2000 SPENDING REVIEW

CROSS-CUTTING STUDY OF SCIENCE RESEARCH FUNDING
ANALYSIS, ARGUMENTS AND PROPOSALS

CONTENTS

SECTION 1. INTRODUCTION AND SUMMARY OF RECOMMENDATIONS

What the Review was about

1. The cross cutting review of science research was one of several cross cutting studies undertaken as part of the 2000 Spending Review (SR2000). It was led by the Minister for Science, Lord Sainsbury, and supported by officials of the Department of Trade and Industry, Department for Education and Employment and the Treasury.

2. The review was remitted to **"Ensure that science that is supported from public funds is of maximum excellence and that it is exploited to the benefit of the economy at large".** The review considered the contribution of university research to economic growth and productivity. It examined how well current funding levels and mechanisms for publicly funded science research maximised this wider economic contribution. In particular the review was asked to:

- assess how well current funding mechanisms promote research excellence and the optimal balance between types and disciplines of research;
- develop proposals for funding university capital requirements which (a) make the money follow - and bolster - excellent research; (b) incentivise universities to make proper provision for maintenance, renewal and new investment;
- make proposals for ensuring that exploitation of research and interface with business are embedded in the core mission of universities; and
- ensure that Government departmental science and technology (S&T) spending plans sit well with funding proposals for the science and engineering base, and that they are underpinned strategically.

3. The review looked at science and engineering research supported by public funds (through the Higher Education Funding Council for England and the Research Councils); as well as funding by other Government departments of research and development in universities and public sector research establishments (PSREs).

4. The remit of the review did not cover the devolved administrations in Scotland, Wales and Northern Ireland. It therefore made recommendations in relation to the Higher Education Funding Council for England (HEFCE), the Research Councils (which cover the whole of the UK) and the science and technology activities of UK Government departments.

5. The working group reviewed the available research literature on the connections between science and economic growth. The group also conducted an extensive consultation, seeking the views of more than a hundred senior academics in 12 universities, as well as those of the Committee of Vice Chancellors and Principals (CVCP), the Higher Education Funding Council for England (HEFCE) and the Wellcome Trust.

Summary of conclusions and recommendations

Public funding for science

6. **Publicly funded science is increasingly important for the UK's innovation and productivity performance** in a globalising knowledge economy. It is also a vital underpinning of regional economic growth and of high technology clusters. There is considerable evidence of the links between science and economic growth (See Section 2), suggesting high rates of return to public investment in science. Other OECD countries have been increasing real terms spending on science.

7. **Current spending on the UK science base should, at the least, be kept constant in real terms** and there is a strong case for increasing the volume of research undertaken if resources are available. Increased spending on research in post-genomics, e-science and basic technology is in particular likely to pay economic dividends.

8. Trained personnel at the postgraduate and postdoctoral level are critical to maintaining the innovative capacity of the UK economy, both within the science base and in industry. The current PhD stipend of £6800 is uncompetitive and likely to become still less attractive to those who have taken out loans as undergraduates. To forestall an increasing potential problem of recruitment at this level, **PhD stipends should be significantly uprated.** There is also a need for universities to improve their capacity to recruit and retain top academic talent in an increasingly global market. This has implications both for the level of resources devoted to pay and for the flexibility with which these resources can be deployed.

"Dual support": the funding system for university research

9. The review looked at how well the current funding system – "dual support" - helped universities achieve critical mass in research effort and to deliver a satisfactory spread of effort across modes and disciplines of research. The review found that these objectives are broadly met within the current system, but that there is some room for improvement.

The review made a number of detailed recommendations in this regard, mostly in relation to the further evolution of the research assessment exercise (RAE).

Capital funding for research infrastructure.

10. **Overcoming the backlog of basic infrastructure investment is vital** if universities are to maintain excellent research, attract top international talent, secure funding from industry and charities and build and maintain effective links with business. This priority was recognised in the 1998 Comprehensive Spending Review, which established the Joint Infrastructure Fund (JIF), jointly with the Wellcome Trust.

11. The cross cutting review concluded that JIF will not be sufficient to clear the investment backlog, particularly in the repair, maintenance and upgrading of buildings. Further substantial investment will be needed. It should be ring-fenced to ensure that universities are not under pressure to switch funding from capital into current spending, and it should be allocated so as to provide incentives for universities to plan strategically and to build links with the private sector. Transaction costs should be minimised. That suggests that further funding needs the following key features:

- a single round of funding decisions for the SR2000 years;
- size of allocations to institutions to be determined largely by quality and volume of their research;
- universities to justify their allocations against a medium term capital plan, which relates to their research strategy; and
- universities to find some of the capital from their own or third party resources.

Commercialisation of research and collaboration with industry (knowledge transfer)

12. Universities' knowledge transfer activities take a large variety of forms, all of which have the potential to deliver large economic benefits. Universities increasingly see knowledge transfer as a core part of their mission, and associated activities and outputs are on an upward trend. Much of the activity is not fully self-financing for universities, despite the wider economic benefits. There is thus a market failure, which has been a brake on growth of activity.

13. The review recommended that Government should help to correct the market failure in the

following ways:

- a continuing and enlarged stream of funding through HEROBC (The Higher Education Reach Out to Business and Community Fund): in the short term to build up the capacity of universities to engage in knowledge transfer; in the longer term to reward universities against agreed performance measures;

- one further round of University Challenge to provide more seedcorn finance for commercialisation of research;

- one further round of Science Enterprise Challenge to give further momentum to the fostering of an entrepreneurial culture: cultural factors also to be addressed in universities' knowledge transfer strategies; but

- Government funds should not subsidise activities for which universities can or should recover the full costs - for example contract work for large firms.

