A THE ECONOMIC CASE FOR INVESTMENT IN SCIENCE AND RESEARCH

Summary

A.1 This chapter summarises the economic evidence supporting public investment in the science base. It highlights the need to embed this science core within a broader well-functioning national innovation system, involving the investments and actions of many other public and private sector actors. Finally, it presents evidence on the internationally measured quality and impact of UK science.

Economic Benefits

A.2 Modern economies recognise the importance of a strong public science base to support improvements in welfare. The outputs we get from the science base, which include new knowledge, skilled people, new methodologies, and new networks, have contributed to improvements in the things that matter to us, such as our wealth, education, health, environment, and culture. They have also improved decision-making about the governance of these things, including better public policy.

A.3 It is difficult to quantify the contribution of science to advances in these areas, but a wide range of economic studies over a long period have recorded a range of direct benefits to the economy as a whole and to firms individually. Surveys of the views of R&D managers suggest that academic research has led to innovation accounting for up to 5 per cent of industry sales.[1] [2] [3] Patent data has also been used to identify the importance of public research for innovation.[4] Evidence from Australia, for instance, found that 90 per cent of research papers cited in Australian-invented US patents were publicly-funded. There have been fewer studies of individual industries but those of the pharmaceuticals industry highlight the importance of public investment in science, with one study recording a 30 per cent return.[5] [6]

A.4 Research confirms that engagement between innovators and the science base creates real welfare benefit. An important recent study by the OECD found that 1 per cent growth in public R&D leads to a 0.17 per cent increase in total factor productivity in the long run.[7] Moreover, this effect increases with the share of public science conducted in universities. Other studies confirm the positive contribution of academic research to economic growth.[8] [9]

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[1] *Academic research and Industrial innovation*, Mansfield, Research Policy, 1991

[2] *Academic research and Industrial innovation: an update of empirical findings*, Mansfield, Research Policy, 1998

[3] *Public research and industrial innovations in Germany,* Beise and Stahl, Research Policy, 1999

[4] *The linkages between US technology and public science*, Narin, Hamilton and Olivastro, Research Policy, 1997

[5] *Publicly Funded Science and the Productivity of the Pharmaceutical industry*, Cockburn and Henderson, NBER Conference on Science and Public Policy, 2000

[6] *The impact of public research on industrial innovation: evidence from the pharmaceutical industry,* Toole, SIEPR Discussion Paper, Stanford CA, 2000

[7] *R&D and Productivity Growth: Panel data analysis of 16 OECD countries,* Guellec and van Pottelsberghe de la Potterie, 2001

[8] *The economic impact of industry funded university R&D*, Bergman, Research Policy, 1990

[9] *The economic impact of Canadian university R&D*, Martin, Research Policy, 1998

Delivering benefits through open innovation systems

A.5 Studies show that R&D delivers benefits by allowing an economy to do two things: understand and appreciate the value of others' findings and results; and make new discoveries.[10] [11] Drawing on the concept of the dual roles for R&D, Griffith, Redding and Van Reenen (2000) found that to assimilate R&D information that 'spills over' from other countries, an economy does need to be doing R&D itself.[12] The same logic applies to the membership of networks. If a country, company or university does not have anything to contribute then it is unlikely to be a valued part of the network.

A.6 The ability to engage and work in partnership with other R&D performers is likely to become increasingly important as commentators suggest that national innovation systems are moving to an 'open model'. The OECD has described this model succinctly: '… innovation systems … become less centred on the individual firm and more based on markets and knowledge networks'.[13] The innovation system is the set of interrelated organisations joined together by the opportunities and incentives that exist to bring something new and better to the market.

A.7 Companies commercialise their most promising ideas in the pursuit of higher profits or to fend off threats from their competitors. Past investment in the skills of their workforce and R&D put them in the position to seize these opportunities.

A.8 Companies may not, however, invest sufficiently in R&D, particularly in more long-term research, because the benefit of their efforts may spill over on to other companies. They may also find it difficult to find sources of financing that give them the means to hedge against the risk inherent in these activities. Government can help companies to overcome these difficulties through instruments such as R&D tax credits, the patent system and a number of DTI innovation programmes, which include R&D Grants, Collaborative R&D and Grants for Investigating an Innovative Idea. Chapter 4 explains the Government's approach to supporting business R&D.

A.9 At earlier stages of the innovation process, companies may work with other organisations that offer them the opportunity to monitor a wider portfolio of research and to gain access to specialist skills. Doing this helps them to innovate more efficiently and to avoid the risk of a narrowly-defined research portfolio. Some emphasise that this is the key part of the 'open model', which innovation systems are moving towards, where working in partnership with other innovators and the science base is important for germinating the most promising ideas. This is different to pure outsourcing of research, which has an earlier tradition, where there is less opportunity for the cross fertilisation of ideas and a narrower range of research avenues – see chart A.1.

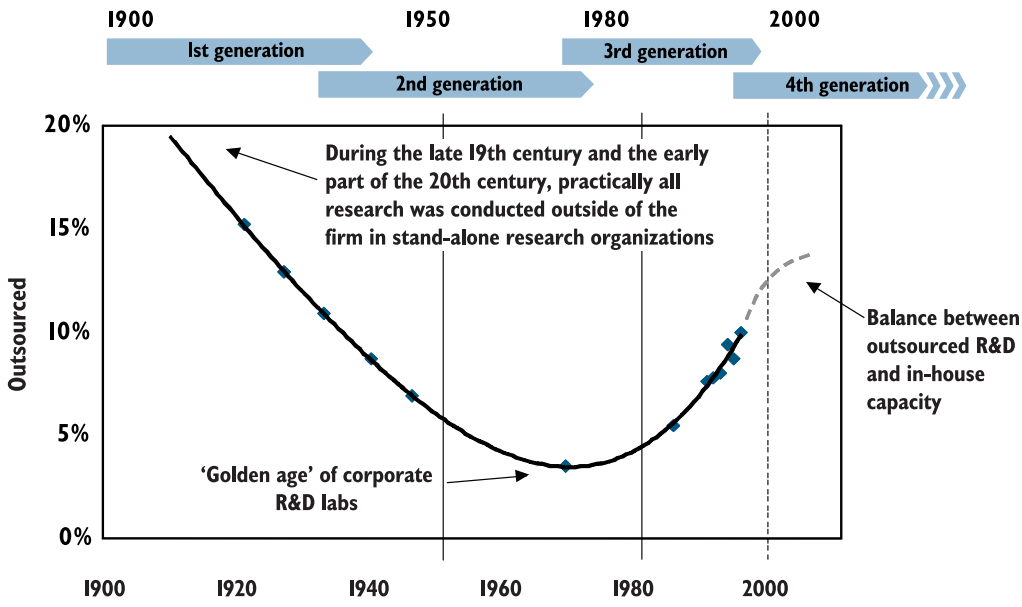
[10] Zucker and Danby (1995) report that "as with the 1973 Cohen - Boyer discovery – then any scientist wishing to make use of the knowledge must first acquire hands on experience". The Cohen-Boyer discovery allowed scientists to isolate genes from any organism and to make large amounts of that gene for analysis, which is essential for genetic engineering, and hence biotechnology. Zucker and Danby (1995) Virtuous Circles of Productivity: Star Bioscientists and the Institutional Transformation of Industry, NBER Working Paper

[11] *Innovation and Learning: the two faces of R&D – implications for the analysis of R&D investment,* Cohen and Levinthal, Economic Journal, 1989

[12] *Mapping the two faces of R&D: productivity growth in a panel of OECD industries,* Centre for Economic Policy Research Discussion Paper, Griffith, Redding and Van Reenen, 2000

[13] OECD (2003) Patents and Innovation: Trends and Policy Challenges

Chart A.1: An historical perspective on outsourcing R&D



Source: European Industrial Research Management Association

(chart A.1)[14]

A.10 Universities have an important partnership role to play in the innovation system. Gibbons et. al. (1994) have characterised this role as follows:

"…it is no longer like a relay race, in which the baton is passed cleanly and quickly from one runner to the next. Technology transfer looks more like a soccer game in which the university is a member of a team. To score, it [the innovation system] needs the aid of all its team mates. The ball is passed back and forth among the players who may include business people, venture capitalists…".[15]

A.11 Swann (2002) identified that enterprises are more likely be a part of this "soccer team", and work with the science base, if they:

- are doing R&D, and so have the capacity to value information;
- employ qualified scientists and engineers, who have the capability to understand new information; and
- lack key personnel, that is, they recognise where they need to bring in outside expertise.[16]

A.12 The science base can gain additional income and insights into applications of their field of research when they work with companies. Government has supported the development of the science base's capacity and capability to engage business through the Higher Education Innovation Fund (HEIF) and the Public Sector Research Establishment (PSRE) Fund. It did this because private sector finance may not have

[14] Based on an presentation by TNO to EIRMA, using source material from: *Research and technology outsourcing and innovation systems: an exploratory analysis Industry and Innovation and Research and Technology Outsourcing Technology Analysis & Strategic Management; and analysis*, Roland Berger Consultants, Howells, 1999

[15] *The New Production of Knowledge*, Gibbons, Limoges, Nowotny, Schwartzman, Scott, and Trow, 1994)

[16] *Innovative Business and the Science and Technology Base: An analysis using CIS 3 data*, A report for DTI, Swann, 2002

been forthcoming as a consequence of the uncertain nature of research and the form of the science base's assets – largely people, who are free to move around employers.

