



ERAWATCH Analytical Country Report 2007: United Kingdom

Mark Boden



EUR 23389 EN/6 - 2008

European Commission
Joint Research Centre - Institute for Prospective Technological Studies
Directorate General Research

Contact information

Address: Edificio Expo. c/ Inca Garcilaso, s/n. E-41092 Seville (Spain)
E-mail: jrc-ipst-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

IPTS website: <http://ipts.jrc.ec.europa.eu>
JRC website: <http://www.jrc.ec.europa.eu>
DG RTD website: <http://ec.europa.eu/research/>

Legal Notice

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

*Europe Direct is a service to help you find answers
to your questions about the European Union*

Freephone number (*):

00 800 6 7 8 9 10 11

(*) Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server <http://europa.eu/>

JRC 47866

EUR 23389 EN/6

ISSN 1018-5593

Luxembourg: Office for Official Publications of the European Communities

© European Communities, 2008

Reproduction is authorised provided the source is acknowledged

Printed in Spain

ERAWATCH ANALYTICAL COUNTRY REPORT 2007: UNITED KINGDOM

Mark Boden

Joint Research Centre
Institute for Prospective Technological Studies (IPTS)

**Joint Research Centre
Directorate-General for Research**

Acknowledgements:

This analytical country report has been prepared as part of the ERAWATCH project. It makes use of information provided in the ERAWATCH Research Inventory (<http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>) with support of the ERAWATCH Network (country correspondents for the UK: Paul Cunningham, Dimitri Gagliardi). It has benefited from comments and suggestions of Dr Khaleel Malik (University of Manchester), who reviewed the draft report. The contributions and comments of Jan Nill and Alexander Grabowitz from JRC-IPTS and Marnix Surgeon from DG Research are also gratefully acknowledged.

Executive summary

Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in Guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development, with a particular focus on the private sector.

As part of ERAWATCH, JRC-IPTS is producing analytical country reports to support the mutual learning process and the monitoring of Member States' efforts. The main objective of the reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This analytical approach has been tested in 2007 by applying it to a number of countries, of which the United Kingdom is one. This report is based on a synthesis of information from the ERAWATCH Research Inventory and other important publicly available information sources.

The main results of the analysis are summarised in Tables 1 and 2 below:

Table 1: Main Strengths and weaknesses of the UK research system

Domain	Challenge	Assessment of system strengths and weaknesses
Resource mobilisation	Securing long-term investment in research	<ul style="list-style-type: none"> Public sector spending on R&D has generally increased over last decade Coordinated long term S&T policy framework with associated budgetary process
	Dealing with barriers to private R&D investment	<ul style="list-style-type: none"> There is still relatively low business investment in R&D relative to GDP
	Providing qualified human resources	<ul style="list-style-type: none"> Supply of Scientists and engineers targeted as a challenge, but university recruitments problems persist
	Justifying resource provision for research activities	<ul style="list-style-type: none"> Despite recent investments, there remain legacies of lack of investment in research infrastructure
Knowledge demand	Identifying the drivers of knowledge demand	<ul style="list-style-type: none"> A coordinated long term S&T policy framework Variety of sources used to assess and address the demand for knowledge
	Channelling knowledge demands	<ul style="list-style-type: none"> Weaker demand for university-industry interactions in knowledge transfer and exploitation
	Monitoring demand fulfilment	<ul style="list-style-type: none"> A strong evaluation and review culture monitors the impacts of policy initiatives
Knowledge production	Ensuring quality and excellence of knowledge production	<ul style="list-style-type: none"> Scientific quality of science base high: strong performance and high world ranking in research outputs (publications and citations) Use of and competence in evaluation and review, including excellence based funding allocation
	Ensuring exploitability of knowledge	<ul style="list-style-type: none"> The degree of linkage between business and higher education is reviewed on an annual basis

Domain	Challenge	Assessment of system strengths and weaknesses
Knowledge circulation	Facilitating circulation between universities, public research organisations and business	<ul style="list-style-type: none"> Good history of dedicated policy instruments, and supporting structures (finance, science parks) Level and type of university-industry interactions in knowledge transfer have not closed the gap between research performance and translation into commercially competitive products, processes and services
	Profiting from international knowledge	<ul style="list-style-type: none"> Attractiveness to inward investment High level of international scientific participation
	Enhancing the absorptive capacity of knowledge users	<ul style="list-style-type: none"> Improvement of skills levels is an identified challenge, particularly in the SME sector. Overall level of higher education is good, but some decline is causing concern.

In terms of the mobilisation of resources, a key strength of the UK research system is the core policy emphasis on maintaining and enhancing the high quality of the UK science base, as well as promoting its role in providing both a rich source of innovation potential and a supply of human resources. The UK's public system of funding research at universities, based on the dual support system with the competitive allocation of funds both to institutions and researchers, can also be highlighted as a strength. This is in a general policy context of long term policy planning, backed up by long term funding commitments. In the private sector, particular areas of strength include high levels of R&D in pharmaceuticals and aerospace, and, more generally, the mobilisation of foreign research investments. Overall, however, the relatively low research intensity of business R&D is a perceived weakness.

In the articulation of demand, the comprehensive process of review, monitoring progress and the role and value of evaluation contribute to long term policy planning. While complex, the incorporation of stakeholder views across government, industry and academia provides a sound basis for policy decisions.

The quality of knowledge production by the UK science base is an evident strength, as is the Government commitment to build on these strengths. One of the UK's relative weaknesses is, however, in the circulation of knowledge and the translation of this potential into the market. Transfer of knowledge from the science base, however, does benefit from a high position on the policy agenda and from increasing orientation towards collaborative R&D and innovation. This builds on the generally strong international outlook of the UK science base, both in terms of collaboration and education and research training.

While aspects of the UK system have already been highlighted above as strengths, the current long term policy framework can also be seen as providing opportunities across all four domains of the current report's analytical framework, identifying and addressing challenges. Table 2 summarises specific policy opportunities and threats.

Table 2: Main policy related opportunities and threats in the UK research system

Domain	Main policy-related opportunities	Main policy-related threats
Resource mobilisation	<ul style="list-style-type: none"> • Good identification of resource mobilisations issues and challenges • Promoting attractiveness to foreign researchers and foreign corporate investors 	
Knowledge demand	<ul style="list-style-type: none"> • Identification of issues and challenges in a long term perspective • Role of Technology Strategy Board 	
Knowledge production	<ul style="list-style-type: none"> • Policy emphasis on renovation of research infrastructure • Development of innovation potential and scope to build on the strength of the science and engineering base 	<ul style="list-style-type: none"> • Introduction of Full Economic Costs may discourage industry spending in higher education sector
Knowledge circulation	<ul style="list-style-type: none"> • Establishment of Technology Strategy Board 	<ul style="list-style-type: none"> • Policy focus on UK attractiveness could lead to dependence on high level of FDI

The recently established Technology Strategy Board is an example of the potential for capturing and reacting to knowledge demand, and it is also set to play a potentially key role in inter-sectoral knowledge circulation.

As an example of policy-related threats, the current policy context which encourages inward private R&D investment might strengthen the relatively high dependence on FDI in research in the UK. This may have an erosive effect on the UK's domestic competences and identity.

TABLE OF CONTENTS

Executive summary	3
Chapter 1. Introduction	9
1.1 Scope and methodology of the report in the context of the European Research Area and the Lisbon Strategy	9
1.2 Overview of the structure and governance of the research system.....	11
Chapter 2. Resource mobilisation.....	15
2.1 Analysis of system characteristics.....	15
2.1.1 Securing long term investment in research	15
2.1.2 Dealing with uncertain returns and other barriers to private R&D investment.....	17
2.1.3 Providing qualified human resources	19
2.1.4 Justifying resource provision for research activities	19
2.2 Analysis of recent changes and policies.....	20
2.2.1 Relevant recent trends	21
2.2.2 Role and expected impact of recent policies	21
2.3 Assessment of resource mobilisation.....	23
Chapter 3. Knowledge demand	24
3.1 Analysis of system characteristics.....	24
3.1.1 Identifying the drivers of knowledge demand	24
3.1.2 Co-ordinating and channelling knowledge demands	25
3.1.3 Monitoring and evaluating demand fulfilment	26
3.2 Analysis of recent changes and policies.....	27
3.2.1 Relevant recent trends	27
3.2.2 Role and expected impact of recent policy initiatives	27
3.3 Assessment of knowledge demand.....	27
Chapter 4. Knowledge production	28
4.1 Analysis of system characteristics.....	28
4.1.1 Ensuring quality and excellence of knowledge production	28
4.1.2 Ensuring exploitability of knowledge	29
4.2 Analysis of recent changes and policies.....	30
4.2.1 Relevant recent trends	30
4.2.2 Role and expected impact of recent policies	31
4.3 Assessment of knowledge production	31
Chapter 5. Knowledge circulation	32
5.1 Analysis of system characteristics.....	33

5.1.1	Facilitating inter-sectoral (public- private) knowledge circulation.....	33
5.1.2	Profiting from access to international knowledge	34
5.1.3	Enhancing absorptive capacity of knowledge users.....	35
5.2	Analysis of recent changes and policies.....	35
5.2.1	Relevant recent trends	35
5.2.2	Role and expected impact of recent policies.....	35
5.3	Assessment of knowledge circulation.....	36
Chapter 6.	Integrative assessment and conclusion	36
6.1	Strengths and weaknesses of research system and governance	36
6.2	Policy dynamics, opportunities and threats from the perspective of the Lisbon agenda.....	38
References	40
Abbreviations	43

Chapter 1. Introduction

1.1 Scope and methodology of the report in the context of the European Research Area and the Lisbon Strategy

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task of the JRC-IPTS within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts. The main objective of the reports is to characterise and assess the performance of national research systems and related policies in a comparable manner.

To ensure comparability across countries, a dual level analytical framework has been developed and applied. On the first level, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions in the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: the research system has to identify knowledge needs and how they can be met, thus determining priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of any research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in the economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
<ul style="list-style-type: none"> • Long-term research investment • Barriers to private R&D • Qualified human resources • Justifying resource provision 	<ul style="list-style-type: none"> • Identification of knowledge demand drivers • Channelling of demand • Monitoring and evaluation 	<ul style="list-style-type: none"> • Quality and excellence of knowledge • Exploitability of knowledge 	<ul style="list-style-type: none"> • Inter-sectoral knowledge circulation • International knowledge access • Absorptive capacity

On the second level, the analysis within each domain is guided by a set of "challenges", common to all research systems, which reflect conceptions of possible bottlenecks, system failures and market failures (see list above).

The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective and eases the transition from analysis to assessment. Actors, institutions – and the interplay between them – enter the analysis in terms of how they contribute to performance in the four domains.