Departmental spending on science and technology

14. Spending on departmental science and technology underpins service innovation, informs policy advice and equips departments to respond to anticipated and unanticipated change. It is as vital as investment in the science base and private sector investment in research and development but it must be properly directed to realise these benefits, and underpinned by proper strategies.

15. Departmental spending on science and technology must be sufficient to:

- underpin expansion or major change in service provision;

- allow the anticipation of new developments which have a scientific dimension and public policy implications ("horizon scanning");

- support policy in areas which are high priority for Government, fast-evolving, or of major public concern;

while also ensuring that resources are withdrawn from areas of declining importance.

Impact of the cross cutting review of science and research

16. The thrust of the review, and many of the detailed recommendations, were reflected in the SR2000 settlement for science and research. The Spending Review White Paper, and the White Paper "Excellence and Opportunity – A science and innovation policy for the 21st century", confirmed that the Government would increase combined DTI and DfEE spending on science research by annual average of 5.4% in real terms from 2000-01 until 2003-04. Key outcomes were:

- a new £1 billion capital programme in partnership with the Wellcome Trust to renew the infrastructure for science, providing world-class buildings and equipment for leading edge research;
- a £250 million boost to research in key new areas that will shape life in the 21st century: genomics, e-science and basic technology such as nanotechnology, quantum computing and bio-engineering;
- additional funding to increase over three years the basic support for post-graduate research students to £9,000 a year;
- a Higher Education Innovation Fund of £140 million over three years incorporating the Higher Education Reach Out to Business and the Community fund to build on universities' potential as drivers of growth in the knowledge economy. This will triple existing funding by 2003-04, to increase universities' capabilities to work with industry, particularly small firms;
- one further round of the University Challenge competition, to provide seed venture funding for knowledge transfer; and £15 million more into Science Enterprise Centres to bring business skills into the science curriculum;
- a commitment to publish science and innovation strategies for Government Departments, with anticipated real terms rises in the biggest civil R&D programmes – those of the Ministry of Agriculture, Fisheries and Food (MAFF), Department of Health (DH) and the Department of Environment, Transport and the Regions (DETR).
- a commitment to investigate whether there are any structural causes of underinvestment in universities' research capital.

SECTION 2: THE ECONOMIC CONTRIBUTION OF UNIVERSITY RESEARCH

Background

17. Science and technology are the vital underpinnings of the knowledge economy - in which comparative advantage will increasingly lie in the generation of knowledge and its exploitation to create innovation. The level of R&D in the economy is a crucial determinant of innovation. But the UK's innovation performance is relatively weak. Government is addressing this weakness through:

- measures to boost firms' investment in R&D and their capacity to exploit scientific and technical knowledge;
- improvements to personal incentives for enterprise through the tax system;
- boosting investment in the science and engineering base, including the 1998 £1.4 billion CSR settlement (jointly with the Wellcome Trust);
- measures to increase the commercial exploitation of science, and science base/industry interaction - eg University Challenge, Science Enterprise Challenge and the HEROBC fund; and
- measures to promote the development of high technology clusters.

18. Government recognises that firms' propensity and capacity to invest in R&D are critical to the innovation process. But publicly funded science research provides an essential underpinning, principally by:

- **Producing people with knowledge**: trained scientists and engineers who generate knowledge in the science base and apply their expertise to developing new products and processes for industry.
- **Generating and disseminating new knowledge**: scientific and technological developments with applications which can lead to new products and processes Tracking and interpreting the outputs of the 95% of world science conducted outside the UK is also of critical importance.

19. There is an increasingly recognised role for universities in contributing to national and regional economic growth and competitiveness through:

- attracting and nourishing high-tech clusters through research partnerships with major industrial players and the output of trained people;

- acting increasingly as the "research arm" of large corporations which are reducing their in-house research capacity;

- spinning out new companies and licensing technology;

- enhancing business competitiveness by transferring technology and people, problem-solving for firms, and helping to build up self-reinforcing networks of firms, scientists and financiers; and

- acting as advocates for local and regional economic development alongside Government agencies.

20. The role for publicly funded science cannot and should not be displaced by increasing private sector investment. The rationale for Government investment in basic science is to correct a market failure. Firms will most likely invest in applied R&D with specific, appropriable applications in mind, rather than in basic research, the benefits of which are longer term and more uncertain. Nor will firms tend to invest in very early development work before the proof of concept stage.

21. Publicly funded research is able to devote resources to curiosity-driven or "blue skies" research. The immediate payback is uncertain, but in the longer term such research is the source of breakthroughs of vital economic importance. Public science also increases the variety of scientific options available to firms: reducing the risk of "locking" society into sub-optimal technological solutions[1].

Evidence

22. There is a substantial literature on the relationship between science, innovation and economic growth. The importance of science to industry clearly emerges from the research evidence. DTI surveys quoted by SPRU[2] show that 50% of UK manufacturing firms cite universities as sources of information for innovation - with larger firms more likely to use universities.

23. A number of economic studies have explored the rates of return on publicly funded investment in science. The studies have a narrow focus and there is no UK evidence. (Indeed, there is a strong case for Government to support some UK research in this area). Nonetheless, most of the studies find a rate of return falling in the range between 20% and

[1] David, PA (1985) Clio and the economics of QWERTY. American Economic Review. Papers and Proceedings 75(2)

[2] Science Policy Research Unit, University of Sussex

50%[3]. Other studies have attempted to trace more directly the link between academic research and firms' behaviour. For example, Mansfield (1998)[4] found in a sample of US firms that 15% of new products and 11% of new processes could not have been developed (without substantial delay) in the absence of academic research. Beise and Stahl (1999)[5] reported similar findings in a sample of 2300 German manufacturing firms. Narin et al (1997)[6] found that citations of academic research in US and UK industrial patents tripled in a 6 year period.