A.13 As a consequence of increased support, the UK science base has been widening and strengthening its capability to engage users in recent years. This capability includes the management of intellectual property (IP), through formal IP rights and spin-out companies. It includes broadening the skills of staff and students through enterprise training. Complementary assets, such as seed-corn funding, incubator facilities and sources of business advice are also a vital part of this capability.

A.14 With the capability in place to engage users, there are a number of channels through which knowledge can be exchanged, as identified by recent research[17]. They include: the sale of intellectual property rights and spin-out companies; research under contract with business as well as in collaboration with it; and bespoke services such as advisory and consultancy work, training and hiring out facilities. Universities also exchange knowledge rather than sell it, and this happens through the exchange of people and active participation in networks. Who initiates this engagement does not matter. What is important is that people make use of the information that the science base generates.

A.15 HEIF, the PSRE Fund and Collaborative R&D Grants, Knowledge Transfer Networks and Knowledge Transfer Partnership schemes provide a package of support for these activities because a number of factors may stop business, the science base, and, ultimately, the UK enjoying the full benefit of them. One set of hampering factors include a difference in the benefit to the individual organisation and to the partners from organising and conducting innovative work. Others include differences in incentives and culture between differing types of partner. Public infrastructure measures such as standards, measurement and the intellectual property rights system help define property rights and the characteristics of information, which are vital for any type of technology transfer.

A.16 Business and the science base have increasingly worked together for the past 20 years, and, as the Lambert Review highlighted, there is benefit in increasing this further. The Government's approach to knowledge transfer is set out in chapter 5 of this document.

Relative international performance of the science base

A.17 For companies seeking to develop technological advantage it is natural that they want to work with the best quality university departments. The most highly cited 1 per cent of scientific papers are nine times as likely to be cited in a patent as a randomly chosen US paper.[18] The UK is well placed to benefit from the trend towards the 'open model' of innovation as companies are able to find excellent research resources in the UK, as an international benchmarking study commissioned by the Office of Science and Technology (OST) shows.[19] The report concluded that the UK research base retained its:

"….strong relative international performance in terms of achievement, productivity and efficiency. We are probably strongest overall in the natural sciences, and on many indicators are second only to the USA. Where the UK has been overtaken by other nations, we still have a more consistent performance across fields than those countries.

[17] *Measuring Third Stream Activities, A report to the Russell Group of Universities* SPRU, 2002

[18] Periodic Newsletter, Vol VIII, No 1, July 2000, CHI Research

[19] *PSA Target Metrics for the UK Research Base*, Evidence Ltd, www.ost.gov.uk/research/psa_target_metrics2.pdf

Our strong international performance has been achieved with lower average investment compared to our competitors and with relatively lower availability of people with research training and skills".

A.18 Publications are a readily measurable output from the public expenditure on science. The UK's share of world publications (around 8.5 per cent) has long ranked second to the USA but it has declined recently, with the UK being overtaken by Japan. The UK also performs well in terms of PhD awards, another important output of expenditure. The UK's number of PhD awards per head of population is behind the US and Germany, but it is similar to Japan.

A.19 The quality of the UK's outputs is also high. The UK's 11 per cent share of citations – the generally accepted measure of research excellence – ranks second only to the USA, though Germany is now a close third and increasing its share at a faster rate than the UK. The UK has generally fewer (and a declining share of) lower quality papers than its competitors; it also has the second highest share of the world's most highly cited papers.

A.20 This quality is mirrored in all of the nine main research fields except mathematics, where the UK is third, and the physical sciences and engineering (fourth in each case). These results are also broadly borne out by the Research Assessment Exercise (RAE), which also grades, by peer review, research of international excellence. The improvement of the quality of research assessed by the RAE has been dramatic. In 1992, 23 per cent of researchers were in a 5 or 5* rated department, rising to 31 per cent in 1996 and 55 per cent in 2001. Nearly two-thirds of all universities now have at least one 5 or 5* department.

A.21 The UK's excellent research performance compared to its relatively low use of inputs suggests that UK science generates high output per unit of input, and this is the case. Whether based on Gross Expenditure on R&D (GERD), Higher Education R&D spend (HERD), or total public expenditure on R&D, the UK is the best performer in the G7 per unit of R&D spend. The UK also produces relatively more PhDs per unit spend than most of our competitors.

A.22 A recent study by the Science and Technology Policy Unit (SPRU), also commissioned by the OST, sheds more light on the way that public expenditure on science leads to outputs[20]. The combined impact of UK and other countries' spending on Higher Education R&D means that a 1 per cent increase in each of these sources of funding leads to a 1 per cent increase in publications and a 1.1 per cent increase in citations.

A.23 These effects do not happen immediately. It takes six years for the full effect to impact on papers and seven years for citations. SPRU also found that public funding of Higher Education R&D neither encourages nor discourages business and other sources of funding for this type of R&D, the latter including charity and foreign funding bodies.

A.24 SPRU also compared the productivity of a group of OECD countries. The measure they used captures the efficiency with which a country uses all of its resources devoted to R&D to produce publications and citations. Hence, it takes into account differences in the distribution of R&D between higher education and the private sector, the amount of spillover benefits and the effects of past spending on higher education

[20] *The productivity of science: an international analysis,* SPRU, 2004

R&D. SPRU found the US to be the most productive country, followed by the UK. However, other countries are catching up.

Role for government to support public research

A.25 Investment in public science supports a successful innovation system by providing knowledge assets, infrastructure and trained people that help organisations, whether public or private, seize opportunities. The private sector generally does not have the incentive to invest in knowledge made publicly available because it could not earn a return. The Government therefore funds this type of research, particularly the more fundamental, long-term research that is unlikely to have immediate application but has the potential for greatest spillover benefit. A recent review of economic, statistical studies tentatively concluded that public R&D is a complement to private R&D.[21] Hence, public sector R&D does not substitute for private sector effort.

A.26 Skilled people are the lifeblood of any successful innovation system. Companies and individuals often face difficulties financing training that leads to skills that are transferable amongst employers. The Government therefore supports undergraduate and postgraduate training, as well as other types of education and training. Chapter 7 explains what the Government is doing to support the development of higher level skills.

A.27 In addition to funding, the government also has an important role to play in managing the national research system to deliver effectively and sustainably over the medium term. The key actors in the science base are universities who are charities and are free to make their own decisions about how they use institutional funding. Other important players include the Public Sector Research Establishments (PSREs) which have varying degrees of institutional autonomy. The individual decisions of these organisations may not work to the benefit of the system as a whole, though may well be a response to the incentives they face. The Government response to this system-management challenge is covered in chapter 3 on the management of the science base.

[21] *Is public R&D a complement or substitute for private R&D? A review of econometric evidence.* David, Hall and Toole Research Policy, 2000

B SETTING TARGETS AND MEASURING PROGRESS

Summary

B.1 The Government has set out in this ten-year investment framework a challenging goal for the UK economy which will require concerted public and private effort across a range of actions over a sustained period. To shape future planning across government and business, the Government will set out clear high-level goals for the targeted outcomes from the UK science and innovation system, linked to inputs and intermediate indicators. It will monitor and publish a range of input, output and outcome data on a regular basis. This progress reporting will both inform policy development within the public sector, and provide the basis for a continuing dialogue with business, the science base and other stakeholders about the impact of collective investment in UK science and innovation. Future public spending decisions will be made in the context of demonstrable progress and engagement with private sector stakeholders in business, and the charity sector.

Attributes of the UK science and innovation system

B.2 The Government set out, in the consultation paper issued in March 2004 on the investment framework, a series of high-level attributes which it sought to achieve from concerted public and private investment in the UK science base, knowledge transfer and the supply of relevant skills.[1] The consultation revealed strong support from across universities, scientific organisations and business for these attributes, set out below with proposed qualitative goals:

Box B.1: World class research at the UK's strongest centres of excellence

The UK's leading research remains among the world's best, and can act both as a magnet for globally mobile corporate and private R&D investments and personnel, and as an inspiration to the next generation of researchers and educators. We must ensure that the institutions which foster the most excellent research can continue to compete at the highest level, and that the benefits of this global leadership can be leveraged across the UK economy.

Sustainable and financially robust universities and public labs across the UK

The high quality research and personnel in the UK science base must be maintained. High levels of productivity are to be welcomed, but not where this means that research is subsidised at the expense of under-investment in other areas. Increased funding for Research Councils project costs, and a significant level of dedicated capital funding, as allocated in previous spending reviews, provides a sound underpinning for sustainability. However, action is also needed from other funders, in order to properly recognise the worth of the research they are commissioning from the science base. Universities themselves also need to ensure that their corporate governance and financial management continue to develop to enable effective and sustainable management and delivery of their teaching, research and knowledge transfer. Public Sector Research Establishments and their parent departments similarly need to clarify their long-term approaches to sustaining their research activities and supporting infrastructure.

[1] http://www.hm-treasury.gov.uk/consultations_and_legislation/science_innov/consult_sciinnov_index.cfm

Box B.1 continued:

Greater responsiveness of the research base to the needs of the economy and public services

Better translation of the wealth of knowledge in the science base into innovation by business and the improvement of public services will bring benefits to the science base, government, business and the economy as a whole. Universities and public laboratories must continue to develop a stronger programme of engagement with users on knowledge exchange, to create conduits for productive flows of ideas and people between research and its practical application. Government funding for the science base must fully recognise applied and business-relevant research as it does basic research. Businesses need to improve their links to and engagement with the science base to access the raw materials needed to improve their innovative potential. Government's own R&D needs to be of high quality, and focused on improvements in public services. Synergies between different funders and the science base should be recognised and the complementarities maximised to improve the impact of research and funding.