Based on the above framework, the analysis here proceeds in three steps. The first step is to analyse the characteristics of the current research system; the second step is to analyse recent changes in policy and governance. The third step in the analysis aims at an evidence-based assessment of the system's strengths and weaknesses and its policy-related threats and opportunities in the light of the Lisbon process ("SWOT" analysis).

The national research system is defined in functional terms as an open system comprising actors, institutions and the processes by which they interact to contribute to the production and circulation of scientific, technical and related knowledge, as well as to the mobilisation of resources and articulation of demand for R&D. Thus, the research system also includes research policy actors, together with actors and institutions at the interface with the wider innovation system. The national dimension remains important, but it has to be seen in the broader context of an increasingly open system. The report focuses here on the European context of the national research system. Many of the challenges analysed also reflect important concerns of the European Research Area (ERA). Where interactions with the EU level are relevant in addressing domain challenges they are explicitly included in the system characteristics and trend analysis – insofar as the information is readily available. In addition, the jointly agreed research-related EU Lisbon Strategy goals serve as a key reference for assessing recent trends and policy developments.

This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory¹ and other important publicly available information sources as of autumn 2007. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis. After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these four main chapters contains a subsection on relevant recent policies in the domain. The report concludes in chapter 6 with an overall assessment of the strengths and weaknesses of the research system and governance and policy dynamics, opportunities and threats across all four domains in the light of the Lisbon Strategy's goals.

¹ ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at <http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>. Other sources are explicitly referenced.

1.2 Overview of the structure and governance of the research system

The United Kingdom research system comprises three main types of actor: policy bodies, research funders and research performers, with certain actors combining these functions (see Figure 1 below).

The past two decades have witnessed the evolution of UK S&T policy into an innovation policy, with S&T issues increasingly and deliberately integrated into the broader national system of innovation. Following the appointment of Gordon Brown as Prime Minister in June 2007, the role of science in innovation has been given yet further emphasis, with the disbandment of the Department of Trade and Industry (DTI) and the transfer of many of its functions, including responsibilities for science and innovation, to a new Department for Innovation, Universities and Skills (DIUS). This new department also has responsibility for further and higher education and skills, which previously were part of the remit of the Department for Education and Skills. The DIUS also works closely with the new Department for Business, Enterprise and Regulatory Reform (BERR), which assumed other functions of the former DTI. The aim of the Department is to bring together the nation's strengths in science, research, universities and colleges, seen as necessary to build a dynamic, knowledge-based economy, with the requisite skilled workforce.

The DIUS thus now plays the lead executive role in research issues, and is the home of the recently created Government Office for Science, which replaces the former Office of Science and Innovation (OSI) located in the DTI. The Government Office for Science is headed by the Government's Chief Scientific Adviser (CSA) and plays the lead role in improving the quality of science in the UK. The CSA reports directly to the Prime Minister and the Cabinet.

Reporting directly to the Prime Minister, the Chief Scientific Adviser chairs the principal high level national policy making and coordination body, the Council for Science and Technology, which in turn draws on policy advice from a range of bodies both within and outside the Government structure, including dedicated committees in both the upper and lower houses of Parliament. The lower house, the House of Commons has replaced its Science and Technology Committee with a Committee on Innovation, Universities and Skills with effect from November 2007 to reflect the change from DTI to DIUS. High level UK science policy making also places particular emphasis on the use of systemic reviews and evaluations.

The DIUS is the major provider of research funds for the public sector, with the Director General of Science and Innovation (DGSI) within the DIUS responsible for the allocation of the UK Science Budget.

In particular, the Science Budget provides funds for the Research Councils, which in turn support R&D both in higher education institutions and their own institutions with a total annual budget approaching €5 billion. These provide research grants both for projects and for research students. In addition, they fund research facilities in the UK and abroad for researchers, investing around 40% of their annual budget (€2 billion) in research in UK universities.

The seven UK Research Councils are organised on a broad disciplinary basis, each with its specific separate identity. Using a wide range of flexible funding mechanisms, they support a highly diversified portfolio of research, comprising the full spectrum of academic disciplines from the medical and biological sciences to astronomy, physics, chemistry and engineering, social sciences, economics, and the arts and humanities. Research funded ranges from basic, blue skies investigator-led research, through longer-term strategic research, observation and survey, to more applied research activities. Funds are awarded to UK universities, the Research Councils' own Institutes, other public sector research establishments and independent research organisations in the form of research grants, based on independent, expert peer review.

Each Research Council sets out its research priorities in a strategic plan, developed through extensive consultation with both the academic community and a wide range of users and stakeholders, from Government Departments, industry, the wider public sector and also the public more generally. A coordinating body, Research Councils UK, was established in 2002 to improve the ways in which the research councils work together both in meeting their respective objectives and in contributing to the delivery of the Government's overall objectives for science and innovation.

The UK government provides support to the private sector to help companies invest in R&D through a number of mechanisms, including tax credits administered via the Treasury, and the work of the Technology Strategy Board (TSB), which has responsibility for the formulation and delivery of national technology strategy.

The UK Government established the TSB with the aim of ensuring that the promotion of technology and innovation in business is led by business itself. The TSB was originally established as part of the DTI to advise the Secretary of State for Trade and Industry on business research, technology and innovation priorities for the UK. However, from July 2007, the TSB was revitalised, changing both its status and focus, and now operates at "arm's length" from the government as a non-Departmental government body. Its current focus is the translation of knowledge into innovation and new and improved products and services, complementing the Government's significant investments (around €5 billion per annum in 2007) in knowledge creation, across all important sectors of the economy.

The TSB is sponsored by the Department for Innovation, Universities and Skills and targeted funding of €275 million in 2007 to support technology and innovation, largely through collaborative work between businesses or between businesses and academia to develop technologies needed for the products and services of the future. Membership of the TSB is business-led and includes leading figures in the fields of industry, research and innovation.

Other Ministries and Departments, particularly Department for Environment, Food and Rural Affairs, the Ministry of Defence and the Department of Health, also have significant research portfolios within their areas of responsibility, and commission R&D through their own laboratories and institutes (or in many cases their former institutes which are now privatised or have intermediate agency status).

The main actors in the performance of public sector research are the Higher

Education Institutes, most of which are universities. The major part of their research funding is provided in the form of grants from the seven Research Councils, awarded to individual researchers as well as to longer running programmes, units and centres.

The private sector is both a major funder and performer of R&D. In 2004, the sector's total expenditure on R&D amounted to some €18.9 billion, including just under €3 billion on defence. Just over 10 per cent (€1.97 billion) of this came from Government sources and 23 per cent from overseas sources. However, the majority – 66 per cent (€12.5 billion) – came from within the private sector itself.

The UK has nine English Regions and three Devolved Administrations (Scotland, Wales and Northern Ireland) all categorised at the NUTS 1 level. Regional coordination of science and research is closely linked to that of innovation at the regional level.

The DBERR is aiming to build the capability of regions, with emphasis on growth within all regions and strengthening the building blocks for economic success and boosting regional capacity for innovation and enterprise. The Government's Ten-Year Science and Innovation Investment Framework (2004-2014), includes the aim of developing closer working relationships between the regions and central Government departments in order to ensure the best use of resources at national and regional level. Consequently, certain elements of Government funding are now being managed at the regional level to ensure that business support for innovation, and access to relevant expertise, is tailored to the individual needs of local, innovative businesses.

In the nine English regions, Regional Development Agencies (RDAs), in consultation with a broad range of regional and local actors, have developed Regional Innovation Strategies (RIS). Particular concerns include the development of regional networks to foster collaboration, and interactions between universities and research institutions and local/regional businesses, particularly SMEs. RDAs are also being encouraged to set up Science and Industry Councils (SICs) or similar bodies to bring together representatives from both the private sector and universities. These SICs are intended to provide leadership at regional level and can also contribute to the development of policy at national level. The devolved administrations of Scotland and Wales have similar arrangements, but with greater autonomy in the development of policy and separate funding arrangements.

Funding for universities, including research funding, in England, Wales and Scotland is provided by the DIUS through dedicated non-departmental funding councils: the Higher Education Funding Council for England (HEFCE); the Scottish Further and Higher Education Funding Council (SFC); and the Higher Education Funding Council for Wales (HEFCW). In Northern Ireland, funding for research in Northern Ireland comes directly from the Department for Employment and Learning, Northern Ireland (DEL or DELNI).

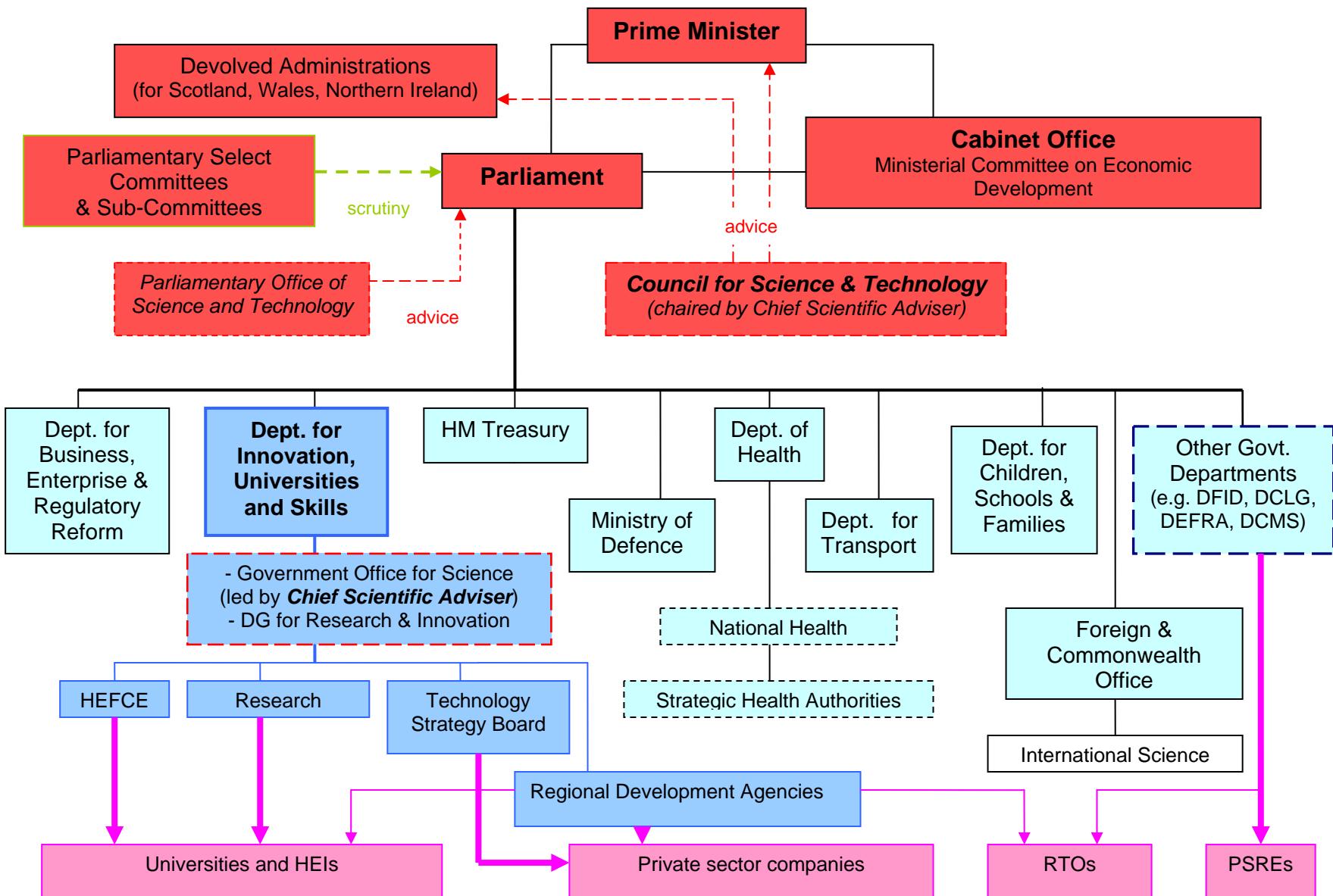


Figure 1: UK National system of Research and Innovation (ERAWATCH Research Inventory 2008)