24. Other developed countries, recognising these benefits, have been increasing public spending on science research and plan to continue to do so. They include the US, Germany, Canada, Japan, Finland, Denmark and Sweden. The CSR settlement for the UK science base went in the same direction, but not as far as other countries. The OECD[7] has argued that UK spending increases were "less ambitious" than for other member countries and that the new funding was "partly [to] compensate for lower spending over the early part of the 1990s".

25. There is a broad spectrum of activities that constitute knowledge transfer, reflecting wide variety in the nature of the science/technology, relevant applications and markets, local and regional factors, and the university's broad mission. The Government should not be prescriptive about the forms that knowledge transfer should take: they all have the potential to generate wider economic benefits. But there is an important role for Government in helping universities to pursue forms of knowledge transfer which they cannot fully self-finance, but which have wider economic benefits -eg helping to boost the performance of small and medium-sized enterprises (SMEs).

26. There are particular pitfalls in too exclusive a focus on university-engendered commercial spin outs, especially given the progress that has already been made on this front. Academic evidence suggests limits to the role of universities as commercial agents directly engaged in the exploitation of their own research. Florida (1999)[8] argues that universities

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[3] Ibid

[4] Mansfield E (1998) Academic research and industrial innovation. Research Policy 20

[5] Beise N and Stahl H (1999) Public research and industrial innovations in Germany. Research Policy 28

[6] Narin F et al (1997) The increasing linkage between US technology and public science. Research Policy 26

[7] OECD (2000) Science, Technology and Innovation Policy in OECD countries - a review of recent developments. Paris

[8] Florida R (1999) The role of the university: leveraging talent, not technology. Issues on Science and Technology Vol XV (4)

should be seen primarily as a source of talent not technology. US universities have been most successful in supporting economic development when they have been free to develop and disseminate ideas and recruit and retain talented people.

27. Geuna (1999)[9] maintains that knowledge transfer is best achieved when universities are able to conduct high quality research, and that short-term aggressive and narrow drives to encourage universities to commercialise technology can be counterproductive (by diverting resources and expertise away from research).

28. Similar issues were raised by the CVCP[10] in a recent report on the US experience of technology transfer from universities. Key success factors in the US include:

- continuing large scale public sector investment in basic research;
- an entrepreneurial, pro-business culture in universities, with knowledge transfer treated as a "public duty" mission;
- strong incentives for staff to engage with business
- properly organised and funded university knowledge transfer efforts;
- an entrepreneurial business culture more generally, including high availability of risk capital and management skills, and a high level of entrepreneurialism among students and graduates - indeed much of the spin out and clustering phenomenon noted in US universities like MIT and Stanford can be attributed to these factors.

Policy implications

Research

29. The UK produces 4.5% of world science, so cannot expect to be pre-eminent across the board (though it punches above its weight, with 8% of publications and 9% of citations). But in a globalising knowledge economy, **the UK must nonetheless maintain both breadth and depth in its science base** and seek to ensure that as much as possible of its science research is of world-class standard.

30. A *broad* science base maximises the synergies between research, teaching and knowledge

[9] Geuna A (1999) The economics of knowledge production. London. Pinter

[10] Technology Transfer: the US experience. Report of a CVCP mission funded by the Gatsby Charitable Foundation, 1999

transfer activities; these activities are closely intertwined and mutually reinforcing. Breadth of scientific endeavour provides the platform for inter-disciplinary research, which is increasingly where cutting edge developments are located. Breadth also ensures that the UK retains sufficient expertise to effectively track, interpret and translate leading edge research developments overseas.

31. A focus on research excellence, particularly internationally benchmarked excellence, is vital to maintain and enhance the UK's position where it is already a world leader. Excellence is also increasingly a prerequisite for:

- attracting the best academics and students in an increasingly competitive and international market for people;
- international academic collaborations, which are increasingly important for keeping UK science at the cutting edge. Excellence and good reputation are the "entry ticket" for such link-ups; and
- engaging business in partnerships and collaborations - most typically when large companies need access to leading-edge research.

32. These considerations, coupled with the evidence outlined above, create a strong case for holding spending on the science base at least constant in real terms - and a strong case for increasing spending.

Knowledge transfer

33. The above evidence suggests that Government should encourage universities to pursue knowledge transfer activities in line with their broader strategies. Government funding should help universities pursue those activities which they are unlikely to be able to self-finance fully, but which generate wider economic benefits.

34. The US experience highlights the importance of creating a more entrepreneurial climate within universities, among their graduates and in the business community more generally - and suggests that there are limits to the focus of Government policy and funding on direct commercial spin outs. In the UK the University Challenge and Science Enterprise Challenge schemes have been helpful in encouraging commercialisation by providing supporting infrastructure, and promoting an enterprise culture, rather than distorting incentives. Further support of this sort is likely to be particularly fruitful, against a background of improved personal incentives offered by the Government in its more general tax changes.

SECTION 3. RESEARCH FUNDING

Remit

35. The relevant review remit was to **"assess the extent to which the current funding mechanisms promote research excellence and the optimal balance between types and disciplines of research, and any proposals for changes."**

Introduction

36. Government funding for the science base is provided under a dual support system. The Funding Councils -in England the Higher Education Funding Council for England (HEFCE) - provide core funding for university research, paying for the costs of staff, premises, libraries and central computing. Allocations to universities are driven by a periodic assessment of their research quality - the Research Assessment Exercise (RAE). The Research Councils allocate project funding on the basis of competitive bids. They fund direct project costs and a proportion of indirect costs.

37. The 1999-2000 HEFCE contribution to research was £855million, with the Research Councils funding a further approximately £730million in the universities including support for postgraduate student. A further £300m or so of Research Council money is estimated to support university researchers, although it is directed through Research Council institutes, and national and international facilities. Universities also receive substantial research income from a variety of other sources, in particular other Government departments (some £300 million), UK charities (some £400 million), UK industry (some £210 million), and overseas including the EU (some £250 million).