Increased business investment in R&D, and increased business engagement in drawing on the UK science base for ideas and talent

Leveraging up the levels of business investment in R&D in the UK is crucial to increasing the innovation performance of the UK economy. More businesses need to engage with the science base, either directly or through intermediary bodies. More businesses need to adopt the practices of the best UK-based companies in creating and sustaining partnerships with a network of research teams, providing a productive means for companies to access the creativity and expertise of the science base. More businesses should become engaged in shaping school and university curricula to inspire and attract the next generation of trained personnel.

A more responsive supply of science, engineering and technology skills to the economy and greater flexibility within schools and universities to attract the skills they need

The UK education and training system needs to become far more attuned to the evolving needs of UK-based businesses and public services in shaping the quality and quantity of students produced by schools and universities. To do so effectively, schools, colleges and universities themselves will need to be able to compete effectively with other employers to secure the right quality and quantity of teachers and researchers.

Confidence across UK society in scientific research and innovative applications

The UK must continue to be open to new ways of extending human knowledge and reaping the benefits of this through new products and processes. Science and innovation must continue to be set within a robust legal framework which supports and protects research operating within boundaries set by society through Government. Researchers and policy makers must earn public confidence and trust in science through addressing public priorities and concerns. In this way the scientific community, working with Government and other partners, can ensure that society's understanding and acceptance of scientific advances moves forward, and does not become a brake on social and economic development in the UK.

Managing the science base to deliver knowledge and innovation

B.3 The Department of Trade and Industry (DTI) manages a significant proportion of the UK Government's funding for science and innovation, with expenditure on science, engineering and technology is set to total over £3 billion in 2004-05, accounting for 34 per cent of total public sector expenditure on SET, or 48 percent of civil SET.[2] Its aim is to ensure that it manages this expenditure well and helps the UK to improve its innovation performance.

B.4 Managing science and innovation expenditure is, however, challenging due to the inherent uncertainty about the creative and experimental nature of the work, and the long timescales over which performance becomes evident. To meet this challenge DTI has designed a robust management system around the Public Service Agreement it has agreed with HM Treasury for the present 2004 Spending Review, namely to:

Box B.2: Science and innovation PSA target

Improve the relative international performance of the UK research base and increase the overall innovation performance of the UK economy making continued progress to 2008, including through effective knowledge transfer amongst universities, research institutions and business.

B.5 This is a major task and so DTI has broken it down into a number of smaller, mutually reinforcing ones. This is set within the framework of the UK's National Innovation System, a conceptual model which highlights the rationale for DTI policy interventions, providing the first steps in managing funding – identifying rationale and the objectives for action. The subsequent steps define measures to check progress against objectives and how this information is to be collected and used in a forward-looking manner.

Box B.3: The UK Innovation System

DTI's expenditure is designed to improve incentives to innovate and to provide assets that support and enable innovation. It uses programmes that affect all roles needed for a successful innovation system, including:

- the 'innovation dynamo', where in response to market signals and technological opportunities innovators work to commercialise the most promising ideas;
- 'transfer factors', to identify and promote the sharing of promising ideas that innovators are likely to need and to provide cooperation opportunities with partners who share a common understanding and can bring specialist skills to applied problems. National innovation assets form key linking and supporting factors – including the National Measurement System, the standards infrastructure and the Design Council; and
- the 'science and engineering base', which has the assets to solve applied problems and the infrastructure to help the exchange of ideas.

[2] OST/ONS (2003) *The Forward Look, Government Funded Science, Engineering and Technology*

Box B.3 continued:

The Innovation Dynamo

Companies commercialise their most promising ideas in the pursuit of higher profits or to stave off threats from their competitors. The opportunities they have to do this depend on what they know about the likely success of commercialisation strategies to meet consumers' demand, and how they can overcome any remaining technical challenges. These opportunities will, therefore, depend on the company's past investments in knowledge creation, including R&D, the skills of their staff, and the ability to combine and develop these capabilities in conjunction with external sources of knowledge.

Companies may under-invest in R&D (compared with an economically desirable level) because the benefit of their efforts may spill over on to other companies. They may also have insufficient opportunities to cover risk because capital markets offer limited financial instruments to hedge against the uncertainty inherent in R&D projects. The instruments the Government uses to narrow the difference between the benefits to the economy and to the company of R&D, and to spread risk, include R&D tax credits, the Patent System and a number of DTI programmes to co-fund applied R&D.

At earlier stages of the innovation dynamo a company may need to work with other organisations to help mitigate the risk of having a narrowly defined R&D portfolio. This is also likely to raise the research productivity of the company since it can concentrate on research areas it knows well, integrating the knowledge and expertise of others and keeping abreast of promising results in other fields.

Transfer factors

Increasing profitability through learning about the likely success of R&D strategies give companies good reason to work with other companies and the science and engineering base. Working with other players in the National Innovation System requires the capacity to absorb new knowledge and the capability to value and use it. Hence a company's past investment in R&D and training will hold it in good stead to work with others on innovative projects.

Partners, such as the science and engineering base, gain from working with other innovators through the income they earn as well as the knowledge they learn from the other parties. Specialist knowledge, skills and infrastructure give these organisations opportunities to play a full part in the National Innovation System. Past government investment in science and innovation creates a valuable stock of intellectual capital which can be drawn down over decades, enhanced by additional investment, and applied to a series of evolving business challenges which require technology inputs.

To take advantage of these opportunities the science and engineering base needs the capability and the capacity to work with partners, developed with government support. Private sector support for knowledge transfer activities of universities and Public Sector Research Establishments (PSRE) may not have been forthcoming because of the uncertain nature of research, the diffuse nature of the benefits, and the form of these organisations' assets – largely their staff, who are free to move to other employers.

Box B.3 continued

There are clear benefits to all from working collaboratively and past investments in R&D, training and infrastructure give these players the opportunity to enjoy these benefits. What may stop companies and the science and engineering base enjoying the full benefits of working together, however, are differences between the benefit they get individually and the benefit for the partnerships as a whole. These differences can stem from the benefits that spill over to other partners (and those outside the project or network) when knowledge is exchanged and from the cost to the individual innovator of organising a network. There may also be other difficulties, such as describing the characteristics of information, necessary to exchange it, and differences in the culture and incentives faced by different players. These problems give the Government reason to take action beyond its funding of the research base.

The science and engineering base

The science and engineering base has a clear role to play in the National Innovation System, by acting as a source of knowledge, skills and infrastructure. Innovators may work with it to solve applied problems and to explore potential research strategies.

The two key outputs of the science and engineering base are trained people and freely available research results. Both of these outputs exhibit strong spillover effects across the economy, creating the rationale for financing by government. The final outputs of the research base are academic results, practice-based research in collaboration with users, and a supply into the economy of highly trained people. These depend crucially on a healthy infrastructure and flow through of the supply of young people educated and trained in science, technology, engineering and maths. This flow is in turn dependent on a complex mix of supply factors, regarding the quality and attraction of STEM education, training and research, and demand factors shaping individuals' perceived rewards from undertaking STEM-based learning and professional development.

B.6 In addition to the DTI's role in leading the management of the UK science base and translation of research into wealth creation, the DfES[3] provide underpinning support through their maintenance and development of the education system. Increasingly, the DfES are working in partnership with DTI and employers to ensure that the supply of skills, educated young people, and lifelong learning for adults meets more closely the evolving needs of the UK economy and society. Science, technology, engineering and maths have a core role in the future health of sustainable higher value-added activity in the UK. As such, the DfES will play a more strategic role in the coming years towards monitoring the quality and quantity of outputs from the education system, at all levels, in STEM subjects, and acting decisively to redress emerging mismatches between supply and demand for skills.

Setting targets and measuring progress

B.7 The following section identifies, for each of the broad attributes of the UK science and innovation system, the Government's overall goals for the coming decade and the measures which will be used to track progress and influence policy. These build out from the core set of metrics for the DTI's science and innovation PSA target for the SR2004 period (see box B.2 above), taking a broader view of desirable progress over the ten year framework. Progress towards each of the attributes will be measured annually, against a basket of indicators as set out in this Annex.

[3] And counterparts in Devolved Administrations

World class research at the UK's strongest centres of excellence

B.8 The UK already performs at or close to the world's leading edge in quality and impact of research. The challenge over the coming decade will be to maintain this performance as established industrial economies renew their research endeavour and the more successful developing nations move rapidly to compete with the UK for world class science.

B.9 Delivering world class research and effective university engagement with major businesses increasingly require a cross-disciplinary approach. The market for top talent and multinational investment is becoming ever more globally competitive. These factors point towards the UK needing to ensure, for the achievement of its research and innovation goals, the sustained health and global competitiveness of a small core of leading universities and other centres of excellence which perform a national role in making the UK a partner of choice for mobile investment and talent.

B.10 At the same time, the Government will continue to promote competition within and across research fields and institutions, to foster excellence wherever found in the UK and maintain competitive pressure for funding as a strong performance stimulus. No leading institution should be without credible competition for funding from the next tier down, and the funding system should enable promotion to and relegation from the top tier over time.