Chapter 2. Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges affecting the provision of inputs for research activities are addressed by the national research system: its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, guided by the Barcelona objective of a R&D investment of 3% of GDP in the EU as a whole and an appropriate public/private split.

Four different challenges in the domain of resource mobilisation for research can be distinguished which need to be addressed appropriately by the research system and research policies:

- Securing long-term investment in research
- Dealing with uncertain returns and other barriers to private R&D investment
- Providing qualified human resources
- Justifying resource provision for research activities

2.1 Analysis of system characteristics

In 2005, the UK spent €29.96 billion on R&D². R&D intensity, measured as R&D expenditure (GERD) as a percentage of GDP is with 1.73% (2005), falling just below the EU average of 1.84%. It has fluctuated around this level for more than a decade. The share financed from abroad is significant, at 17.2% (2004), while the UK contributes 15% of the aggregate EU 27 R&D expenditure (2005).

The UK Government takes the view that adequate levels of investment from both the public and private sector are required to sustain a well-functioning R&D system. This is seen as a vital component of the national research and innovation system and is fundamental to national competitiveness. The main lines of government support for research have therefore shifted away from more traditional disciplinary lines to the constituent and contributory processes of innovation and include:

- the promotion of linkages between higher education and industry and the flow of research ideas from the Science Base into the commercial environment.
- support for Science Base infrastructure
- maintaining an appropriately skilled and educated workforce
- promotion of linkages at the regional level and with specific communities

2.1.1 *Securing long term investment in research*

Over the past two decades the UK public sector has generally tended to invest less than its major competitors, with reductions in capital budgets and greater private sector involvement in activities that had previously been delivered by the public sector. Since 2000, however, UK government investment in research has, in general, been increasing.

² If not referenced otherwise, all quantitative indicators are based on Eurostat data.

The UK Government has adopted a long-term perspective on research investment within the UK economy, with science and technology a high spending priority (HM Treasury *et al.* 2006). Its stated aim is to increase the level of knowledge intensity (expressed as R&D as a percentage of GDP) from its 2005 level of 1.73% to 2.5% by around 2014. This is somewhat less ambitious than the European Union's Barcelona target of 3% of GDP on R&D by 2010.

Of the total amount of GERD in 2004, 34% was funded by the public sector (including higher education), and 44% by the business enterprise sector. In terms of the execution of research, the business sector accounted for 63% of GERD and the public sector for 33% (the majority - 23% - in the higher education sector). In 2005, GBAORD as a percentage of GDP stood at 0.72, slightly below the EU25 average of 0.74, having fluctuated around this level over the past five years between 0.68 in 2001 and 0.77 in 2002.

Since 1997, the Government science budget has more than doubled and is currently around €5.5 billion. UK government funding is split between government departments, the Higher Education Funding Councils (which provide block grant funding to UK universities) and the Research Councils (which fund research, again largely in universities and in their own in-house institutes). Almost half of government funded R&D is currently performed in the higher education sector and 20% by the private sector.

UK Government Funding, across all ministries, is allocated through the Comprehensive Spending Review (CSR). Conducted every three years, the Spending Reviews set firm and fixed three-year Departmental Expenditure Limits and define the key improvements that the public can expect from these resources. Providing longer term stability for expenditure planning by public bodies, this mechanism ensures that public money is being spent, efficiently and effectively, according to defined priorities. Public Service Agreements (PSAs) were introduced with the 1998 CSR to set performance targets for Government organisations and leading to improvements in service delivery and outcomes.

The Ten-Year Investment Framework for Science and Innovation was published alongside the 2004 Spending Review. It aims to ensure sustainability in research funding accompanied by demonstration by universities and public laboratories of robust financial management to achieve sustainable levels of research activity and investment. Broader debate on the issue of university funding has also focused on the use of student fees to generate university support and on the planning for the 2008 round of the Research Assessment Exercise (RAE), through which Government funds are allocated to the universities in the form of an institutional 'block grant'. After the 2008 exercise, however, the RAE will be largely replaced by a metrics based system.

The past two decades have witnessed significant changes in the UK's public laboratories. Originally established within Government departments to perform research in support of departmental policy responsibilities, many of these laboratories have undergone a transition from contractor status, through 'arms-length' executive agency status to full privatisation, with a concomitant shift in the relationship between these agencies and their former parent Departments. These

agencies must now compete with other contract research organisations, including universities, for Government contract research funds.

A number of Government Departments have, nevertheless, retained their intramural research capabilities in some form or other. To these must also be added the institutes and centres maintained by the Research Councils.

The UK Higher Education sector receives most of its funding through the 'dual support system.' This combines 'block grants' from the Higher Education Funding Councils made to individual universities and other higher education institutions, according to departmental performance, as determined by the Research Assessment Exercise and of grants from the Research Councils paid to individual researchers, research groups or research centres within the institutions.

Since the 2004 Spending Review, an additional €1 billion funding has been allocated for the Science Base, including dedicated capital funding for the renewal of university infrastructure. This builds on the response to concerns in the late 1990's on the declining quality of the UK research infrastructure in the Higher Education sector, which had resulted from a long-term under-investment, and the subsequent launch of the Science Research Investment Fund (SRIF) to support university research infrastructure and Research Council Institutes. The 2004 Comprehensive Spending Review also included a €104 million Strategic Fund administered by the Director General of the Research Councils (now the Director General of Science and Innovation), to provide more targeted support for energy and clinical research.

In the UK, the private non-profit sector is a significant actor in both the funding and performance of R&D. In 2004, it contributed over €1.4 billion in research expenditure and performed €983 million worth of R&D activities. It is composed of a range of foundations and charities, the largest of which are in the medical and health sector. These charities make a substantial contribution to medical research in the UK, around €1 billion per year, which is larger than the budget of the Medical Research Council. Indeed, the Wellcome Trust is the major funder of research in the medical and health sector in the UK (annual spend €600 million), and is one of the largest charitable foundations in the world, supporting clinical and basic scientific research in biomedical science and the history of medicine. In terms of volume of research expenditure, the four next largest, foundations and charities are: Cancer Research UK, the British Heart Foundation, the Arthritis Research Campaign and the Nuffield Foundation.

2.1.2 Dealing with uncertain returns and other barriers to private R&D investment

The UK Office of National Statistics estimates indicate that some 11,000 companies are engaged in R&D in the UK. In 2006, UK BERD stood at 1.1% of GDP, a ratio that had been in gradual decline for more than a decade. In 2006, total expenditure on R&D performed within UK enterprises was around €20 billion, an increase of 7% on the previous year. According to the 2006 DTI (now DBERR) R&D Scoreboard³,

³ The UK Government monitors business R&D activity, with the aim of benchmarking the performance of UK companies against the best in the world. The annual [Scoreboard](#) examines expenditures on R&D and capital equipment for 1,000 companies from abroad and 750 from the UK, and presents a series of analyses.

the proportion of UK companies with R&D above €5m and with high R&D intensity (above 10%) is rising and is significantly above that of the rest of the EU although still below the USA. In 2006 (Office of National Statistics), almost two thirds of BERD was financed by industry itself.

Almost one quarter of business sector research funding comes from abroad. The Scoreboard also notes the significant role of multinational investment in the UK, with the top ten foreign-owned UK companies accounting for just over half of the €7 billion (i.e. one third of the total) R&D performed by foreign-owned UK companies. Eight of the 2006 top ten UK companies have higher R&D intensities than their overseas parents, a fact which is seen to emphasise the advantages of the UK as a location for corporate R&D activities.

In 2004, around 10% of UK BERD was accounted for by businesses with fewer than 100 employees, 30% by firms with less than 1000 employees and only 25% by firms with 5000 or more employees. More generally, SMEs represent a very important part of the UK economy and account for half of total employment and turnover in the UK.

Among its targets for research investment, the Ten-Year Investment Framework for Science and Innovation includes increased business investment in R&D, together with increased business engagement with the UK science base as a key source of ideas and talent. The UK government operates a grant scheme for R&D in small and medium sized firms, although the main emphasis is on the use of indirect measures to promote and stimulate civil industrial R&D. However, Government funding for defence-related R&D does constitute a considerable proportion of UK GOVERD (almost 50% of total government R&D expenditure).

The UK Government's general approach to promoting private sector investment is to maintain a stable macroeconomic environment and to remove microeconomic barriers that prevent the market from functioning properly. UK Government enterprise policy has, in recent years, focused on increasing the incentives for and removing the obstacles to entrepreneurial activities and promoting an enterprise culture more generally.

The UK exhibits relatively low administrative burdens for businesses and has low start up costs. Its capital markets are relatively well-developed. Access to debt finance and total private equity funds invested in the UK have increased over the last decade, although venture capital remains relatively difficult for early-stage businesses to obtain.

Tax incentives for start-up firms, including for R&D activities, have increased the incentives to start new businesses, together with improvements to the regulatory environment. Initiatives to reduce barriers to enterprise have focused primarily on access to finance, especially to early-stage businesses.

In 2000, the Government introduced an R&D tax credit for SMEs, extending the scheme to large companies two years later. Under this scheme, companies receive tax relief either reducing their tax bill or, in the case of some SMEs, providing a cash sum. The aim of the scheme is to encourage greater R&D spending. It allows companies to deduct up to 150% of eligible expenditure on R&D activities when calculating their profit for tax purposes.