The dual support system

38. The review considered whether the dual support system is the most effective or efficient means of delivering funding for the science base. It found that the system is effective on the whole but needs further refinement. It suggested guidance on a number of matters (see below) which HEFCE should take account of in its current review of research policy and funding. But the review saw no case for a fundamental overhaul of dual support - for example, merging the dual support streams.

39. A key strength of the system is that it maintains plurality and balance in public funding for the science base. HEFCE funding gives universities the capacity to undertake research, and in particular the flexibility to pursue "blue skies" research and develop new areas of excellence. Research Council funding ensures that science research relates to

Government's strategic concerns - for example the need to exploit the opportunities afforded by human genome sequencing. There is a need to maintain balance in the funding devoted to core and project funding; and to blue skies and strategically driven research - to minimise the risk of over-determining the direction of university research (and thus putting Government in the position of picking winners).

Research excellence

40. The key driver for excellence in the funding of research is the RAE. The review examined the RAE in detail, consulting universities, HEFCE, and the CVCP, and taking account of HEFCE's fundamental review of research policy and funding, which is currently out for consultation. The cross cutting review found no evidence of a need for radical reform of the RAE, but raised a number of concerns which point to some modest changes in future RAEs.

41. The RAE and the HEFCE formula for translating RAE ratings into allocations for universities command widespread legitimacy - even among those institutions that are critical of aspects of the system. It is also clear that the RAE has been a huge driver for improved research excellence. The review noted that the RAE incentivises universities to improve recruitment and retention of key staff, to address poor infrastructure and to look hard at critical mass of research effort (in some cases leading to mergers of departments - see below). The assessed excellence of UK science improved significantly between the 1992 and 1996 exercises - an uplift that cannot be attributed solely to universities getting better at "playing the system" (although this was undeniably an element). Further improvements are widely expected in the 2001 exercise.

42. The review also looked at selectivity - the degree of concentration on RAE funding on the best facilities. The RAE needs to reinforce research excellence - which calls for considerable selectivity. But it also needs to nurture emerging areas of excellence or promise, which could be tomorrow's world-beaters. Not all of these pockets will be in the traditional research-led universities. Too much concentration of resource could cut off this seedcorn funding. The result could be a loss of dynamism in the system leading to ossification and ultimately atrophy of UK research capability.

43. The review concluded that the current degree of selectivity is broadly right, but might need further refinement. RAE funding is already highly concentrated - with 75% of funding going to 25 institutions. RAE funding has also enabled some new universities to develop areas of real strength in particular research niches.

44. The review identified no need for Government to become involved in HEFCE's review at the level of detail, but recommended that Government press on HEFCE the importance of:

- maintaining the drive for excellence and in particular preventing performance ossifying or reaching a plateau in top-rate departments;

- nurturing emerging centres and pockets of excellence across the university sector, including the new universities (which means recognising the limits of the scope for greater selectivity);

- universities making resources available for growing new areas of research excellence;

- recognising and rewarding excellence in cross-disciplinary research (identified as a possible weakness in the last RAE);

- recognising and rewarding excellence in applied and industrially relevant research (another perceived weakness in the current system) - and making a reality of HEFCE's commitment to give parity of esteem for patents, for example, as a form of research publication for assessment;

- ensuring the minimum necessary administrative burden on universities in preparing for future RAEs (a widespread complaint about the RAE); and

- developing international benchmarking as a means of assessing research excellence.

Funding requirements

45. The analysis in Section 2 sets out the economic importance of public investment in science. Like all forms of investment, there is a theoretical risk of diminishing returns. But in the context of a fast-changing economy the limited risk that we might have reached this point is significantly outweighed by the risks that would attach to insufficient investment. The periodic re-allocation of resources within the system, with Research Councils and universities responding to changing demands, is also critical to ensuring that the best is made of the investment Government makes.

46. Against this background the review saw a very strong case for holding the real terms value of investment in the science base at least constant in real terms, and it favoured some enhancement of real terms current spending. In particular, **increased research in the area of post-genomics and informatics has the potential for economic pay-off.** There is a need for the UK to capitalise on the opportunities arising from human genome sequencing. This work will lead to new drugs, better disease diagnosis and better environmental management - but it is pre-market and therefore will only happen with public funds. Given its leading position in genomics, the UK is well placed to reap the social and economic benefits, and the returns on the investment should be good.

47. Additional funding would also allow an enhancement of the UK's work on informatics (or e-science) - research leading to the convergence of IT, computing, communications and electronics, which could put the UK in a strong position to shape and exploit the next generation of the Internet. A key part of this is the generation and handling of unprecedented volumes of data in many areas of science - leading to global data systems. The UK's contribution can only advance through international collaboration, in particular with the US, where both the public and private sectors are investing heavily in these areas. This would, however, require the UK to offer a significant contribution to the overall activity. Further enhancements are also needed to research in certain basic technologies to underpin aspects of the science base (witness the demands of particle physics for computing technology), to provide the platform for future product developments, and to maintain the attractiveness of the UK to mobile, technology based firms.

48. **Support for postgraduates**. Trained personnel at the postgraduate and postdoctoral level are critical to maintaining the innovative capacity of the UK economy, both within the science base and in industry. The current PhD stipend of £6800 is uncompetitive and likely to become still less attractive to those to those who have taken out loans as undergraduates. To forestall a potential problem of recruitment at this level, PhD stipends should be uprated significantly. More broadly there is also a pressing need for universities to improve their capacity to recruit and retain top academic talent in an increasingly global market. This, among other things, could mean a move away from standard, sector-wide salary scales.