B.11 Wherever research is conducted, the Government will continue to aim for world class quality, impact and productivity overall and balanced strength across research disciplines. In particular, the Government will focus on improving areas of emerging relative weakness which are of strategic significance for the broader research base, business innovation and public services.

Table B.1: Indicators of progress: world class excellence

Indicator	Goal
Share of world citations, overall and in each of the broad nine science disciplines	Maintain overall ranking as second to the USA, and current lead against rest of OECD. Close gap with leading two nations where current UK performance is third or lower
Citations per unit GDP Citations per researcher Citations per unit of research spend in higher education	Maintain UK lead in impact and research productivity across these indicators
Benchmark research strength and impact of top ten UK universities against international peers Benchmark research strength and impact of top ten UK public research centres against international peers within the relevant subject area	UK to retain sufficient world class centres of research excellence to continue to attract internationally mobile R&D investment and highly skilled people, to support delivery of overall goal of higher R&D intensity and innovation impact
Benchmark research strength and impact of top ten UK universities against second tier of next twenty institutions Benchmark research strength and impact of top ten research departments/centres in each broad discipline against second tier of next twenty departments/centres	Ensure that leading UK centres are complemented by a broader network of strong institutions, departments and centres, to create a dynamic and competitive market for research funding and people

Sustainable and financially robust universities and public laboratories across the UK

B.12 The Government is concerned to ensure that the excellent performance of UK science in efficiently delivering high quality and high impact outcomes is underpinned by robust financial management across the research base. The Government will work with universities and research establishments to improve financial sustainability through balancing direct and infrastructure funding, and creating stronger incentives for universities and private and not-for-profit sector funders to work towards the same goal.

Table B.2: Indicators of progress: financial sustainability

Indicator	Goal
Research costs versus revenues (public and private) across higher education sector	Ensure a financially sustainable level of activity across UK higher education sector by early in 2010 decade, avoiding over-reliance on non-research incomes and under-investment in research infrastructure
Share of full economic costs paid by Research Councils for projects conducted in universities	Research Councils to provide close to full economic cost of university projects (taking account of capital funding streams)
Research costs versus revenues (public and private) across public sector research establishments	Ensure a financially sustainable level of activity across UK public sector research establishments by early in 2010 decade, avoiding over-reliance on non-research incomes and under-investment in research infrastructure

Greater responsiveness of the research base to the needs of the economy and public services

B.13 The major challenge for the UK science base in the coming decade is to translate investment effectively into economic and public service impact, through stronger synergies with other investment from a range of public and private sources, and increased engagement with business.

Table B.3: Indicators of progress: responsiveness

Indicator	Goal
Research Councils' engagement with business and public service R&D users in design, co-funding and delivery of R&D programmes	Research Councils' programmes more strongly influenced by and delivered in partnership with end users of research
The quantity of patent applications and grants from higher education institutions and public sector research establishments, relative to total research activity	Overall improvement in performance against these metrics, towards world-leading benchmarks
The quantity and value of HEI and PSRE intellectual property licences, relative to total research activity	
HEI and PSRE income from business for contract research, relative to total research activity	
Research publications jointly authored between science base and industry, relative to total research activity	
Quantity and economic value of spin-outs companies from HEIs and PSREs, relative to total research activity	
Level of business confidence in university knowledge transfer activities	Continued improvement

Increased business investment in R&D, and increased business engagement in drawing on the UK science base for ideas and talent

B.14 Delivering the Government's overall ambition for wealth creation and productivity growth from innovation will require sustained business investment and engagement in UK science, to translate research ideas and deploy trained personnel effectively. The Government will support the translation of R&D into commercial innovation through a range of framework conditions and specific measures, and will track progress on innovation performance against a range of outcome indicators. Regional Development Agencies (RDAs) will also develop their own indicators to measure business-university collaboration as part of their tasking framework.

Table B.4: Indicators of progress: business investment and engagement

Indicator	Goal
Business investment in R&D as a share of GDP	Increase from 1¼ per cent towards goal of 1.7 per cent over the decade
Business R&D intensity by sector Investment in innovation-directed activities, including R&D, as a percentage of business turnover	Narrow the gap in performance between the UK and leading international competitors in each sector, reflecting the size distribution of companies in the UK
Proportion of businesses that collaborate with HEIs and PSREs	Increase to reach leading position in Europe and close gap with the US
Patents granted per capita	Narrow the gap in performance between the UK and leading international competitors in each sector
Business innovation performance, as measured by basket of indicators (share of firms which had introduced new product, service or process improvement; average turnover in firms accounted for by new or significantly improved products and services; share of firms which are 'innovation active'	Narrow the gap in performance between the UK and leading international competitors in each sector

A more responsive supply of science, technology, engineering and mathematics skills to the economy

B.15 The Government will actively monitor and target improvement in the supply of science, technology and engineering (SET) skills across the education and training system. It will relate evidence on supply trends with that on evolving patterns of demand for SET skills, and use the monitoring data to inform policy development over the coming decade. Its overall aim is to ensure a stronger and higher quality supply at every stage of the transition from school into the workforce.

Table B.5: Indicators of progress: skills

Indicator	Goal
Science GCSEs	To improve science GCSE results
Recruitment into science teacher training	To eliminate as far as possible the undershooting of the national Initial Teacher Training targets by 2007/08
SET participation at A-level and other level three equivalents	To increase the number of young people choosing to study these subjects
Post-16 learner success	To improve success rates in SET
Qualifications of the post 16 workforce	To achieve a fully professionally qualified FE and training workforce in post-16 SET teaching
Post 16 inspection results	To improve the number of institutions graded outstanding or good on the quality of SET teaching and learning
Recruitment and retention of SET teachers in the post 16 sector	To reduce shortages
Graduates in SET subjects	To increase the numbers qualifying
PhDs per head of population	To maintain international rank and remain above the average for the G8 countries over ten years
Quality of researchers	To increase the UK ranking of citation share in nine research fields to top three in G8 in 7-9 super units of assessment by 2006
Proportion of minority ethnic and women participants in higher education	To increase at various levels, including among researchers, lecturers, professors and senior professors
Recruitment and retention trends in HE institutions	To monitor with particular regard to shortages reported by the UCEA

Public engagement and confidence in science and research

B.16 The Government's goal is for the UK public to be confident about the governance, regulation and use of science and technology, by both government and business, to be positively engaged with science activity and feel that its views are valued. The Government will also work to improve the evaluation of public engagement and confidence over the next ten years, and is currently considering a range of indicators for this, set out in the table below.

Table B.6: Indicators of progress: public engagement

Indicator	Goal
Independently measured trends in public attitudes towards key science and technology issues	Evidence of improvement
Independently measured trends in public confidence in science and technology policy	
Acknowledgement and responsiveness to public concerns by policy-makers and scientists	
Trends in media coverage of science and technology issues	

Conclusion

B.17 The Government will publish an annual stocktake on progress against the attributes of the science and innovation system as set out in the framework, reaching a judgement on progress informed by a range of indicators. It will conduct every two years, to inform periodic reviews of public spending, a detailed assessment of the progress towards the goals for each attribute. In drawing up this assessment, it will consult widely across Government, and with other stakeholders including the Funders Forum, to reach a balanced judgement about the UK-wide progress on science and innovation, and the implications for future policy.

C The Government's response to the Lambert Review

C.1 The Lambert Review of Business-University Collaboration was commissioned by the Chancellor in the 2002 Pre-Budget report, with a remit to examine whether the links between universities and businesses in the UK could be improved. The Review was led by Richard Lambert, member of the Bank of England's Monetary Policy Committee and former editor of the Financial Times. The final report was published in December 2003.[1] This Annex sets out the Government's response to the recommendations of the Review.

Recommendation 2.1

C.2 UK business should establish a high-level forum to enhance the effectiveness of technical innovation in the UK.

C.3 Chief Executives of R&D-intensive businesses in the UK should agree its remit: it should be business-led and focused on the key issues for retaining and expanding high value-added business in the UK.

C.4 **The Government agrees with the Lambert Review's finding that more needs to be done to stimulate demand from business for research and development (R&D) activities. The Government also agrees that business leaders of research-intensive companies are the people best placed to tackle this challenge. The Government therefore welcomes the establishment of a business-led group of top R&D-intensive companies under the chairmanship of Sir Tom McKillop of AstraZeneca. The group held its first meeting in May 2004, to explore how leading businesses can work more effectively with Government to improve the UK's R&D and business innovation performance.**

Recommendation 2.2

C.5 The Government should seek ways of directing a higher proportion of its support for business R&D towards SMEs.

C.6 **In the DTI Innovation Report[2] the Government noted that, "While the public sector purchases significant amounts of R&D, it has proved difficult for small and medium-sized enterprises (SMEs) to get access to research funding". A major cause of this is the high concentration of government R&D directed towards defence, an industry dominated by large companies. However, the Government recognises that more can be done to direct government R&D towards the SME community. The Small Business Research Initiative (SBRI) was established in 2001 to increase the success of smaller businesses in obtaining contracts from government bodies to conduct research and development. Those government departments involved have a target of purchasing 2.5 per cent of their R&D from SMEs this year. The Innovation Report set out a number of initiatives to improve the effectiveness of the SBRI by strengthening the DTI's role in coordinating and monitoring the programme, extending the collection of SBRI data across departments, publishing the results on an annual basis, and looking to broaden the scope of SBRI to encompass a wider range of R&D**

[1] *Lambert Review of business-university collaboration: final report,* December 2003

[2] *DTI Innovation Report: Competing in the global economy: the innovation challenge* December 2003

opportunities from, for example, Regional Development Agencies (RDAs) and local authorities. The DTI is taking forward these actions.