The scheme has shown strong take-up with over 22,000 claims received by early 2006 – around 19,000 under the SME scheme and 3,000 under the large companies' scheme - amounting to a total of around €2.6 billion of support claimed.

Among the schemes improving access to finance, the Small Firms Loan Guarantee, which has recently been modified to ensure that support is provided to the newest businesses, guarantees loans from the banks and other financial institutions for small firms that have viable business proposals but lack security.

2.1.3 Providing qualified human resources

The Ten-Year Investment Framework for Science and Innovation has among its targets "a strong supply of scientists, engineers and technologists." In particular, the following are targeted for increases and improvements:

- The quality of science teachers and lecturers across the educational system;
- The results for students studying science at GCSE level (16 years old);
- The numbers choosing SET subjects in post-16 education and in higher education;
- The proportion of better qualified students pursuing R&D careers; and
- The proportion of ethnic minority and women participants in higher education.

The UK performs well in terms of inward student and graduate mobility, attracting a high number of foreign born students, particularly in terms of their participation in advanced research programmes. High numbers of highly qualified UK-educated people are resident in other OECD countries. This reflects the quality and attractiveness of the UK education system but also implies an outward flow of high level human resources.

In terms of the uptake of human resources, less than half of UK graduates in engineering and physical sciences go on to pursue science related careers, including research. There are concerns that the demand for qualified researchers, in both academia and industry, will not be met by the supply.

In subject areas such as physics and chemistry, some UK universities, which have met with difficulties in attracting sufficient numbers of students in these subjects, have been forced to merge, and even close, relevant departments. A report by the University College Union has revealed that 10% of science and maths university courses have been discontinued over the last decade, while some 70 UK university science departments have closed over the last seven years. In order to deal with strategically important research areas that have been identified as 'at risk', the Government has launched the Science and Innovation Awards scheme to fund research staff.

However, it might also be argued that a declining intake of science students, and thus the eventual supply of trained researchers might be indicative of a lack of job opportunities in R&D activities and of more attractive opportunities elsewhere, not least in the finance sector, particularly as large numbers of science graduates seem to find the rewards of jobs in London's financial institutions more attractive than those from a career in research (Cunningham, 2007a).

2.1.4 Justifying resource provision for research activities

As mentioned above, the Government's long-term view as embodied by the "Science and Innovation Investment Framework 2004-14" has the objective of increasing the level of knowledge intensity, wherein science and technology are clearly stated spending priorities. A specific challenge therefore addressed in the plan is to build confidence and increase awareness across UK society in scientific research and its innovative applications.

The plan seeks to demonstrate improved public awareness of science against a variety of measures, such as trends in public attitudes, public confidence, media coverage, and the responsiveness to public concerns of both policy-makers and scientists.

The Sciencewise programme addresses public understanding of and engagement with science and has moved to directly commission work that delivers a legitimate public voice into scientific decision-making. Where new technologies have ethical, safety, health and environmental complications, such issues need to be considered and debated before the technologies come to the market. Attention has been given to building public engagement in the key areas of nanotechnology, brain science and stem cell research. These have been chosen to reflect the importance of public debate in developing areas deemed critical to future economic success. Also under this initiative, "Sciencehorizons" uses a variety of processes to engage the public in dialogue about the implications of future science and technology. The outcomes from this project will help to further identify specific areas where public dialogue may be appropriate.

2.2 Analysis of recent changes and policies

The long term Government action plan – "Science and Innovation Investment Framework 2004-14" provides a long term policy context for the prioritisation of expenditure on science and technology. However, formal annual reviews enable changes and adaptations to be made in line with progress, measured against a series of indicators. So far, working within the Framework, these adaptations have been oriented towards improving the ways in which policy objectives are realised.

In 2006, a "next steps" review document was released, followed later in the year by the second *Science and Innovation Investment Framework 2004-14 Annual Report*. The next steps document builds on the priorities of the framework and includes practical proposals, and budget allocations, for:

- maximising the impact of public investment in science on the economy through increasing innovation;
- increasing the effectiveness of the Research Councils;
- further supporting excellence in university research, with reforms to the universities research assessment exercise;
- supporting world-class health research;
- and increasing the supply of science, technology, engineering, and mathematics (STEM) skills.

The framework seeks to retain a degree of flexibility to ensure a healthy balance between bottom-up responsive research and top-down strategic direction. Therefore, research goals and priorities must and will change in response to new knowledge, new technologies and new strategic economic and social needs. Through the

Spending Review process, UK research funding is under continuous review, while seeking to maintain the strength of the research base in all key disciplines.

The third Annual Report, published in 2007, notes further good progress in implementing the programme. The UK continues to maintain its international standing in scientific excellence, remaining second only to the US. Meanwhile, the historical lack of capital investment in research infrastructure is successfully being addressed. Knowledge transfer and commercialisation of results from the science base continue to display a positive trend, as evidenced by increases in licensing and consultancy income and the number of spin-outs.

Business investment in R&D is growing in real terms and is keeping pace with growth in GDP, although the 2007 report notes the need for continued rapid growth to meet the long-term ambitions set out in Science and Innovation Investment Framework. Further enhancement to UK innovation performance is expected from the Technology Strategy Board (TSB).

At the time of writing the publication of the Sainsbury Review of Science and Innovation was imminent, and was foreseen to recommend further action to ensure that the UK science and innovation system can meet both the challenges and opportunities of globalisation and continues to drive economic growth, with a leading role to be played by new Department for Innovation, Universities and Skills (DIUS).

It should also be noted that many of the UK's policies and programmes have multiple objectives, which is why they are mentioned under more than one of the following sections of this document.

2.2.1 *Relevant recent trends*

As mentioned above BERD has been undergoing a slow decline over the past decade. To reverse this trend remains a challenge for UK policy, with little evidence yet available of the impact and effectiveness of recent measures (e.g. R&D Tax Credits) in reversing this.

2.2.2 *Role and expected impact of recent policies*

In preparation for the 2007 Comprehensive Spending Review, which ranges across all Government activities, there has been an assessment of what the sustained increases in public spending and reforms to public service delivery have achieved since the first review in 1998, together with an examination of the key long-term trends and challenges that will shape the next decade and an assessment of how public services will need to respond. The next review will cover departmental allocations for the years 2008-11.

The Sainsbury review, as mentioned above, October 2007 sees the publication of a Review of the UK science and innovation system by Lord Sainsbury of Turville, the former UK Science Minister. This review examines the role of science and innovation in ensuring the UK remains competitive in our increasingly globalised economy. This can build on the UK's strong record in scientific discovery and increasing ability to transfer knowledge into industry from UK universities. In addition the review

examines how successful policies to strengthen the science base and to provide innovation support that have been introduced in recent years can provide opportunities for the future.

In line with the progress reported in implementing the Science and Innovation Investment Framework, the UK's research policy goals may be summarised as:

- To maintain and boost UK research excellence, both overall and through world class centres of excellence
- To ensure the public research base responds efficiently to the needs of the economy and the public sector
- To promote business investment in R&D and to increase its interaction with the UK science base

The Annual Report 2006 presents progress in reaching its stated targets against a number of indicators, namely:

1. Research excellence, including continued strong research performance, with an increase in the UK's share of world citations and highly cited papers, progress in addressing investment backlog in university infrastructure;
2. University Knowledge Transfer, including growth in licensing and intellectual property in higher education institutions (HEIs), engagement with industry on R&D and Technology transfer initiatives
3. Supply of Scientists, Engineers and Technologists (noting a mismatch between supply and demand), centred on progress at school and undergraduate levels;
4. Public engagement with scientific Research and Innovation, with the above mentioned efforts of the Sciencewise programme

Recently (May 2007) the government reported on efforts to better measure the economic impacts of investment in research and innovation and the health of the system used to deliver economic impacts, including:

1. Overall economic impacts
2. Innovation outcomes and outputs of firms and governments
3. Knowledge generated by the research base
4. Investment in the research base and innovation

These categories and influence factors comprise the new UK economic impact reporting framework (OSI, 2007).

Among the most recent measures addressing the improvement of the UK's research infrastructure has been the Large Facilities Roadmap. This Roadmap is a joint effort between the UK Research Councils, across all disciplines, and has been conceived to provide UK policy makers and researchers with a clear, strategic view of both how to ensure UK scientist can work with the best facilities, worldwide, and that public funds are invested appropriately, particularly in the construction and renewal of facilities.

Established in 2007, the UK Science and Technology Facilities Council, is now one of Europe's largest multidisciplinary research organisations supporting scientists and engineers world-wide. The Council operates world-class, large scale research facilities and provides strategic advice to the UK government on their development. It

also manages international research projects in support of a broad cross-section of the UK research community. The Council also directs, coordinates and funds research, education and training.

2.3 Assessment of resource mobilisation

The UK's formulation of and commitment to a long term strategy for science and technology is clearly the most notable development in recent UK science and technology policy. It builds on a thorough review of the UK S&T landscape, including the associated policy mechanisms. Clear identification of the issues and challenges represents a considerable opportunity, and steps towards meeting these challenges are articulated.

While setting long term trajectories, Science and Innovation Investment Framework also incorporates a degree of flexibility, in line with robust procedures for the monitoring and analysis of progress against targets. These reflect the UK's emphasis on the utility of evaluation and review in policy making.

It seeks to build on existing identified strengths, such as the already high scientific quality of the UK science base, but balances them against the relative weaknesses in UK resource mobilisation, such as relatively low levels of business R&D expenditure, the enduring effects of protracted under-investment in scientific infrastructure, and human resource supply issues concerns.

To date, the review of progress in the implementation of policy has indicated steps towards further reinforcing areas of strength, such as scientific excellence, as well as addressing the perceived weaknesses, such as investment in S&T/research infrastructure.

Further opportunities relate to promoting the UK's attractiveness to foreign investment, particularly the science base, and to foreign students, including postgraduates.

The main strengths and weaknesses of the UK research system in terms of resource mobilisation for R&D can be summarised as follows:

Strengths	Weaknesses
<ul style="list-style-type: none"> Public sector spending on R&D has generally increased over last decade Coordinated long term S&T policy framework with associated budgetary process 	<ul style="list-style-type: none"> Relatively low business investment in R&D relative to GDP Legacies of lack of investment in research infrastructure

In the light of the Lisbon Strategy, the main opportunities and threats for resource mobilisation in the UK arising from recent policy responses can be summarised as follows:

Policy Opportunities	Policy Threats
<ul style="list-style-type: none"> Good identification of resource mobilisations issues and challenges Promoting attractiveness of UK to foreign researchers and foreign corporate investors 	

Chapter 3. Knowledge demand

The purpose of this chapter is to analyse and assess how knowledge demand contributes to the national research system's performance. It is concerned with the mechanisms used to determine the most appropriate use of, and targets for, resource inputs. Main challenges in this domain relate to governance problems stemming from specific features of knowledge and the need for priority setting. These include:

- Identifying the drivers of knowledge demand
- Co-ordinating and channelling knowledge demands
- Monitoring and evaluating demand fulfilment

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D aimed at in the Lisbon Strategy Integrated Guideline 7.