49. **Restructuring and mergers.** The RAE has encouraged a growing interest in departmental mergers between institutions to achieve critical mass and realise efficiency savings. An example is the joint Manchester/UMIST Materials Science department (which is 5-rated in the RAE and a JIF winner). The review was clear that there is potential for much more of this kind of restructuring.

50. There are financial barriers to realising these benefits. To the extent that mergers will increase future revenue streams or reduce costs, they can be financed by borrowing. But mergers can also lead to reduced income (eg if student places fall). And they can carry deadweight costs - for example, decommissioning, redundancy - which can be high and which universities cannot self-finance. In these circumstances, it can be difficult for a university to drive such change, despite the wider benefits. In recognition of these financial barriers, HEFCE has been running a £15m pa fund to support restructuring, but this has been able to achieve only limited impact and it is not restricted to science or to research.

51. There is a particular need to help the sector rationalise research activity in high-cost areas that also suffer from static or declining student numbers - chemistry, physics and

engineering being prime candidates. Any resources for this would be distributed on a cost-sharing basis with universities. Allocations would be in response to proposals from universities, but there would be merit in looking at necessary provision subject by subject.

Optimal balance between different types and disciplines of research

52. Government also has an interest in the relevance of research to broader economic and other policy objectives. The "relevance" agenda for the science base is driven by the Research Councils, which support research efforts in particular areas (eg in post-genomics or informatics) which fit with strategic priorities. In a broad sense, this is "directed" research (albeit that much Research Council funding is awarded in response to research proposals from grant applicants). Part of the science base is also "undirected", with universities producing curiosity-driven or "blue skies" research, largely on the back of Funding Council funds.

53. Both directed and undirected research give rise to important developments. There clearly needs to be a balance between the two. The review concluded that the central Government cannot and should not determine the optimum balance between directed and undirected research and between different areas of research. This is mainly because research is highly dynamic - with needs, opportunities and priorities constantly evolving. The test of a functioning research funding system is how well it facilitates, rather than hinders such dynamism. The review therefore explored in consultation with universities and the Research Councils:

- whether universities felt they had the freedom to develop their research portfolios in line with their own strategies, building on their existing strengths and taking risks as necessary (a measure of dynamism at the "undirected" end of the spectrum); and

- whether Research Councils felt that the universities had been able to respond effectively in recent years - coming forward with excellent research proposals in areas which the Councils identified as priorities (a measure of dynamism at the "directed" end of the spectrum).

54. There was a broadly positive response to both these questions. But there were some qualifications. Universities reported varying degrees of constraint on their ability to build up new areas of research as fast as they would have liked. Research Councils felt that their own ambitions in the universities have been limited - mainly by:

- problems with capital infrastructure;

- shortages of research active staff in particular disciplines and of technicians;

- difficulties in recruiting PhD students and research assistants.

55. The review saw no evidence here of any systemic problem with the dual support system itself. Rather this feedback confirmed more general problems of resourcing and recruitment and probably also reflected the irreducible friction to be found in any large system that is asked to respond to rapid change.

56. Universities have the freedom to distribute RAE monies as they see fit and are under no obligation to follow the HEFCE methodology. In practice, universities adopt a range of approaches. Some follow the HEFCE approach closely in the interests of transparency. Others top slice significantly to provide seedcorn funding for new areas of research or to improve areas of relative weakness.

57. There is no universal model, nor should there be one, but universities must preserve their flexibility to develop their research portfolio or it will ossify. It is in their longer- term interests to do just that, since flexibility allows them to respond to the demands of Research Councils and charity and industry funders, and thus increase their research revenues. Nonetheless, the review saw merit in HEFCE giving guidance to universities on the importance of this point.

SECTION 4. CAPITAL FOR UNIVERSITY RESEARCH

Remit

58. The relevant review remit was **"to develop proposals for funding university capital requirements which (a) make the money follow - and bolster - excellent research; (b) incentivise universities to make proper provision for maintenance, renewal and new investment".**

59. The review considered both the levels of infrastructure funding needed for the science base in the SR2000 years, and the mechanisms for distributing it. It used analysis provided by OST and HEFCE and evidence submitted by universities and others.

Introduction

60. Under dual support both HEFCE and the Research Councils have a role in meeting the capital costs of research. Historically, HEFCE bore the responsibility for funding the capital infrastructure - buildings and equipment - while the Research Councils met the direct capital costs - mainly equipment - associated with particular research projects it supported.

61. In response to the accumulated backlog of infrastructure investment during the 1980s and 1990s, the CSR established the £**750m Joint Infrastructure Fund** (JIF) including £300m from the Wellcome Trust, as the principal mechanism for funding research capital infrastructure. JIF - an OST-led process - awards capital funds on the basis of a project-by-project challenge competition. The CSR separately provided £150m for research capital infrastructure, which HEFCE is distributing on a formula basis.

62. There has been no other funding stream in the CSR years specifically for basic research infrastructure. HEFCE have set aside £250m (in the period 1998/2002) for improving poor university estates - but this covers the entirety of university activities including non-science disciplines and teaching. The Research Councils have made capital funds available to support specific projects and for national facilities. The Joint Research Equipment Initiative has delivered £270m since its inception in 1996 - including matched funds from the private sector - for specific equipment needs.

The investment backlog

63. There is clear evidence of a continuing large-scale investment backlog for university research infrastructure. The review identified three broad reasons for this backlog:

- **Historic underfunding**: capital spend in universities was severely constrained in the 1980s and 1990s and, following the 1995 public expenditure survey, capital was no longer separately specified in Government's allocations to HEFCE. The review estimated that this resulted in a reduction of some £150m per year in the amount that universities spent on research capital;

- **1960s and 1970s estate**: much of the university estate arising from the building boom of the 1960s and 1970s is at or near the end of its useful life; and

- **Changing requirements for research**: in particular the growing need for accurate environmental control in life sciences laboratories, and growing health and safety requirements.