Recommendation 2.3

C.7 The Review recommends an enhanced role for the development agencies in facilitating business-university links. A priority should be to identify non-collaborating SMEs that have the potential to gain significant benefits from working with universities.

C.8 The Government agrees that RDAs have a very important role to play in helping promote demand from business for research activities and in facilitating business-university links. The Government has set out proposals to give the RDAs new responsibilities for promoting innovation in their regions. (See Recommendations 6.2 and 6.3 for details.)

Recommendation 2.4

C.9 The Government should continue to support Knowledge Transfer Partnerships (formerly TCS) but the programme should be better marketed to business. Increasing the regional focus of the scheme would allow it to be tailored more closely to the needs of local businesses.

C.10 Knowledge Transfer Partnerships (KTPs) are a key element in the DTI's suite of new business support products and it is a strategic priority to raise awareness of their full potential to businesses and the knowledge base. KTPs, by their "local partnerships" nature, have a strong "regional" element built in to them and have been particularly successful in the devolved administrations. The RDAs in England are now being encouraged to use some of their resource to support projects tailored to the needs and capabilities of regional business clusters and knowledge-base partners.

Recommendation 2.5

C.11 The Government should market the R&D tax credits better in order to increase their take-up by business.

C.12 The R&D tax credits have been taken up by business as a valuable source of co-funding for R&D in the UK. Over 10,000 tax credit claims were received from SMEs up to 6 May 2004, with £570 million of support provided since the inception of the credit. For the year 2002-03, 95 per cent of eligible SMEs made a claim. Early indications show significant interest in the credit by larger companies. DTI will be working with HM Treasury and Inland Revenue to further promote the R&D tax credits to business in 2004, building on the enhancements to the tax credits and simplification of the R&D definition introduced in Budget 2004. During 2004, the Inland Revenue will be producing and disseminating more comprehensive guidance material to help companies, their advisers and tax inspectors to understand and claim the R&D tax credit.

Recommendation 3.1

C.13 Universities UK (UUK) and the Standing Conference of Principals (SCOP) should establish a list of academics with relevant qualifications who are interested in becoming non-executive directors on company boards, and should arrange training for them in this role.

C.14 **The Government supports the view that more companies need to have research and development issues represented at the board level and that appropriately qualified and skilled academics, sitting as non-executive directors, would be one way to achieve this goal. The Government therefore welcomes UUK's decision to proceed with this recommendation and to develop a database of academics interested in becoming non-executive directors.**

Recommendation 3.2

C.15 The Department for Education and Skills should exempt business people from the requirement to undertake training to lecture in universities.

C.16 **Higher education is enriched by other professional groups who contribute their expertise and knowledge of practice and the business world to teaching and learning as visiting lecturers and professors. As well as supporting teaching, these interactions between business people and the sector can provide a valuable source of future business-university collaboration activity and, as such, should be encouraged by Higher Education Institutions (HEIs) wherever possible.**

C.17 **The Higher Education Funding Council for England (HEFCE), UUK and SCOP are working together to develop a national professional standards framework for teaching. HEFCE is also providing funding for institutions to enable them to expand training, continuing professional development and career development provision to prepare for the agreed professional training standards, linked to accredited qualifications for all new staff, from 2006.**

C.18 **Within this framework, individual HEIs will be expected to define the precise training arrangements for business people engaged in part-time or visiting lecturing. The Government supports the Lambert Review's recommendation that such arrangements should be applied proportionately, ensuring that they do not impose unnecessary demands on professional people and that they encourage more professional people to contribute to teaching and learning in universities. The HE Academy will be asked to build into their evaluation of the implementation of the new standards a specific focus on their impact on the participation of business people in teaching.**

Recommendation 3.3

C.19 Universities, departments and faculties should develop their alumni networks in order to build closer relationships with their graduates working in the business community.

C.20 **The Government supports this recommendation. Departments that regularly interact with their alumni are able to develop more leads for possible business-university collaborations. Not only can alumni bring and effectively articulate business demand to departments and the institution as a whole, but more developed alumni interaction would also bring wider benefits to the alumnus and the HEI concerned. The Higher Education Endowment Task Force has reviewed the importance of alumni relations as a cornerstone to effective fundraising and the Government supports the view that alumni interactions at all levels of the university should be aggressively encouraged.**

Recommendation 3.4

C.21 Where they do not exist, clear codes of conduct to avoid conflicts of interest in carrying out research with business should be developed by universities.

C.22 As HEIs engage in more commercial activity, so the complexity of their relationships with both internal and external stakeholders increases, and the potential for conflicts of interest emerges. The Government agrees that HEIs should develop and publish policies and codes of conduct governing the work they undertake with business, and supports the Committee of University Chairmen's plan to include guidance on conflicts of interest codes in its revised *Guide To Members of Governing Councils*, due to be published in autumn 2004.

Recommendation 3.5

C.23 The Association for University Research and Industry Links (AURIL), the Confederation of British Industry (CBI) and the Small Business Service (SBS) should produce a small set of model research collaboration contracts, for voluntary use by industry and universities.

- Develop a range of model agreements, setting out various approaches to IP ownership, management and exploitation rights including, but not limited to, ownership of the IP by the university with non-exclusive licensing or exclusive licensing to industry.
- Agree model contracts by the main representative bodies, distributed to universities through AURIL and UUK and to industry through CBI and SBS.

C.24 The Government welcomes the establishment of an Intellectual Property (IP) working group comprising representatives from business and universities. The working group intends to draw up a range of model collaborative contracts and undertake work to develop an IP protocol (see recommendation 4.1). The working group has already begun its discussions and will continue to meet under the chairmanship of Richard Lambert. The group aims to have completed its work by spring 2005.

Recommendation 3.6

C.25 The Government should continue to invest in a permanent and substantial third stream of funding, while simultaneously monitoring and evaluating the outputs from its investment.

C.26 Third stream funding should be increased to around £150m per annum in England in the future, in order to increase the flow of knowledge and ideas from the science base into business and the wider community.

C.27 The Government is committed to build the Higher Education Innovation Fund (HEIF) as a dedicated third stream of funding for universities in England to further build capacity in the university sector for knowledge transfer. To reflect this, Spending Review 2004 allocates funding to increase HEIF to £110 million a year by 2007-08.

Recommendation 3.7

C.28 Third stream funding should be allocated for three years on the basis of universities' business plans for their third stream activities. Universities that meet their third stream benchmarks in year one would automatically receive their second and third year allocations.

C.29 Simultaneously, work should be undertaken by Funding Councils to develop a basket of metrics that might in the future provide the basis for a predictable way of allocating funds on a formulaic basis.

C.30 In summary, if knowledge transfer is to achieve its full potential in the UK, the Review recommends that third stream funding should be substantial, permanent and allocated in a way that enables universities to make long-term plans for these activities.

C.31 The Government's aim for future policy is to create a funding regime that promotes and rewards high quality knowledge transfer, addresses demonstrable funding gaps inhibiting the translation of research and expertise into the market, and further embeds knowledge transfer as a permanent core activity in universities alongside teaching and research. The OST and the DfES will work with the universities, PSREs, and business to create a long-term career path for academics and knowledge transfer professionals who wish to focus on interacting with business and external partners.

C.32 With these aims in mind, the Government will move towards a predictable funding allocation on the basis of research, commercialisation and other knowledge transfer metrics. This new allocations process will be introduced for a substantial part of HEIF in 2006-7. OST and HEFCE will take this forward working with stakeholders through a series of formal and informal consultations. As part of this work, a robust basket of measures will be developed, building on the Higher Education Business and Community Interaction Survey, that focus primarily on economic benefit, including metrics of the volume and quality of collaborative research with business, as well as of licensing, spin-outs and business perceptions, but also reflect the broad range of knowledge transfer activity across the higher education base. The Government will continue to work with universities to encourage those institutions without a strong track record of knowledge transfer to develop, with funding support, effective strategies tailored to the research and teaching strengths of the particular institution.

Recommendation 4.1

C.33 The Funding Councils and Research Councils, in consultation with universities, the CBI and other industry groups, should agree a protocol for the ownership of IP in research collaborations.

See recommendation 3.5

Recommendation 4.2

C.34 The Government should use third stream funding to support regional shared services in technology transfer.

C.35 The Government agrees that universities with greater experience of technology transfer should help other universities move forward and develop their own capacity. It is also recognised that sometimes shared services in technology transfer can be

beneficial, in order to achieve a minimum efficient scale, particularly where specialist technical skills are needed. The Government therefore welcomes the increased amount of collaboration between institutions demonstrated in the bids for the second round of the Higher Education Innovation Fund (HEIF2). HEIF2 funding will include support for more than 40 collaborative projects involving around 100 institutions.

Recommendation 4.3

C.36 The Government should increase the level of funding for technology transfer and knowledge transfer training to stimulate the development of new training courses.

C.37 The Government agrees that there is a need to stimulate increased levels of training for knowledge transfer practitioners and has already invested £1 million to support training for knowledge transfer practitioners which will be delivered by a consortium of AURIL, Praxis (the UK university technology transfer training programme) and the University Companies Association (UNICO). Training is also a fundable activity under both HEIF and the PSRE Fund.