3.1 Analysis of system characteristics

Looking at the sectoral structure of the UK economy in terms of BERD (2002), the percentage share of BERD in high tech stands at almost 57% in comparison with 33.4% in medium high tech and 9.6% in medium low tech and low tech. Service industries account for 20% of BERD. In terms of BERD specialisation compared with the EU15 average, UK specialisations include financial services, aerospace, ships, pharmaceuticals and petroleum.

Expenditure on defence R&D in the UK is also significant, and a general decline in UK government defence spending has contributed to an overall reduction in UK GERD. The share of GERD used for defence objectives was 32% (in 2003-2004). The Ministry of Defence is the leading government spender on defence-related research, and, as part of its programme of defence equipment procurement, has predominantly provided funds for experimental development work. In 2005, in cash terms and compared with 2004, total BERD increased by 5 per cent to around €20 billion, including an increase in Defence R&D expenditure of 10 per cent to over €3 billion.

3.1.1 *Identifying the drivers of knowledge demand*

The UK draws on a wide network of committees and advisory groups for input into the formulation of science and research policy. These reflect the full spectrum of research related concerns from the general to the highly specific and are located at various levels of the government policy making system, from Cabinet level, through Parliament and departmental levels, down to a range of both ad hoc and standing committees.

Specific reviews or inquiries may be commissioned into aspects of science, technology and innovation policy, and may be conducted by individuals or groups drawn from any of the various committees and advisory groups, or independent consultants from the public or private sectors. Ongoing Government initiatives, such as Foresight and "horizon scanning", also feed into this policy making process. However, a particular strength of this approach is the variety it embraces, with no single predominant source of advice or information.

In 2005, the UK Science Forum was set up to support the UK's R&D and innovation goals and to inform future funding decisions, particularly within the context of the 10 year Framework. The forum was also intended to incorporate the views of business, together with those of Government and academia, and appointed an industrialist from the pharmaceuticals sector as its chair.

In terms of the broad sectoral distribution of private R&D expenditure, the largest single manufacturing product group is pharmaceuticals, contributing around 30% of manufacturing spend and 24% of the total R&D spend. After pharmaceuticals, UK R&D is also strong in aerospace, and has a growing software sector, in terms of both its proportional contribution to, and intensity of, R&D. In addition, the UK has much larger proportions of firms in the sectors of pharmaceuticals, aerospace, food producers and oil & gas than the global average and much lower proportions of automotive, IT hardware and electronics R&D.

3.1.2 *Co-ordinating and channelling knowledge demands*

With a few exceptions, such as the defence and health sectors, the UK does not generally prioritise specific areas of research, but rather applies horizontal support to improve and maintain the overall performance of the research system. This is coupled with the objectives of ensuring the responsiveness of the science base to the needs of the economy and of increasing the level of investment by business in R&D as well as its level of engagement with the science base.

"Science in Government" is an initiative launched to improve cross government coordination of science and technology policy advice in relation to research and related activities. It brings UK government departments together to ensure that scientific advice is fully reflected in planning and policy issues. Improvement of the monitoring and delivery of high quality science and research in government departments, as well as the use of scientific advice in policy formulation and delivery is included as part of the Science and Innovation Framework 2004 - 2014. The Comprehensive Spending Review 2007 identified five trends with far-reaching implications for government and society and which clearly cross departmental boundaries. These were: demographic and socio-economic change, globalisation, climate and environmental change, global uncertainty, and technological change. Scientific research and advice plays a major role in meeting the challenges of these trends.

A key policy objective is improved responsiveness of the publicly-funded research base to the needs of the economy and public services. To this end, the funding programmes of the Research Councils' are more strongly influenced by and delivered in partnership with the end users of research. Thus research funding is more in line with user needs and complements increased business investment in R&D, and increased business engagement with the UK science base. The Research Councils have a strong user orientation, through user representation on their Councils and advisory bodies, including their specific user advisory panels and in their peer reviews. In addition, a substantial proportion of the research funded is delivered in partnership with users as either joint funders or collaborators.

Both the UK Houses of Parliament (the House of Commons and the upper chamber, the House of Lords) operate a number of Parliamentary Select Committees, the remit of which includes the conduct of reviews, the gathering of evidence and the

production of reports to which the Government must respond. In particular, the House of Lords Select Committee on Science and Technology has a broad remit "to consider science and technology" and conducts, on its own initiative, inquiries into issues where science and technology affect public policy in order to provide a more independent view. In contrast, the House of Commons Committee for Innovation, Universities and Skills (which recently replaced the Science and Technology Select Committee) has a narrow remit, centring its activities on selected topical issues in science policy.

One notable example of the improved articulation of and response to demand at sectoral level is the Government's Energy Research Partnership (ERP), an initiative aimed at the dual challenges of climate change and the need to address skills and research gaps. ERP brings together top energy industry executives, Civil service officials and senior academics to provide greater strategic direction to UK energy research, development, demonstration and deployment. This includes addressing the high level skills shortages in the energy sector.

3.1.3 *Monitoring and evaluating demand fulfilment*

The UK Government has, in recent years, undertaken a number of reviews of both the entire UK research system and specific elements of it. Among these, the 2003 "Lambert Report," presented to the DTI, the Treasury and the Department for Education and Skills concerned the demand for research from business. The report found that UK universities are developing their already strong international reputation for good quality research, while also enhancing their economic significance at both national and regional levels. Nevertheless, cooperation with business could be further developed, through a combination of better identification by universities of their main areas of competitive strength, increased Government support for business-university collaboration, and better awareness among businesses of how to better exploit ideas developed in the university sector.

These findings fed directly into the DTI's 2003 Innovation Report, which in turn constituted a further system level review, contributing directly to UK Government research and innovation policy, as outlined above. October 2007 sees the publication of a review of the UK science and innovation system by Lord Sainsbury, the former UK Science Minister. A central concern of this review is how to further build on successes in the transfer of knowledge from UK science to industry.

The Government's Research Base Funders' Forum has been established to allow governmental and non-governmental funders of public good research to examine the collective impact of their strategies on the sustainability, health and outputs of the UK research base. The Forum meets quarterly and comprises representatives from charities, industry, Research Councils, Funding Councils, Regional Development Agencies, the Higher Education sector and Government departments.

Many government supported programmes and schemes, including most research and innovation support programmes, are subject to evaluation and assessment, either by in-house or independent teams. While the outcomes of such evaluations are not always reported publicly, as evaluation at programme level is generally focused on the operation, management and scope of the continuing programme, their findings may influence policy at a broader level and may feed into the general policy making process in a similar manner to that of other sources of advice.

3.2 Analysis of recent changes and policies

3.2.1 Relevant recent trends

The UK R&D scoreboard, formerly published by the DTI, provides a key source of information and analysis on R&D-active companies both globally and in the UK. It analyses R&D by company, sector and country and is used by companies and investors as a benchmarking tool and by business policy. In the 2006 edition, the Global 1250 (the world's top R&D investors), includes 72 UK-owned companies, making the UK the third largest country group (jointly with Germany), with a combined R&D expenditure of €19 bn, an increase over the previous year (2005) of over 8%. This increase is mainly attributable to greater disclosure of R&D under by companies in sectors such as banking, insurance, media and retail as well as to an increase in R&D more generally (up 4% in 2006 compared to a decrease of 1% in 2005).

UK R&D is particularly strong in pharmaceuticals and aerospace and contains a growing software sector (119 companies in 2006). The proportion of UK companies with R&D above €5m and with high R&D intensity (over 10%) is rising and is significantly above that of the rest of the EU although still below the USA. R&D in financial services is also substantial.

3.2.2 Role and expected impact of recent policy initiatives

In 2007, the National Audit Office produced a report for the Government on Public Investment in Large Research Facilities. This found the approach to planning investment in line with priorities across the science base in line with the primary policy objective of advancing scientific knowledge. However, economic potential and possible exploitation by industry are less well taken into account.

3.3 Assessment of knowledge demand

The strategic policy framework employed in the UK has attempted to identify both national strengths and the challenges faced in the creation and exploitation of knowledge. The mechanisms by which this framework has been articulated and is being progressively implemented and reviewed build on a variety of both long established and new mechanisms to articulate and capture knowledge needs and to target investments accordingly.

This framework has identified weaknesses in the UK system, and defines them up as challenges to be addressed. A key issue in this respect is the transfer and exploitation of knowledge between academia and industry, which the establishment of the Technology Strategy Board has specifically sought to address.

The main strengths and weaknesses of the UK research system in terms of how the demand for knowledge demand is articulated can be summarised as follows:

Strengths	Weaknesses
<ul style="list-style-type: none"> Coordinated long term S&T policy framework Variety of sources used to assess and address the demand for knowledge 	<ul style="list-style-type: none"> Demand for university-industry interactions in knowledge transfer and exploitation.

In the light of the Lisbon Strategy, the main opportunities and threats for knowledge demand in the UK arising from recent policy responses can be summarised as follows:

Policy Opportunities	Policy Threats
<ul style="list-style-type: none"> • Strategic identification of issues and challenges in a long term perspective • Role of Technology Strategy Board 	

Chapter 4. Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role of creating and developing excellent and useful scientific and technological knowledge. Any response to knowledge demand has to balance two main challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis of scientific and technological advances. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities, which often emerge at the frontiers of scientific disciplines. Due to the expertise required, quality assurance processes are here mainly the responsibility of scientific actors, but may be subject to corresponding institutional rigidities.
- On the other hand, there is considerable interest in producing new knowledge which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable by economic producers as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to an exploitability challenge.

Both challenges are addressed in the research-related Lisbon Strategy Integrated Guideline.

4.1 Analysis of system characteristics

4.1.1 Ensuring quality and excellence of knowledge production

The UK Science base is generally viewed as in good shape (Cunningham, 2007a). It continues to enjoy a good international reputation both in terms of the volume and quality of publications. There is a high level of participation in international cooperation activities, particularly the European Commission's Framework Programmes.

The dual support system of the UK Higher Education sector combines "block grants" from the Higher Education Funding Councils made to individual universities and other higher education institutions with grants from the Research Councils paid to individual researchers, research groups or research centres within the institutions. Both mechanisms function on quality measures designed to ensure excellence in research.