64. The review's key findings on capital in its consultations with universities were as follows:

- **Capital investment is the biggest problem for university research**. There is a critical need to upgrade buildings that are no longer fit for purpose – for the reasons listed above.

- **Good facilities are vital for doing excellent research**, recruiting top academics, attracting funding from industry and charities, and sustaining links with business. Better infrastructure will lead to better science, while poor infrastructure threatens to undermine research and links with business.

- **JIF funds have not been optimally targeted** on the problems they were meant to tackle. Universities perceive that the JIF mission shifted significantly from the original aim of restoring an investment backlog toward underpinning new or expanded research activity. There was felt to be a bias toward novelty, and towards equipment rather than fabric. This bias was felt to have influenced the nature of the bids put forward, as well as the judging process. While JIF funds had been very welcome, a lot of essential but unglamorous work remained to be done.

<u>Quantifying the funding need</u>

65. The review attempted to quantify the continuing need for capital investment in university research. Quantification of the funding need cannot be precise because:

- the split between the research and teaching elements of universities' capital spend is not fully known (the current Transparency Review should help);

- there are problems in defining the "backlog": there is no precise distinction between forward-looking and catch-up investment. This is compounded by uncertainty about the extent to which JIF has funded basic underpinning infrastructure, rather than the more specific capital costs associated with new research.

66. In the light of the views of universities themselves, and those of HEFCE and PREST, and of data emerging from the JIF process, the review concluded that the total funding need for research infrastructure (including buildings, equipment and maintenance, but excluding project-specific investments) could be in the region of £1 billion for years 2 and 3 of SR2000 (funds already being committed, and accounted for in year 1).

Funding mechanism

67. The review concluded that a large-scale challenge competition along JIF lines is not the most suitable way of distributing infrastructure funds. Consultation with universities revealed a consistent view that:

- JIF cut across universities' capital planning and prioritising and amounted to Government micro management. There were several examples of universities succeeding in lesser priority bids, but failing in their most important ones.

- The bidding process itself had imposed heavy costs on universities. The requirement to present full bids, including outline planning permission, despite the low probability of success, had committed large resources unproductively.

68. The review concluded that its remit in this area - to make capital funding follow research excellence and to incentivise universities to make proper provision for capital - calls for a largely formula-based allocation of funds. Universities' reactions to JIF also underlined the need for a funding approach that empowers them to invest strategically and which minimises transaction costs. The review was also keen to ensure that public funds for capital can be used to lever in additional sources of funding, through public private partnerships or other means.

69. The review proposed a funding mechanism for the SR2000 years which is designed to meet these criteria. In its consultations with universities and with HEFCE and CVCP, the review found broad support for this approach. The key features were:

- Funding for capital infrastructure in both HEFCE and OST provision should be distributed as much as possible on a common basis for years 2 and 3 of SR2000 (year 1 funds are already committed). The ideal would be a single, "virtual" pot for England. (In Scotland, Wales and Northern Ireland, it would be for the devolved administrations to decide whether and to what extent they matched OST funds).

- There should be a single round of spending funding decisions. Money must be ring-fenced so that universities are not under pressure to vire it into current account spending.

- Some OST funds would need to be held back for capital investment in Research Council Institutes and for large national facilities.

- The fund would be for infrastructural backlog, new projects and ongoing maintenance. It would be for universities to decide and justify the balance between these elements.

- Indicative allocations for years 2 and 3 for each university would be calculated by a formula that takes account of both the excellence and volume of research conducted. Universities would have to justify their allocations against a medium term capital plan for research, relating investment plans to their research strategies.

- There should be a light-touch assessment of university plans.

- Universities would be asked to find additional resources – equivalent to 33% of their allocation from Government and expected to raise these themselves or from third party sources. The Government contribution would thus represent 75% of total capital spend on research. It would be for universities to determine how to do this - eg by various kinds of public private partnership including direct sponsorship of facilities, using reserves, or borrowing against increased revenues generated by the planned investments.

70. This last requirement would encourage universities to reach out to their local and regional business communities and to form partnerships. It would also provide an important reality check on university capital plans (by requiring them to contribute to the cost).

71. Consultation with universities and with others supported the view that the requirement for universities to find 25% of total capital funding themselves would be stretching but realistic. It compares, for example, with HEFCE's requirement that recipients of its grants under the Improving Poor Estates strategy find matching funding. The 75%/25% split would apply at the aggregrate level for each university. There would be no requirement for universities to raise 25% of the costs relating to each investment in their capital plans (and, indeed, this would be impractical).

SECTION 5. EXPLOITATION OF UNIVERSITY RESEARCH AND COLLABORATION WITH INDUSTRY

Introduction

72. The relevant review remit was to **"develop proposals for the mix of financial incentives and other mechanisms which best ensures that exploitation of research and interface with business are embedded in the core mission of universities."**

Review's assessment

73. Section 2 showed that the economic impact of direct knowledge transfer routes is now better understood and increasingly encouraged. These routes range from the exploitation of university intellectual property - via licensing and spin out companies - to various forms of collaboration with industry. All universities have the potential to contribute in this field and Government funding mechanisms need to reflect and encourage breadth of participation.

74. The rationale for Government intervention in this area is to encourage universities to engage in activities which create wider economic benefit, but which produce inadequate short-term returns to the university without some help - either because they require an up-front outlay with a long-term payback, or because they will never be fully self-financing for universities. Universities will have insufficient incentive to engage in these activities, despite the likely benefits. Such activities fall into three broad categories:

- **capacity building**: eg recruiting experts in technology transfer; building a proper interface with business; establishing robust systems for identifying and managing intellectual property portfolios;

- **seed funding** for early stage feasibility work on commercialisation proposals; and

- **services for industry** for which the costs cannot be fully recovered (eg advice and expertise for SMEs, research collaborations involving several firms).