Recommendation 4.4

C.38 As third stream funding increases, university technology transfer offices should actively seek to attract individuals with industry background and experience.

C.39 The Government agrees that developing industry experience among technology transfer offices is important and therefore welcomes the commitment by AURIL and UNICO, to take forward this recommendation. It is also essential that new staff are brought in and trained to professional standards, which will allow them to move between industry and academia with ease. This is the rationale for the co-ordinated £1 million knowledge transfer training programme supported by the DTI and initiated earlier this year by AURIL, UNICO and Praxis. AURIL will develop a Continuing Professional Development programme and an Institute for Knowledge Transfer; UNICO will produce a series of printed and electronic guides for technology transfer professionals; and Praxis will increase the number and range of its short courses and develop an online information resource.

Recommendation 4.5

C.40 UK organisations representing technology transfer should look to the US Association of University Technology Managers to see what lessons can be learnt in terms of providing quality training, increasing industry involvement and sharing best practice.

C.41 One important means of strengthening the quality and capacity of technology transfer offices is by providing universities with opportunities to increase their skills and experience. Involvement of business is important to improve understanding of the needs of business (and vice versa) and to build productive networks. The Praxis courses were designed for the UK after studying the AUTM courses in the US and taking account of the different regulatory, legal and funding frameworks, as well as the different cultural attitudes to risk.

C.42 Recognising the need for more formal support for technology transfer staff, AURIL have developed a continuing professional development programme, which alongside complementary provision from Praxis, is funded by the DTI. AURIL–CPD provides flexible opportunities to gain accredited qualifications. It is designed to

benefit individuals and organisations, employers and clients. It forms the first step in the establishment of the proposed Institute of Knowledge Transfer. The Government welcomes the commitment of AURIL, Praxis and UNICO to taking forward this recommendation.

Recommendation 4.6

C.43 Government should set clear guidelines for third stream funding to rebalance commercialisation activities towards licensing. In particular, it should:

1. increase the availability of proof of concept funding; and
2. reduce the availability of seed funding, and use public seed funds to draw in private finance wherever possible.

C.44 The Government agrees with the Lambert Review that commercialisation activities need to be balanced and that quality of spin-outs may be more important than quantity. The measurement framework for the DTI's science and innovation Public Service Agreement, set out in Annex B, places spin-outs as one of a broader set of options for commercialisation of university research. The bids for HEIF2 funding reflected strong demand for proof-of-concept funding. For example Cambridge, Imperial College, Oxford, and University College London have been awarded funding to establish a proof of concept programme to develop technologies prior to licence or spin-out, and to explore and prove the commercial potential of technology-based propositions.

Recommendation 5.1

C.45 Regional Development Agencies should have targets that promote business-university collaboration.

- Their core outcome target for innovation should reflect the long time lag between R&D and economic impact.
- All RDAs should set a specific milestone for building business-university links.

C.46 DTI's science and innovation Public Service Agreement is to, "improve the relative international performance of the UK research base and increase the overall innovation performance of the UK economy, making continued progress to 2008, including through effective knowledge transfer amongst universities, research institutions and business". The Regional Development Agencies in England recognise the important role that they can play in promoting knowledge transfer and business-university interaction within their regions. The RDAs have welcomed the opportunity to expand this role and agree that it should be reflected in their tasking framework, to be finalised in autumn 2004. The RDAs have agreed that they will deliver specific outputs in relation to business-university collaboration and this will be reflected in their Regional Economic Strategies. All of the outputs to be delivered by each RDA will be set out in their Corporate Plans, early in 2005.

Recommendation 5.2

C.47 The Government should change Regional Selective Assistance so that it can support more knowledge-intensive clusters and businesses, and be used to help build a region's infrastructure for collaborative R&D projects with universities.

C.48 The DTI's new business support product, Selective Finance for Investment in England, which replaced Regional Selective Assistance in April 2004, is aimed at attracting high productivity and high skills investments to the Assisted Areas in England. The new product will help to deliver the RDA Regional Economic Strategies, including facilitating the development of clusters. More generally, high quality, innovative projects which meet the criteria will rank highly for support.

Recommendation 6.1

C.49 The Government should now take stock of the proposals in the review of research assessment and in the review of the sustainability of university research. It should consider the conclusions of these two reviews together when deciding on the future direction of research funding and policy in the UK.

C.50 The ten-year investment framework for science and innovation takes stock of reforms to both sides of the Dual Support system. In particular, the Government welcomes the Funding Councils' commitment that:

- **the next Research Assessment Exercise will be designed to recognise excellence in applied research, in new disciplines and in fields crossing traditional discipline boundaries; and**
- **membership of panels and sub-panels will include people with experience of commissioning and using research, including industry and commerce.**

Recommendation 6.2

C.51 The Government should create a significant new stream of business-relevant research funding, which would be available to support university departments that can demonstrate strong support from business.

C.52 Demand for the funding from business would need to be assessed but funding in the region of £100m-£200m could be an appropriate starting point.

Recommendation 6.3

C.53 There are a number of possible ways to allocate the new business-relevant research funding stream including an expansion in the scope of Higher Education Innovation Fund, an expansion of existing schemes such as LINK, or allocation through the Regional Development Agencies and their equivalent bodies in Scotland, Wales and Northern Ireland.

C.54 The Review's preferred approach is to allocate the new funding stream to the RDAs through their single pot allocation, and to provide them with targets on promoting business-university collaboration.

C.55 The Government agrees with the Lambert Review that the Regional Development Agencies as business-led organisations are best placed to promote the needs of businesses within their regions and have an important role to play in

encouraging greater interchange and engagement between universities and business, especially SMEs. RDAs will also have a strong role to play in facilitating cross-regional activity – a responsibility shared with the higher education sector. Universities are already one of the drivers of regional economic development and this role can be developed further. RDAs, as part of their strategies for improving regional economic performance and reducing regional disparities, recognise the importance of innovation and R&D to their long-term competitiveness. Many RDAs are already making a significant investment in science and innovation and are taking an active role in making links between business and universities, for example through Science and Industry Councils.

C.56 The Government wishes to enhance the role of the Regional Development Agencies in England in supporting business-university collaboration. As indicated in the second report on the review of devolving decision making,[3] the Government is working to ensure that the tasking framework for RDAs is more closely aligned to the priorities identified in their Regional Economic Strategies as well as the Government's high-level PSA targets. The new approach will come into effect from April 2005, with the outputs to be delivered by each RDA set out in their Corporate Plans. As part of this framework, the Government will task the Regional Development Agencies to help a broader spectrum of businesses develop more productive links with the university base in each region, including through support for business-focused research. This will complement national third-stream funding, which builds up HEI capacity for knowledge transfer and interaction with business.

C.57 The Government is investing substantial amounts of funding to build up capacity in universities and Public Sector Research Establishments to interact with business. The Government is also investing in new science infrastructure (see Chapter 3 for details). The RDAs are exceptionally well placed to stimulate demand in the business community for this new enhanced capability in the science base. We have already seen early examples of success in this area. For example, Yorkshire Forward has created six centres of industrial collaboration that act as intermediaries between the science base and businesses in the region.[4] The effectiveness of business-university interaction can be further enhanced by the deployment of regional technology advisors to build networks within and between regions, signposting business to the best sources of advice wherever they are located. The Government will work with the RDAs to further develop their capabilities in this area.

C.58 The Regional Development Agencies recognise the important role that they can play in promoting knowledge transfer and business-university interaction within their regions. The RDAs welcome the opportunity to expand this role and are responding to Lambert in different ways – see the example of the three RDAs in the North of England below. The first steps towards this will be assessed in their tasking framework, to be finalised in autumn 2004. The RDAs have agreed that business-university collaboration will be one of the measures of RDA performance and the importance of knowledge transfer and encouraging business-university collaboration will be reflected in their regional economic strategies. RDAs output targets are due to be finalised in the autumn and will include measures of business-university activities.

[3] Devolving decision making: 2 – Meeting the regional economic challenge: Increasing regional and local flexibility, HMT/ODPM/DTI, March 2004

[4] Details at http://www.yorkshire-forward.com/view.asp?id=2147&pw

C.59 **Building on current plans to support business innovation through links to the research base, the three Northern RDAs will aim to enhance those plans in response to Lambert to over £100 million by 2010, strengthening university-business collaboration and technology transfer across the North. To complement this and the growing engagement of all RDAs in this area of economic development, the Government will work with RDAs in the development of the new HEIF metrics (details of which are set out in paragraph 5.28), to ensure that proper account is taken of measures underpinning Regional Economic Strategies and the RDAs' tasking framework, and that universities and the RDAs work in partnership to deliver this agenda.**

C.60 **Working in close consultation with the HE sector, the RDAs' deployment of their own funds in this area should meet the following broad criteria:**

- **investment should be driven by demonstrated support from business;**
- **regional investment should complement national innovation priorities; and**
- **public support should not directly subsidise industry's near-market research that is rightly for them to fund.**

C.61 **The Government will support the RDAs in developing the right level of capacity to deliver their knowledge transfer role effectively, and encourage them to make best use of national science and technology strategies in shaping their own regional goals. Regional Science and Industry Councils will be key vehicles for collaboration at a regional level. However, collaborations between universities and businesses across regions must also be encouraged where this provides the best economic opportunities.**

Recommendation 6.4

C.62 The Russell Group of universities should encourage the development of a league table of the world's best research-intensive universities. This could well be produced by the private sector: the Sutton Trust is one group which is already considering the possibility.