The amounts of the "block grants" are related to the quality of institutional research performance, as determined by the Research Assessment Exercise, while research

council funds are usually allocated on a competitive peer reviewed process, and now provide 80% of the Full Economic Costs (FEC) of the research activities.

In terms of sustaining and improving the UK's scientific excellence, the 2006 annual report on the Science and Innovation Investment Framework notes progress in this direction with an increase in the UK's share of world citations to 12%, and a rise in the share of highly cited papers to 13.2%. The UK is sustaining a good and consistent performance across the full range of disciplines and, in terms of the number and world share of citations, is ranked second in biosciences, business studies, clinical medicine, environmental sciences, humanities, pre-clinical research, and social sciences, third in mathematics and fourth in the physical sciences and engineering.

In terms of output of qualified scientists, the UK output of PhDs per unit HERD spend is above the EU average. While, in terms of disciplinary strength, PhD awards in the UK are concentrated in natural sciences.

In collaboration with the other UK Research Councils, which the Engineering and Physical Sciences Research Council (EPSRC) uses a system of international reviews to benchmark the strength of UK research activity against world competitors and to highlight any gaps or missed opportunities. These reviews use international expert panels to examine ongoing research in specific disciplines in the UK. The results of these reviews provide the basis for future development of EPSRC plans.

In order to address the issue of strategically important research areas that have been identified as 'at risk', the Government has launched the Science and Innovation Awards scheme. This provides large, long-term grants (typically €5-8 million over 5 years, with the first round launched in 2005) to support staff in research groups, on the condition that the host institute continues to provide support at the end of the grant. These awards are funded jointly by the Engineering and Physical Sciences Research Council, and the Higher Education Funding bodies in England, Wales, Northern Ireland and Scotland.

As a further element of its support for 'strategic subjects' (i.e. high cost subjects that are strategically important for the economy but subject to low student demand) the Higher Education Funding Council for England (HEFCE) is providing over €100 million of extra resources over the next three years to prevent closures of vulnerable university departments. The extra funding will increase HEFCE teaching grants for the vulnerable subjects by 20% (equivalent to €1500 per student).

4.1.2 Ensuring exploitability of knowledge

In order to assess, in both qualitative and quantitative terms, the degree of linkage between the business enterprise sector and the Higher Education sector, and to provide reliable and relevant information to support the continued public funding of higher education institutions, the Higher Education Funding Council for England (HEFCE) commissions an annual survey of *Higher education-business and community interaction (HE-BCI)*. Data are gathered on a wide range of "third stream" activities (i.e. funding obtained in addition to funding obtained from the dual support system), reflecting the contribution of HEIs to the economy and society. These range

from commercial and strategic interaction with businesses and public sector organisations to working with the local community

The survey is split into two parts: Part A focuses on strategic aims and levels of infrastructure development in the institutions; and Part B presents quantitative data, such as income from knowledge transfer activities and the number of external business partners/clients. Part B provides the indicators that inform subsequent funding decisions.

The 2006 survey of *Higher education-business and community interaction*, which was based on data from academic year 2003-04, shows a significant improvement in the level and quality of various types of higher education-business and community interaction. While not all institutions are active in all areas, a broad range of activities have been successfully developed that contribute to the economy and society including the exploitation of new knowledge under collaborative research projects, and the innovative application of existing knowledge. The latest survey also confirms the UK Higher Education sector's continued success in forming new companies from third stream activity.

The HE-BCI Stakeholders group, which includes representatives from government ministries, the UK higher education funding councils, the research councils, and the Confederation of British Industry has been working to improve the guidance and definitions in advance of the next survey to ensure that it provides a robust and consistent view of the broad range of knowledge transfer and related activity in the UK without placing an undue burden on the HE sector.

Following the 2006 independent Leitch Review of the UK's long term skill needs, the DIUS responded in 2007 with the publication of its strategy to lead the UK into a so-called skills "revolution" by 2020, *World Class Skills: implementing the Leitch Review of Skills in England*.

A comprehensive review of the intellectual property framework in the UK was conducted by Andrew Gowers. The resulting report, published in December 2006, made a number of recommendations across the spectrum of IP issues. In particular, it recommended reducing the costs and improving access to the IP system. It also stated its support for the establishment of a unitary Community Patent (COMPAT), with consequent reductions in the cost of patent applications in Europe.

4.2 Analysis of recent changes and policies

4.2.1 Relevant recent trends

The UK is maintaining and enhancing its strong position in relative research excellence, particularly in terms of research outputs and their impact. However, it should be noted that given the time lags in publication and their subsequent citation, these are essentially historic measures and it will take time for any policies implemented under the Science and Innovation Framework to have effect. However, they are monitored and assessed on an annual basis.

Over the past two years, the Research Councils have been implementing a Performance Management System, whereby they published delivery plans,

scorecards and 'output 1 and 2 frameworks' related to the health of the research base and better exploitation of research. Indicators of success have been noted and the Delivery Plans and scorecards were refreshed and republished in May 2006 to reflect these achievements.

4.2.2 Role and expected impact of recent policies

The importance of scientific excellence is central to the Science and Innovation Investment Framework, with particular emphasis placed on further strengthening the UK science base and in promoting and supporting World class research.

This includes sustained increases in investment in the science base by the Research Councils and the Higher Education Funding Councils and with a particular focus on the UK's most research-intensive universities. This is coupled with the "performance management system" which is designed to ensure that the science budget is appropriately targeted and allocated in line with priorities.

As the Ten-Year Science and Innovation Investment Framework has been in place since 2004, time is required to judge the impact and effectiveness of the policy measures that it has introduced. Nevertheless, the system of annual reporting on progress and the 2006 Annual Report has provided some preliminary insights into and quantitative assessment of developments so far.

Significant benefits were reported by the former OSI from its Science Research Investment Fund (SRIF), a scheme which provides capital funding to UK universities. In providing funds for the maintenance and development of state of the art laboratories and equipment, this scheme aims to contribute to the long-term financial sustainability of research activities and the physical infrastructure that supports them, addressing past under-investment in research infrastructure, promoting collaborative partnerships between the universities, industry, charities, and the Government. Refurbished laboratories and new equipment funded can enhance the attractiveness of UK universities to world-class researchers and academics.

4.3 Assessment of knowledge production

At the time of publication of the 2006 annual report, the implementation of the Science and Innovation Investment Framework was still in its early stages, and thus it was difficult to ascertain the impact of the various new measures proposed. Nevertheless, progress since 2005 has been seen as good, with the programme on track with increased investment and continued improvement in the UK research base. Most notably, the UK has continued to increase its world share of citations and high impact papers and remains at the head of the G8 on research efficiency and productivity measures, while links between universities and business are stronger. In 2005, the number of university spin-out companies floated on the stock market had grown to ten. The announcement of plans to strengthen the role of the Technology Strategy Board across Government has also been seen as a further positive development. These signs of progress have been endorsed by a review of the report by the UK Science Forum (a high-level industry led forum, established to support the UK's R&D and innovation goals and to inform future spending decisions).

The quality and level of knowledge production is an acknowledged strength of the UK science base, and one which the Science and Innovation Investment Framework seeks to further strengthen as one of its central pillars. The UK science base has continued to perform well in terms of measures of the level and quality of its output. Benefits are also being seen from the significant attention paid to the renovation of the UK's research infrastructure, as a key element of the trend of increased public expenditure on research.

In the same way that the previous weaknesses of the research infrastructure are being effectively addressed, new policy measures are geared towards weaknesses, such as improving the translation of knowledge production into competitive advantage.

The introduction of full economic costs in research funding, while seeking, in effect, to increase funding may also have the counter effect of discouraging industry funding.

The main strengths and weaknesses of the UK research system in terms of knowledge production can be summarised as follows:

Strengths	Weaknesses
<ul style="list-style-type: none"> Scientific quality of science base high: strong performance and world ranking in research outputs (publications and citations) Use of and competence in the evaluation and review, including excellence based funding allocation 	

In the light of the Lisbon Strategy, the main opportunities and threats for knowledge production in the UK arising from recent policy responses can be summarised as follows:

Policy Opportunities	Policy Threats
<ul style="list-style-type: none"> Policy emphasis on the renovation of research infrastructure Development of innovation potential and scope to build on the strength of the science and engineering base 	<ul style="list-style-type: none"> Introduction of Full Economic Costs may discourage industry spending in higher education sector

Chapter 5. Knowledge circulation

The purpose of this chapter is to analyse and assess how the research system ensures appropriate knowledge flows and sharing between actors. This is vital for its further use in the economy and society or as the basis for subsequent advances in knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who go on to work in industry, and the comparatively low cost of reproducing knowledge once it is codified. However, there remain three challenges related to specific barriers to knowledge circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors

- Profiting from access to international knowledge
- Enhancing the absorptive capacity of knowledge users

Significant elements of Integrated Guideline 7 relate to knowledge circulation. To address them effectively requires a good knowledge of the system's responses to these challenges.

5.1 Analysis of system characteristics

5.1.1 *Facilitating inter-sectoral (public- private) knowledge circulation*

The issue of linkages between the business enterprise sector and the Science Base is a central aspect of UK innovation policy and a number of policy instruments are in place to encourage and improve knowledge transfer between the two sectors.

The Science and Innovation Investment Framework emphasises greater responsiveness from the publicly-funded research base towards the needs of the economy and public services. Research Councils, in particular, are orienting their programmes in closer cooperation with the end users of research. A further stated aim is to continue to improve UK performance in knowledge transfer and commercialisation from universities and public laboratories towards world leading benchmarks.

First launched in 2001, the Higher Education Innovation Fund (HEIF) is now the core funding programme for the encouragement and support of knowledge transfer in Universities and other Higher Education institutions in England (the devolved assemblies of Scotland, Wales and Northern Ireland have their own support mechanisms). The third round of the programme was launched in 2006 (the two prior rounds allocated funds in 2001 and 2004 respectively), and includes a number of important changes, reflecting Government commitment to provide a permanent "third" stream of funding. In particular, the majority of HEIF third round funds (€240 million) have been allocated using a funding formula to ensure that every English HEI receives some fund. In addition, a smaller competitive element has been introduced to support high impact innovative projects.

To enhance industry's efforts in knowledge circulation, the Government has established, as noted above, the Technology Strategy Board (TSB). The remit of the TSB includes strengthening the links with business and the research base, and the operation of the €260 million Technology Programme, which promotes new technological developments by funding research projects in firms and universities along a number of priority themes including low carbon energy technologies; biopharmaceuticals' manufacture; and sensors and imaging. It is run along similar lines to the research councils, to the extent of being co-located with their head offices in Swindon.