75. Conversely, there is no rationale for Government to support universities, for example, to undertake contract research for large firms or run courses for business people.

76. As Section 2 makes clear, Government support for knowledge transfer should go with the grain of university knowledge transfer missions, which should in turn derive from universities' research and teaching strengths. Government should be specifically concerned with removing barriers to economically beneficial activity. Government should not allow the knowledge transfer imperative to be pursued to the detriment of research and teaching, or focus too narrowly on particular forms of knowledge transfer, particularly

university-led commercial spin outs (which would also have the effect of down- playing the contribution of non-research-led universities).

Overview

77. The review's research and consultation confirmed the following broad picture of the knowledge transfer scene in UK universities:

- **Activity and outputs are on an upward trend**; a more entrepreneurial culture is developing and many universities now have high level champions for knowledge transfer and links with business. But the growth of activity has been slowed by market failure. Knowledge transfer is not fully self financing for universities, which have had to rely on limited sources of public funding - including European funding - or on the relatively small sums they can make available from their own resources.

- **There is a large variety in approaches to knowledge transfer**, linked to institutions' overall strengths and missions, and regional economic factors;

- **Universities are at largely differing stages of development** in knowledge transfer. In some it is long established. In others, there has been a marked ramping up in recent years.

78. Recent research commissioned by the Association of University Teachers tends to confirm that the university sector is in a state of transition, with much progress made, but more to be achieved. The research showed that 40% of academics were in favour of moves towards a more entrepreneurial culture, but 25% opposed. 7% of academics were reported to spend more than 5 hours a week on activities related to the local or national economy.[11]

79. Universities have welcomed the Science Enterprise Challenge scheme as a means of helping to embed an entrepreneurial culture. There is clearly further to go in this direction. Universities emphasised the importance of personal incentives for staff as an agent of culture change - in particular allowing time to engage in knowledge transfer, and ensuring suitable recognition, and reward - including career progression - for this work.

Knowledge transfer capacity

80. Universities need the capacity to underpin knowledge transfer and contract research

[11] University staff and the knowledge based economy , Williams et al, AUT/University of London Institute of Education, March 2000

activities. Essentially this means the right people: skilled professionals at the academic/business interface to manage commercialisation and technology transfer processes and to present an efficient “shop front” to business and the wider community. Many universities need to build up this capacity further. The current HEROBC fund has provided small sums for such capacity building and universities have welcomed this initiative. Universities have also praised the relative lightness of the administrative burden imposed by the scheme.

<u>Commercial exploitation of research</u>

81. There is growing experience of commercialising intellectual property, through licensing technology and spinning out commercial ventures. There has been an acceleration in activity here. It was put to the review that, for example, UMIST reported creating three spin outs a year, and Strathclyde four a year. Manchester was averaging one to two equity sales and 30-40 patent applications a year. Imperial had a total of 37 spin outs - mostly created in the last three years - and was now spinning out about one a month.

82. In the longer term – ie seven to ten years - this activity should be self-financing for universities, with revenues from royalties, licensing and the sale of equity stakes being ploughed back to seedcorn early stage feasibility work, meet patenting costs etc. There is evidence that universities that have been commercialising technology for many years - eg UMIST and Strathclyde - are now approaching break-even point.

83. As they move towards self-sustaining commercialisation, universities identify a funding gap at the earliest, proof of concept stage (where sums of £50,000 to £100,000 may need to be deployed to test the feasibility of commercial propositions, and may well be lost). The private sector will not fund this early stage work, and universities cannot easily find the resources.

84. The University Challenge scheme was designed to fill this funding gap. It has been strongly welcomed by universities, and there are calls for a further round of the scheme, to open it up to another, say, 15-20 universities.

85. But there is some evidence that the financial performance criteria for University Challenge funds are too tight, and that in practice the scheme has not filled the gap at the proof of concept stage. The criteria might need to be amended for a second round of the scheme.

<u>Building regional competitiveness</u>

86. Contract research for industry, charities and Government departments is well established and a substantial source of income for many universities. Some institutions are now marketing themselves aggressively to increase and diversify their sources of contract

income. Universities vary in their success at ensuring they are fully remunerated for contract work. Government departments and charities do not contribute to indirect costs, which is a source of difficulty and frustration for some universities. Industrial clients are generally - but not universally - more prepared to meet full costs.

87. Universities are also engaged in a variety of other work with and for firms, particularly SMEs, which includes research; problem-solving; the transfer of technology, people and expertise and the fostering of networks of firms and those who support them (advisers, venture capitalists, business angels etc). The review was impressed by the efforts of some universities in this arena, and has noted a number of key features of this work:

- it delivers wider economic benefits, contributing significantly to regional economic growth and competitiveness, and cluster development;

- universities' expertise, independence and strong brands can give them particular advantages in delivering support to firms alongside Government agencies;

- the work is generally not fully self-financing for universities, some of which explicitly see this as a "public duty" function.

88. Public funding has therefore been crucial for making these activities happen. The sources of most relevance to universities have been:

- European structural funds - in areas where these are available;

- the TCS (Teaching Company Scheme) and LINK schemes, which universities in particular have praised;

- HEFCE's top-sliced "generic research" or GR funding (£20 million pa) which supports research collaborations with no single beneficiary and where the university retains the intellectual property.

The need for consolidation of schemes

89. A small number of flagship schemes seems to have significantly engaged universities, and been positively received. These are: University Challenge, Science Enterprise Challenge (which were one-offs), TCS, LINK, HEROBC and Faraday Partnerships. Other schemes by and large do not appear to have much impact. This adds weight to the argument that a broader rationalisation of schemes is needed which offers the possibility of greater impact through consolidation.

