. There is only so much funding from Research Councils; there are only so many talented researchers; there is only so much venture capital. The risks are both that small pulses of regional investment will be nugatory, failing to ignite cluster development at an adequate level, and also that there will be a competitive drain on existing excellence, spreading talent and resources to a greater number of smaller centres.

57 There are implicit tensions between regional strategies and national agencies. Will RDA plans tend to work against Government policies for supporting existing excellence? Will RDA priorities work against Research Council disciplinary strategies for structured investment in facilities and leading research groups? Will RDA investment increase HE's funding plurality, and will regional initiatives add to or detract from those at a national level?

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