C.63 **The UK needs a significant number of research-based institutions that are able to compete with the best in the world and the Government supports the recommendation that a league table of world class universities is necessary to measure performance against this objective. The Financial Times and the Sutton Trust are actively investigating ways of developing a league table of the world's best universities which will assess their performance in a number of fields. Meanwhile, the Government supports the recommendation and encourages the Russell Group to actively benchmark university performance internationally.**

Recommendation 7.1

C.64 The Review recommends that the Committee of University Chairmen, in consultation with the sector and Government, develops a concise code of governance, representing best practice across the sector. The draft (Appendix II of the Lambert Review), should be seen as the starting point for drawing up the code.

C.65 While the code should remain voluntary, all institutions should disclose in their annual report when their governance arrangements do not conform to the code, and explain why their particular governance arrangements are more effective.

C.66 The Government welcomes the work the Committee of University Chairmen is undertaking to revise its guidance on good governance and to develop a code to be published in autumn 2004.

C.67 The Government fully supports a code that challenges the sector to meet best practice. The Government also recognises, however, that good practice exists in structures or processes outside that of the proposed code. The code should not become a national prescription. Where an institution's practices are not consistent with particular provisions of the code, an explanatory note should be published in the corporate governance section of the audited financial statements.

C.68 The Government would recommend that the code be revised regularly by the sector to ensure it remains at the forefront of best practice.

Recommendation 7.2

C.69 Each governing body should systematically review its effectiveness in carrying out its obligations to all stakeholders every two or three years.

C.70 These reviews should take into account the stated objectives of the governing body, the performance of the institution against key performance indicators, evaluations of senior management and the results of effectiveness reviews of senate and committees.

C.71 To ensure transparency, the methodology and results should be published in the university's annual report and on the internet.

C.72 The Government recognises that the sector has made significant and positive steps since the first wave of effectiveness reviews were conducted following the Dearing report and is encouraged that the CUC intends to recommend to members a more regular and thorough approach to effectiveness reviews when it publishes its new Guide to Members and its Code of Governance in autumn 2004. The Government fully supports the view that more regular reviews are essential and that these reviews should focus on the performance of the governing body in carrying out its duties.

Recommendation 7.3

C.73 The Review supports the Leadership Foundation as an initiative to address the sector's need for high-quality leadership and senior management.

- The Foundation should focus its efforts as much on future vice-chancellors as current ones.
- Development programmes and training should be implemented with third parties rather than created and supplied internally.
- The Foundation should develop programmes to support council chairs in their increasingly challenging roles.

C.74 The Leadership Foundation was launched in spring 2004 by the Chancellor of the Exchequer. The Chief Executive and Chair for the Foundation have been appointed. The 12 Board members for the Foundation include representatives from

the HE representative bodies. In its first strategy paper, the Board outlined how, among other objectives, it will carry out these recommendations.

Recommendation 7.4

C.75 The Review recommends that the Government and all funders should minimise the use of hypothecated funding streams.

- Funders should continue to consolidate individual funding into larger streams, more proportionate to the necessary level of bureaucracy and regulation.
- Smaller hypothecated funding streams should, where possible, be allocated on a metrics or formulaic basis, rather than by bidding.
- Funders should minimise audit requirements on hypothecated funding streams.
- "Top sliced" funding streams should have a limited life of no more than three years, after which they should be rolled back into core funding, unless policy is explicitly renewed.

C.76 Hypothecated funding can provide a very powerful stimulus to the sector and achieve positive outcomes, but the Government acknowledges the burden that can arise from too many streams existing at one time. The DTI has in recent years rationalised its support for knowledge transfer from university research from three schemes to one, and has also reduced the range of business support products which foster business R&D and networking with the UK research base. DfES and HEFCE have recently reduced the total amount of money diverted to hypothecated funding streams from the core grant from £303 million in 2003-04 to £269 million in 2005-06. As part of this process, the HEROBAC scheme was absorbed in the first round of the HEIF, which subsequently evolved into HEIF2. Within HEIF2, previous separate funding for the University Challenge Fund and Science Enterprise Centres has been combined to provide a single stream of funding, and earmarked human resources funds are being consolidated as part of the mainstream teaching grant. In addition, commitments from the 2003 HE White Paper relating to new schemes such as Promising Researcher Fellowships and additional capital have been mainstreamed.

C.77 HEFCE is also to undertake in 2004 an audit of all hypothecated funding streams to identify ways to reduce this figure still further. Where these streams continue to exist, HEFCE is committed to reducing the associated burden on institutions, for example by adopting two-stage bidding processes or moving to formulaic allocations.

Recommendation 7.5

C.78 The Review recommends that funders and agencies should apply a significantly lighter-touch regulatory and accountability regime to well-run universities.

C.79 One agency should be responsible for risk assessments on behalf of all funders and regulators. In time, assessments should be published. Risk should be assessed on:

- adherence to the sector's code of governance;

- quality of Management;
- financial soundness; and
- institutional performance measured against key performance indicators set by the governing body, as well as other broad policy goals (as set by Government).

C.80 In the longer term, well-run universities should receive greater financial freedoms, such as the freedom to move funding across budget lines and longer, multi-year funding cycles.

C.81 The Government accepts that advances made by the sector on issues of governance, management and leadership should be matched by a corresponding step-change in the approach taken to regulate the sector and hold it to account. An accountability regime predicated on the principle of risk would significantly lighten the burden of accountability for the vast majority of institutions.

C.82 HEFCE is already demonstrating a commitment to risk-based approaches both through the implementation of the QAA's new quality assurance arrangements and with their proposals for revising the Audit Code of Practice. Work is also being undertaken by HEFCE to extend risk-based approaches to earmarked capital allocations and to Rewarding and Developing Staff.

C.83 Work is continuing to reduce the overall accountability burden on the sector, including the recent formation of the HE Gatekeeper Body to replace and build on the work of the Better Regulation Review Group. Any new approach to accountability, therefore, should also deal with the recurring problems of stakeholder coordination and duplication.

C.84 The Government recognises that the accountability regime should better reflect the low level of risks in well run universities and has received input from Universities UK, among others, on how best to proceed with this recommendation. The Government will continue to work with the sector in defining a new way forward and will report on progress at the end of 2004.

Recommendation 7.6

C.85 In three years time, the vice-chancellors of Oxford and Cambridge should take stock of the progress of reform, and agree with the Government what further steps will be necessary for the two universities to sustain their global position.

C.86 The Government supports the view that Oxford and Cambridge, each with a new Vice-Chancellor, should be allowed time to implement reforms. The Government will revisit the situation in three years.

Recommendation 8.1

C.87 Funding Councils should require universities to publish information in their prospectuses on graduate and postgraduate employability for each department (or faculty, if datasets are too small) by 2006.

C.88 This information should include:

- employability statistics and first destination data – to allow students to see whether particular courses are likely to be useful for specific careers;

- starting salary data – to give students an indication of the value that employers place on graduates from particular courses; and
- other information relevant to specific disciplines.

C.89 **The Government welcomes the development of the new Teaching Quality Information (TQI) website which will, from 2005, provide detailed information to applicants about the quality and standards of courses, to help them make informed choices. It will include data about the employment of graduates and postgraduates from each subject at each HEI. It will be linked to the UCAS site and publicised to all applicants from summer 2005.**

C.90 **The Government welcomes the recommendation of the Lambert Review and will ensure high quality information is provided to prospective students on course quality and employment across subjects by each HEI, by 2006 at the latest. Information on salary outcomes is also valuable for students and this data is being collected systematically for the first time this year. The Government will work with HEIs and the sector bodies to explore the most useful and efficient means of them providing all this information, including through the TQI website and HEIs publishing it in their prospectuses, and will report by the end of 2004.**

Recommendation 8.2

C.91 The Government should ensure that Sector Skills Councils have real influence over university courses and curricula. Otherwise, they will fail to have an impact on addressing employers' needs for undergraduates and postgraduates.

C.92 **The Government welcomes this recommendation to bring universities and business closer together to contribute towards improved employability. Over the past six months, Sector Skills Councils (SSCs) and the Sector Skills Development Agency (SSDA) have taken considerable steps with the sector towards greater interaction and debate. The Government warmly welcomes the forthcoming publication of the Concordat between SSDA, UUK, HEFCE, HE Academy, AoC and SCOP which aims to address further the concerns regarding HE courses and curricula failing to meet the needs of business. The Government will support the concordat and continue to develop close working relationships with its partners to further this agenda.**

C.93 **Evidence from recent initiatives between individual Sector Skills Councils and HEIs suggests that there are many models for improving the relationships between SSCs and the sector. The Government will, in summer 2005, review the impact of these and other initiatives on university courses and curricula, and will consider a further response to this recommendation should certain models of interaction prove particularly effective.**

Recommendation 8.3

C.94 The Higher Education Funding Council for England should ensure that its forthcoming review of the teaching funding method for universities:

- takes account of the views of employer-led bodies and representatives from the public and voluntary sector rather than funding courses solely on the basis of historic cost; and
- considers whether the UK university system is producing the right balance of graduates in the disciplines that the economy needs.

C.95 The other Funding Councils should also consider these issues.