Under the technology programme, the TSB is also responsible for the government-funded Knowledge Transfer Networks (KTNs). Based in specific fields of technology or business applications, KTNs bring together a variety of organisations (businesses, suppliers and customers, universities, research and technology organisations, the finance community and other intermediaries) in order to enable the exchange of knowledge and stimulation of innovation. The objective is thus to increase the

breadth and depth of knowledge and technology transfer into UK-based businesses and accelerate the rate at which transfers occur.

In 2007, the UK has around 60 science parks in which businesses are located, usually on or near a university campus or research centre. Their role is to enable companies to engage in collaborative research, professional training or other knowledge transfer. More than 2,200 companies are based in science parks, employing over 47,000 scientists and engineers, 85% of these firms are small or medium sized with a technology base.

Evidence (quoted in Cunningham, P. 2007) shows that companies based on UK science parks tend to grow more quickly, and have higher turnovers than similar companies based elsewhere off science parks. They are also more likely to gain access to finance for start up and business growth.

5.1.2 *Profiting from access to international knowledge*

Under the new structure, the Department for Innovation, Universities and Skills (DIUS), working in collaboration with a wide range government and non-government organisations, is responsible for the development and delivery of the UK's approach to international engagement in science and innovation. The Global Science & Innovation Policy Directorate of the DIUS is responsible for managing government-to-government science and technology relations with countries and international organisations throughout the world. This Directorate defines, with the support of the Global Science & Innovation Forum (see below), the UK's international strategy for science and innovation.

The Department's international science and innovation activities include planning and managing UK involvement in the European Union's science and technology activities, particularly the Framework Programmes.

Outside Europe, the DIUS seeks to develop and strengthen links with major scientific partners across the world, on a bilateral and multilateral basis, where scientific, commercial or political returns to the UK are envisaged. The UK also has quite significant development objectives, which influence the decision making of the Global Science & Innovation Forum (GSIF) and other bodies.

The GSIF is under the responsibility of the new DIUS. Operating across the UK government, and chaired by the Government's Chief Scientific Adviser, it facilitates and promotes exchanges of information and ideas to improve co-ordination of the UK effort in international science and innovation collaboration. It also provides strategic guidance and systematically scans the horizon for new and emerging issues.

The Department also manages government-to-government science and technology relations and membership and participation in international organisations, as well as the definition of an international strategy for science and innovation.

The Foreign and Commonwealth Office's (FCO) Science and Innovation Network is based in 30 countries and territories around the world. Its purpose is to strengthen the UK's long-term prosperity, sustainability and security in a globalised world. Working in collaboration with the Department for Business, Enterprise and Regulatory Reform, the FCO also has responsibility for UK Trade & Investment

(UKTI), the government organisation supporting overseas R&D investments in the UK.

On the academic side, the British Council, the Royal Society and the Research Councils all provide support for UK researchers, postgraduates and international students who are seeking funding for international collaboration in science and technology.

5.1.3 *Enhancing absorptive capacity of knowledge users*

The UK Government has specifically identified the issue of skills and training as a challenge within the SME sector and has introduced measures to address this as part of a wider policy mix.

UK performance on workforce skills levels is mixed, but with relatively good performance in terms of higher-level skills (university degree or other higher-level qualifications), UK participation rates in higher education now exceed 30%, having improved significantly since the early 1990s, with a large proportion of this expansion in higher education in Science, Engineering and Technology (SET). However, there may be problems with specific subjects, particularly physics and chemistry. Some UK universities have met with difficulties in attracting sufficient numbers of students in these subjects, have been forced to merge, and even close, relevant departments.

5.2 Analysis of recent changes and policies

5.2.1 *Relevant recent trends*

In the private sector, the significant international input to business research funding has already been noted. While this underlines the perceived attractiveness of the UK as a location for corporate R&D activities, the impacts on wider knowledge circulation within the UK maybe more diffuse. Likewise, the international attractiveness of the UK higher education system seems mainly to benefit outward knowledge flows. The perceived challenge is thus one of absorption capacity.

Between the public and private sectors, there are good examples of mechanisms in operation to promote knowledge circulation. UK science parks are seen as one example with several success stories. Nevertheless, this remains a key policy challenge in the UK.

5.2.2 *Role and expected impact of recent policies*

Important developments are occurring in terms of both intersectoral and international knowledge circulation. These are clearly taken on board in recent policy developments, with measures implemented in both domains. Indeed, the issue of linkages between the business enterprise sector and the Science Base has, for some time, been taken up by UK innovation policy. It has been given a further boost under the Science and Innovation Investment Framework, with the explicit aim of improving UK performance in knowledge transfer and commercialisation from public sector research.

Likewise, recent policy efforts seek to improve co-ordination of the UK effort in international science and innovation collaboration in a more systematic manner.

5.3 Assessment of knowledge circulation

The strengths of the UK lie in its combination of positive experiences in identifying the benefits of and supporting knowledge circulation. These include both policy measures and initiatives from the actors themselves. The strength and international reputation of the UK science base makes it an attractive source of knowledge to investors. Nevertheless, the scale and scope much of the university-industry knowledge transfers can be limited in scale and scope.

A strength and clear opportunity provided by the policy context is the priority given to knowledge circulation issues at both intersectoral and international levels. In particular, the establishment of the Technology Strategy Board is a significant step towards improving and expanding these linkages on a larger scale. However, the policy emphasis on the UK's attractiveness as a location for inward investment, could lead to a degree of dependence on foreign investors.

The main strengths and weaknesses of the UK research system in terms of knowledge circulation can be summarised as follows:

Strengths	Weaknesses
<ul style="list-style-type: none"> History of dedicated policy instruments, and supporting structures (finance, science parks) Attractiveness to inward investment High level of international participation 	<ul style="list-style-type: none"> Level and type of university-industry interactions in knowledge transfer have not closed the gap between research performance and translation into commercially competitive products, processes and services

In the light of the Lisbon Strategy, the main opportunities and threats for knowledge circulation in the UK arising from recent policy responses can be summarised as follows:

Policy Opportunities	Policy Threats
<ul style="list-style-type: none"> Establishment of Technology Strategy Board 	<ul style="list-style-type: none"> Policy focus on UK attractiveness could lead to dependence on high level of FDI

Chapter 6. Integrative assessment and conclusion

6.1 Strengths and weaknesses of research system and governance

A recent Commission sponsored peer review of the UK research and innovation system concluded that the main strengths of the UK system were in its capacity for R&D, both within the Science Base and its industrial R&D, as well as its system of innovation policy governance, and, in particular the attention to quality and the measures in place to help achieve this (Cunningham, 2007a). This resonates with the analysis presented in the current report, the results of which are summarised in table 3 below.

In terms of resource mobilisation, a key strength in UK resource mobilisation is the core policy emphasis on maintaining and enhancing the high quality of the UK science base, as well as promoting its role in providing both a rich source of innovation potential and the supply of human resources. The UK's system of funding research at universities, based on the dual support system with the competitive

allocation of funds and emphasis, can also be highlighted as a strength, as long infrastructure needs are also adequately met. This is in a general policy context of long term policy planning, backed up by long term funding commitments.

In the private sector, particular areas of strength include high levels of R&D in pharmaceuticals and aerospace, and, more generally, the mobilisation of foreign research investments. Overall, however, the relatively low research intensity of business R&D is a perceived weakness. In connection with this, the contribution of R&D in service industries is the subject of some debate. Direct grant support to firms also has a low priority in UK policy, except for the targeted support of SMEs, with a preference for indirect measures.

The proportion of R&D personnel in the UK, in both public and private sectors is also low compared to other EU Member States (0.45% of population).

Table 3: Main Strengths and weaknesses of the UK research system

Domain	Main strengths	Main weaknesses
Resource mobilisation	<ul style="list-style-type: none"> Public sector spending on R&D has generally increased over last decade Coordinated long term S&T policy framework with associated budgetary process 	<ul style="list-style-type: none"> Relatively low business investment in R&D relative to GDP Legacies of lack of investment in research infrastructure
Knowledge demand	<ul style="list-style-type: none"> Coordinated long term S&T policy framework Variety of sources used to assess and address the demand for knowledge 	<ul style="list-style-type: none"> Demand for university-industry interactions in knowledge transfer and exploitation
Knowledge production	<ul style="list-style-type: none"> Scientific quality of science base high: strong performance and high world ranking in research outputs (publications and citations) Use of and competence in evaluation and review, including excellence based funding allocation 	
Knowledge circulation	<ul style="list-style-type: none"> History of dedicated policy instruments, and supporting structures (finance, science parks) Attractiveness to inward investment High level of international scientific participation 	<ul style="list-style-type: none"> Level and type of university-industry interactions in knowledge transfer have not closed the gap between research performance and translation into commercially competitive products, processes and services

In the articulation of demand, the comprehensive process of review, monitoring progress and the role and value of evaluation contribute to long term policy planning. While complex, the incorporation of stakeholder views across government, industry and academia, as well a commitment to stronger public engagement all provide a sound basis for policy decisions.

The quality of knowledge production by the UK science base is an evident strength, as is the Government's commitment to build on these strengths. Despite a long-term

policy focus, the UK remains relatively weak at translating this potential into the market.

Transfer of knowledge from the science base, however, does benefit from a high position on the policy agenda and from increasing orientation towards collaborative R&D and innovation. This builds on the generally strong international outlook of the UK science base, both in terms of collaboration and education and research training. The attractiveness for "inward investment" in UK higher education, in terms of the large number of fee paying overseas students, also reflects the general attractiveness of the UK for overseas research investments.

Within the UK, the science base contributes in a more focused way to economic prosperity at regional level through facilitating and contributing directly to knowledge circulation, such as through science parks.

The main lessons that may be drawn from the recent peer review of the UK's research and innovation policy system can be summarised as follows:

- The current coordinated approach to policy formulation plays a critical role, although the recent split in responsibilities between the DIUS and BERR may impact upon coordination;
- Clear and realistic long-term targets and goals, together with the production of strategies to reach them clearly communicate the Government's intentions to all actors in the research system.
- There is an open and transparent process of policy making and implementation.
- A strong governance regime which gives a prominent role to the processes of review (at the system and sub-system levels), monitoring and evaluation, coupled with good feedback mechanisms for the future implementation of policies.

6.2 Policy dynamics, opportunities and threats from the perspective of the Lisbon agenda

The peer review of the UK's research and innovation policy system noted the opportunity for cross-fertilisation between the Science and Innovation Investment Framework 2004 – 2014 and the National Reform Programme in the context of the Lisbon Strategy.

While aspects of the UK system have already been highlighted above as strengths, the long term policy framework can also be seen as providing opportunities across all four domains of the current report's analytical framework, identifying and addressing challenges. In addition, more specific opportunities and threats in the policy context have been described above and are summarised below in table 4.