What is needed for the SR2000 years

90. In the light of the preceding arguments, and of consulation with universities and others, the review reached the following conclusions.

91. Universities need further help and encouragement from Government in their efforts to transfer knowledge to the wider economy. This must go alongside measures to stimulate industry demand for university research outputs and expertise.

92. Government involvement needs to come mainly - though not entirely - in the form of funding to build the capacity of universities to engage in knowledge transfer, and to reward them to undertake economically beneficial activities which are unlikely to be entirely self-financing. But Government should not be prescriptive about the forms that knowledge transfer should take, since routes to market vary according to the nature of the science/technology, type of institution, relevant applications and markets, and local and regional factors.

93. The need above all is for a continuing stream of funding, which sends clear signals to the university sector that knowledge transfer is a core part of universities' missions. That will require existing baseline provision for knowledge transfer to be rolled forward, and there is a strong case an overall uplift in provision.

94. At the same time, resources for knowledge transfer should properly reflect the costs to universities, which are of a different order of magnitude to the costs of research and teaching. A massive expansion of funding here would risk delivering poor returns - particularly if resources were diverted from research or teaching.

95. On funding streams for knowledge transfer, the review recommended:

- More funding through HEROBC in the short term to build up the capacity of universities to engage successfully with business and get their commercialisation activities to critical mass; this funding to be awarded on the basis of universities' knowledge transfer strategies, which should address action on the cultural front, including personal incentives for staff.

- Beyond immediate capacity building, a continuing stream of HEROBC to reward universities against agreed, tested and robust metrics for performance in knowledge transfer - in particular recognising activities which build the competitiveness of SMEs, and other work with industry where there is a wider "public good" spin off to the universities' participation.

- The next round of HEROBC should address both short term and longer term needs. University bids should be invited which in particular address capacity building and activities to build the competitiveness of SMEs.

- Another round of University Challenge to widen the availability of seedcorn finance for early stage commercialisation work and help bring forward the break-even point for commercialisation activities;

- Another round of Science Enterprise Challenge to give further momentum to the fostering of an entrepreneurial culture - where more needs to be done.

- University knowledge transfers strategies should also explicitly tackle cultural factors. Universities need to demonstrate that they have thought creatively about how to use their reward and incentive structures, and other relevant means, to ensure that academics are properly encouraged in their effort to exploit research outputs or collaborate with industry - and that they can achieve meaningful status for so doing. Options include, for example, allowing academics sabbaticals to pursue exploitation or collaboration, and awarding some personal chairs in the light of performance in knowledge transfer as well as in research.

96. The review was clear that there is no case for subsidising universities to undertake work for which they can and should fully recover costs - in particular contract work for larger firms.

97. There is a strong rationale for consolidation of knowledge transfer schemes in terms of improved impact of Government support, and more efficient delivery. In particular, attention should focus on the scope for enhancing initiatives like TCS and Faraday that have been successful and well-received (as well as removing schemes that are no longer needed).

98. Universities should be accountable for the resources they devote to knowledge transfer resources and for the outcomes that result. The Review saw accountability as an important determinant of behavioural change, helping to embed a more entrepreneurial culture in universities. It recommended that universities be required to account periodically to their key stakeholders including, for example, the RDAs, for performance in this area. This must not become a major bureaucratic exercise for universities. They could, for example, report progress against the strategies (and metrics) which they would anyway to need to submit for HEROBC funding. Indeed, such periodic reporting could be made a condition of HEROBC funding.

SECTION 6. DEPARTMENTAL INVESTMENT IN SCIENCE AND TECHNOLOGY

Introduction

99. The relevant review remit was to **"ensure that Departmental S&T spending plans are properly addressed in SR2000 and that they sit well with funding proposals for the science and engineering base. In particular, to ensure that Government departments' spending plans for S&T are made in the light of medium term science and innovation strategies**".

Departmental S&T spending

100. Departmental spending on S&T underpins service innovation, informs policy advice and equips departments to anticipate and respond to economic, social and environmental changes, and in particular the challenges posed by globalisation.

101. Just as business needs to invest in R&D to remain competitive, and Government as a whole needs to invest in the science base, so individual departments must commit to R&D in the interests of public service productivity. In a globalising knowledge economy, Government departments, like firms, need to become more knowledge-intensive to add value. In particular, departments need to ensure that short-term considerations do not overly influence decisions on the level and direction of research funding and that they devote sufficient resource to anticipating new developments ("horizon scanning") with a scientific dimension.

102. The review recommended that spending decisions in the SR2000 context should be underpinned by science and technology strategies and that departmental ministers take particular care to ensure that S&T spending is sufficient to:

- underpin expansions or major developments in service provision
- support policy in areas which are high priority for Government, fast-evolving, or of major public concern
- undertake "horizon-scanning"

while also ensuring that resources are withdrawn from areas of declining importance.

SECTION 7: OTHER ISSUES

103. The review heard evidence of problems which were strictly outside its remit but which have a significant bearing on the ability of universities to deliver research and wider economic outputs. The review recommended that DfEE and HEFCE should together consider relaxing constraints on universities that hamper their ability to act in a strategic, business-like way. In particular they should:

- Look at how to encourage universities to make optimum use of their financial flexibility, particularly in borrowing ;

- Identify and if possible remove any barriers to universities entering into public private partnerships where appropriate, with particular reference to VAT liabilities;

- Improve flexibility in the maximum allowable student number (MASN) constraint, to try to ensure that centres of research and teaching excellence have scope to expand their provision where over-subcribed at undergraduate level. The aim here is to ensure that MASNs do not prove a constraint on meeting regional skill needs – limiting the output of high quality graduates needed to underpin regional economic clusters.