C.96 The Funding Council will take a more active role working with HEIs and Regional Development Agencies (RDAs) to evaluate the implications that falling science provision may have for student access at the regional level. The Funding Council will now consider providing additional funding to particular departments if there is a powerful case that weakening provision in a particular region would hinder student access to disciplines that are important to national and regional economic development. This may mean, for example, taking into account actions by the RDAs to develop student demand (such as through student bursary support) in certain subjects that they deem crucial to the development of their region.

The Funding Council is reviewing its teaching funding method. This fundamental review will take into consideration a wide range of issues, including the full costs of teaching and collaboration, innovative means of delivery, the impact of market forces in shaping provision, and the role of the Funding Council in ensuring national teaching capability and capacity, so that it adequately meets the needs of students, employers and society. The review will consider the views of a broad range of stakeholders, including those of employers, regional bodies and HE and FE institutions.

D CONSULTATION

Summary

D.1 In drawing up this ten-year framework, the Government consulted widely with key stakeholders – including the scientific community, businesses, charities and regional bodies – and has received invaluable contributions from a wide range of individuals and organisations.

Consultation responses

D.2 The Government published a consultation document *science and innovation: working towards a ten-year investment framework*[1] as part of Budget 2004. Around 200 consultation responses were received from organisations and individuals. Responses can be requested from scienceframework@hm-treasury.gov.uk.

D.3 The following organisations submitted responses and consented to their publication. Names of individual respondents are available on request.

1994 Group

ABB
Association of the British Pharmaceutical Industry
Academy of Medical Sciences
Applied Industrial Research Trading Organisations
Architects & Engineers for Social Responsibility
Arthur D Little
Association for Science Education
Association of Clinical Biochemists
Association of Medical Research Charities
Aston University
Athena Project
Association for University Research & Industry Links
Avon Longitudinal Study Parents and Children, Institute of Child Health

BAE Systems
Belfast e-Science Centre, Queen's University Belfast
BioIndustry Association
Biosciences Federation
British Nuclear Fuels
Bolton Technical Innovation Centre Limited
British Academy
British Association for the Advancement of Science
British Council

[1] *Science and innovation: working towards a ten-year investment framework*, DfES / DTI / HMT, March 2004. http://www.hm-treasury.gov.uk/media//F1761/science_406.pdf

British Library
British Lung Foundation & the British Thoracic Society
British Psychological Society

Cambridge University Graduate Union
Cambridge-MIT Institute
Cancer Research UK
Confederation of British Industry
Council for the Central Laboratory of the Research Councils
Central Manchester and Manchester Children's University Hospitals NHS Trust
City University
Corus
Council for Higher Education in Art & Design

Department for Environment Food and Rural Affairs & Natural Environment Research Council (Joint Submission)
Department of Medical Physics & Bioengineering, University College London
Design Council

ECSITE-UK
EEF/SEMTA
Eli Lilly & Co Ltd
Engineering Council
Engineering Professors Council

Field Studies Council
Foresight Globe Network
Friends of the Earth

GE Healthcare
GeneWatch UK
GlaxoSmithKline
Greenpeace

Heriot-Watt University
Hewlett-Packard
Higher Education Research Forum

IBM Hursley
Institution of Electrical Engineers
Imperial College London
Institute of Cancer Research
Institute of Directors

Institute of Physics

King's Fund

Lancaster University
Lawson Software
Linear Collider UK Collaboration
LGC Ltd
Lloyd's Register
London Development Agency
London Mathematical Society
London Metropolitan University
London School of Economics and Political Science
Loughborough University

Macaulay Institute
Manchester Chamber
Manchester: Knowledge Capital
Medical Sciences Division, University of Oxford
Mercia Institute of Enterprise, University of Warwick
Morgan Crucible Company plc
MRC researchers at Kings College London

Napier University
National Addiction Research Consortium
National Grid Transco
National Museum of Science & Industry
National Postgraduate Committee
National Endowment for Science, Technology and the Arts
Nirex
North East Science and Industry Council
Northwest Development Agency
Novartis
Nuffield Council on Bioethics
Nuffield Foundation

Open University
Oxford Innovation Ltd

Partnerships UK
Peninsula Medical School
PERA
Pfizer Global R & D

Prospect

Queen Mary University of London
Queen's University, Belfast
QinetiQ

Regional Development Agencies collective response
Research Councils collective response
Royal Academy of Engineering
Royal Astronomical Society
Royal College of Art
Royal College of Physicians & Surgeons of Glasgow
Royal Holloway, University of London
Royal Society
Royal Society of Chemistry
Royal Society of Edinburgh
Russell Group of Universities

Save British Science
Society of British Aerospace Companies
Science Council
Scientific Alliance
Scientists for Global Responsibility
Scientists for Labour
Scottish Science Advisory Committee to the Science and Innovation
Science, Engineering, Technology and Mathematics Network
SETPOINT Devon and Cornwall
SETPOINT Wales
SETPOINT West Yorkshire
Sheffield Hallam University
Society for Academic Primary Care
Stroke Association

Technology Innovation Centre, Birmingham

UK Computing Research Committee
UK Neutrino Factory
UK Science Enterprise Centres
United Kingdom Atomic Energy Authority
UMIST/Victoria University of Manchester
United Nations Millennium Project, Harvard University
Universities UK
University College Chester

University of Birmingham
University of Bristol
University of Cambridge
University of Central Lancashire
University of Durham
University of East Anglia
University of Glasgow
University of Hertfordshire
University of Huddersfield
University of Hull
University of Leeds
University of Nottingham
University of Oxford
University of Plymouth
University of Salford
University of Southampton
University of Stirling
University of Sunderland
University of Surrey
University of Wales College of Medicine
University of Wales, Bangor
University of Wales, Swansea
University of Warwick
University of York

Wellcome Trust

Yorkshire Forward and Yorkshire Universities (joint response)

Meetings

Ministers and officials conducting the consultation met with the numerous individuals and organisations in the period January to June 2004, including the selection below:

Institution	Contact
Advent Venture Partners	Sir David Cooksey, Chairman
Amersham	Sir William Castell, Chief Executive
Association of Medical Research Charities	Diana Garnham, Chief Executive
AstraZeneca	Sir Tom McKillop, Chief Executive
Confederation of British Industry	John Cridland, Deputy Director-General
Engineering & Technology Board	Sir Peter Williams, Chair
Engineering Council	Sir Colin Terry, Chairman
GlaxoSmithKline	Sir Christopher Hogg, Chairman
Institute of Biology	Professor Alan Malcolm, Chief Executive
Institute of Physics	Professor David J Wallace, President
Lambert Review	Richard Lambert, Review Leader
Microsoft UK	Professor Stephen Emmott, Director
National Museum of Science and Industry	Dr Lindsay Sharp, Director
Post-14 Maths Review	Professor Adrian Smith, Review Leader
Regional Development Agencies	various
Royal Academy of Engineering	Philip Greenish, Director
Royal Institution	Baroness Susan Greenfield, Director
Royal Society	Professor Lord May, President
Royal Society of Chemistry	Professor Sir Harry Kroto, President
Save British Science	Dr Peter Cotgreave, Director
Science Council	Sir Gareth Roberts, President
Shell UK	Mark Phillips, External Affairs Manager
Surrey University	Professor Patrick Dowling, Vice Chancellor
The Sanger Institute	Sir John Sulston, Director
Universities UK	Baroness Diana Warwick, Chief Executive
University of Oxford	Sir Colin Lucas, Vice Chancellor
Wellcome Trust	Dr Mark Walport, Director

D.4 Beyond this, the Government is indebted to Sir Tom McKillop, Chief Executive of AstraZeneca, for convening a group of leading executives from major businesses with substantial R&D investment and employment in the UK, to provide senior business input into Government policy making. The group, who also took part in meetings with Ministers and officials prior to Budget 2004, includes:

ARM
AstraZeneca
BAe Systems
BP
BT
Ford UK
GE Healthcare
GlaxoSmithKline
IBM UK
Invensys
Johnson Matthey
Marconi
Microsoft UK
Motorola
Pfizer
Philips UK
Reuters
Rolls-Royce
Shell UK
Unilever
Vodafone

US organisations

D.5 The policy review team is also grateful to Professor Edward Crawley (MIT) and Professor Michael Kelly (Cambridge University), Executive Directors of the Cambridge-MIT Institute, for consulting the following US organisations on the Government's behalf:

Booz Allen Hamilton
Boston University
Council on Competitiveness
DuPont
Ford Motor Company
General Electric
Globalstar
Loral Space & Communications
Massachusetts Institute of Technology (MIT)
Motorola
National Academy of Engineering

National Aeronautics and Space Administration (NASA)
National Institute of Standards and Technology
National Review Online
National Science Foundation
Orbital Sciences Corporation
Purdue University
Science Applications International Corporation
Small Business Administration
United Technologies
University of Michigan
University of Virginia
University of Wisconsin
University of Connecticut
University of Tennessee
University of Arkansas
University of Pennsylvania
US Department of Commerce
US Department of Defense
US Department of Education
US Office of Science and Technology Policy
US Senate

Overseas perspectives

D.6 The policy review team is also grateful to the Foreign and Commonwealth Office's Science & Technology Unit, and in particular to their network of Science & Technology Officers, who provided valuable information from the following countries on overseas perceptions of the UK science base and its attractiveness for scientific collaboration and R&D investment:

Australia
Czech Republic
France
Germany
India
Israel
Italy
Netherlands
Poland
Russia
Singapore
USA