Table 4: Main policy related opportunities and threats in the UK research system

Domain	Main policy-related opportunities	Main policy-related threats
Resource mobilisation	<ul style="list-style-type: none"> • Good identification of resource mobilisations issues and challenges • Promoting attractiveness to 	

	foreign researchers and foreign corporate investors	
Knowledge demand	<ul style="list-style-type: none"> • Identification of issues and challenges in a long term perspective • Role of Technology Strategy Board 	
Knowledge production	<ul style="list-style-type: none"> • Policy emphasis on renovation of research infrastructure • Development of innovation potential and scope to build on the strength of the science and engineering base 	<ul style="list-style-type: none"> • Introduction of Full Economic Costs may discourage industry spending in higher education sector
Knowledge circulation	<ul style="list-style-type: none"> • Establishment of Technology Strategy Board 	<ul style="list-style-type: none"> • Policy focus on UK attractiveness could lead to dependence on high level of FDI

The Science and Innovation Investment Framework has clearly identified the issues and challenges for resource mobilisation in both the short and long term. These provisions and their envisaged effects on the UK science base represent a wealth of opportunities, for the further development and exploitation of the UK science base, both within the UK, and to further attract both foreign researchers and foreign corporate investment.

The identification of issues and challenges in a long term perspective is now an established aspect of the UK system, not only embodied in the framework, but also building the UK's strong experience in Foresight, and more recent "horizon scanning" exercises. The establishment of the Technology Strategy Board is another example of the potential for capturing and reacting to knowledge demand.

In terms of opportunities for enhanced knowledge production, the recent policy support for the renewal and enhancement of the UK's research infrastructure is a leading example, although this was a consequence of the identification of the effects of a chronic underfunding.

The establishment of Technology Strategy Board is also set to play a potentially key role in knowledge circulation, most notably between the public and private sectors in the UK. This can build on the existing set of policy instruments to support industry-university partnerships.

As for threats, the identified supply problems in domestic human resources in S&T, with a decrease in the capacity for rapid 'renewal and growth' of the population of researchers are clearly a concern. While policy seeks to address this, the acknowledged strengths of the UK science base, including the attractiveness of the UK higher education system, in certain ways contribute to the threat, with UK S&T graduates and researchers attractive as employees in the US or outside the S&T domain, such as in the financial services sector.

Although some initial results are promising, the strong dependence on indirect measures in private sector R&D has been questioned (Cunningham, 2007a), particularly the impact on SMEs', where other more direct Government support measures might be appropriate. For example, the impacts of tax credits are a very significant support measure which should be taken into account.

In providing increased support for knowledge production in the UK, the introduction of Full Economic Costs in research grants may discourage industry spending in higher education sector. However, their strong positive effects should easily outweigh the potential negative impacts.

Furthermore, despite the strong recent efforts towards the renovation and enhancement of the UK research infrastructure, infrastructure must be maintained to keep pace with research investment.

Threats related to knowledge circulation in the UK policy context, such as the relatively high dependence on FDI in research in the UK, may have an erosive effect on the UK's domestic competences and identity.

The UK is, in general, highly supportive of EU research initiatives and seeks a high level of participation, both in shaping their development, as in the case of the Seventh R&D Framework Programme (FP7), in the actual conduct of research funded.

The UK is positive towards the European Research Area concept, particularly its contribution to broader objectives such as improving research excellence, improving innovation, and increasing EU influence in major global debates on issues such as climate change and development. In particular, this reflects the UK's strategy for international engagement in science and technology, as formulated by the Global Science and Innovation Forum.

From the UK perspective, of particular importance are: the role of the private sector in the ERA; the role of the UK in the mobility of researchers, as a prime destination for a large and increasing number of EU researcher; and the UK's increasing contribution to extent and quality of collaboration between European researchers.

References

- Cunningham, P. (2007a), CREST 3% OMC Science & Innovation Policy Mix Peer Review United Kingdom: Background and Visit Follow-up Reports
- Cunningham, P. (2007b), Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments - Country Review United Kingdom
- Department of Trade and Industry (2003), Competing in the global economy: the innovation challenge, DTI Innovation Report, December 2003.
<http://www.dti.gov.uk/innovationreport/innovation-report-full.pdf>
- Department of Trade and Industry (2004), DTI Five Year Programme, Creating Wealth from Knowledge (Nov. 2004). Available at:
<http://www.dti.gov.uk/about/fiveyearprogramme.pdf>
- Department of Trade and Industry, 2006, R&D Scoreboard:
http://www.innovation.gov.uk/rd_scoreboard/highlights.asp
- Department of Trade and Industry, The Government's Productivity and Competitiveness Indicators, <http://www.dti.gov.uk/about/economics-statistics/economics-directorate/page21913.html>

- ERAWATCH Research Inventory (2007), UK country information:
<http://cordis.europa.eu/erawatch> (EWN country correspondent: P. Cunningham et al.)
- European Trend Chart on Innovation, 2006, Annual Innovation Policy Trends and Appraisal Report: UK 2006. European Commission, Enterprise Directorate-General prepared by P. Cunningham et al.
- Funders Forum: http://www.dti.gov.uk/science/science-funding/Funders_Forum/index.html
- Global Science and Innovation Forum (2006), A Strategy for International Engagement in Research and Development
- Higher Education Funding Council for England (2005), Guide to Higher Education in the UK, HEFCE, April 2005.
- Higher Education Funding Council for England (2006), Higher Education-Business and Community Interaction Survey:
http://www.hefce.ac.uk/pubs/hefce/2006/06_25/
- Home Office (2005), Science and Innovation Strategy 2005-08, 22 November 2005.
Available at: www.scienceandresearch.homeoffice.gov.uk
- HM Treasury (2007) Lisbon Strategy for Jobs and Growth UK National Reform Programme: Update on progress
http://www.hm-treasury.gov.uk./media/B/9/lisbon_nationalreformprogramme210907.pdf
- HM Treasury (2006) Lisbon Strategy for Jobs and Growth UK National Reform Programme: Update on progress
http://www.hm-treasury.gov.uk./media/6/4/lisbon_natreform151006.pdf
- HM Treasury (2006) Gowers Report on Intellectual Property
- HM Treasury (2005) Lisbon Strategy for Jobs and Growth UK National Reform Programme: http://www.hm-treasury.gov.uk./media/2/F/lisbon_jobs131005.pdf
- HM Treasury, The Lambert Review of Business-University Collaboration, HM Treasury Consultation Review, 2003.
- Malik, K. and Cunningham, P. UK Country report 2007, Inno Policy TrendChart.
- Ministry of Defence (2005), Defence Industrial Strategy – Defence White Paper, December 2005. Available at: <http://www.the-dma.org.uk/Secure/Admin/Diary/Attachments/1849.Pdf>
- National Audit Office (2007), Big Science: Public investment in large scientific facilities HMSO
- OECD 2006a, Going for Growth. OECD, Paris
- OECD 2006b, Education at a Glance, OECD, Paris
<http://www.oecd.org/edu/eag2006>
- Office of National Statistics, 2006a, Business Enterprise Research and Development 2004, National Statistics (London), May 2006:
<http://www.statistics.gov.uk/pdfdir/berd1104.pdf>
- Office of National Statistics, 2006b, Economic Trends 628, March 2006, ONS, pp. 58-64: March 2006. Available at:
http://www.statistics.gov.uk/articles/economic_trends/ET628.pdf
- Department of Business Enterprise and Regulatory Reform, and Office for National Statistics: SET Statistics 2005,
<http://www.dti.gov.uk/science/science-funding/set-stats/index.html>
- OSI – Office for Science and Innovation (2007), Measuring economic impacts of investment in the research base and innovation: a new framework for measurement

The Patent Office, "Innovation Support Strategy":

<http://www.patent.gov.uk/innovationstrategy.pdf>

Science and innovation investment framework 2004-2014: next steps. HM Treasury, DTI, DfES, Department of Health Consultation Review, 2006.

Science and Innovation Investment Framework 2004-2014 Annual Report 2006, HM Treasury, Department for Education and Skills, Department of Trade and Industry, July 2006. Available at: <http://www.dti.gov.uk/science/science-funding/framework/page9306.html>

Science and Innovation Investment Framework: Progress Against Indicators, HM Treasury, Department for Education and Skills, Department of Trade and Industry, July 2006. <http://www.dti.gov.uk/science/science-funding>

Science and Innovation Investment Framework 2004-2014: Progress against Measures: HM Treasury, Department for Education and Skills, Department of Trade and Industry, July 2006: <http://reporting.dti.gov.uk/cgi-bin/rr.cgi/http://www.dti.gov.uk/files/file33142.pdf>

Technology Strategy Board,

http://www.dti.gov.uk/innovation/technologystrategy/innovation_platforms/index.html

Abbreviations

BERD	Business Expenditure on R&D
BERR	Department for Business, Enterprise and Regulatory Reform
COMPAT	Community Patent
CSA	Chief Scientific Adviser
CSR	Comprehensive Spending Review
DELNI	Department for Employment and Learning, Northern Ireland
DGSI	Director General of Science and Innovation
DIUS	Department for Innovation, Universities and Skills
DTI	Department of Trade and Industry
EPSRC	Engineering and Physical Sciences Research Council
ERP	Energy Research Partnership
FCO	The Foreign and Commonwealth Office
FEC	Full Economic Costs
GDP	Gross Domestic Product
GERD	Gross Expenditures on R&D
GOVERD	Government Expenditure on R&D
GSIF	Global Science & Innovation Forum
HE-BCI	Higher Education-Business and Community Interaction
HEFCE	Higher Education Funding Council for England
HEFCW	Higher Education Funding Council for Wales
HEI	Higher Education Institution
HEIF	Higher Education Innovation Fund
HERD	Higher Education Expenditure on R&D
KTN	Knowledge Transfer Networks
OSI	Office of Science and Innovation
PRO	Public Research Organisation
PSA	Public Service Agreement
R&D	Research and Development
RAE	Research Assessment Exercise
RDAs	Regional Development Agencies
RIS	Regional Innovation Strategies
SET	Science, Engineering and Technology
SETM	Science, Technology, Engineering, and Mathematics
SFC	The Scottish Further and Higher Education Funding Council
SICs	Science and Industry Councils
SME	Small and Medium-sized Enterprise
SRIF	Science Research Investment Fund
TSB	Technology Strategy Board
UKTI	UK Trade & Investment

European Commission

EUR 23389 EN/6 – Joint Research Centre – Institute for Prospective Technological Studies

Directorate General Research

Title: ERAWATCH Analytical Country Report 2007: United Kingdom

Author: Mark Boden

Luxembourg: Office for Official Publications of the European Communities

2008

EUR – Scientific and Technical Research series – ISSN 1018-5593

Abstract

The main objective of ERAWATCH analytical country reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. The reports support the mutual learning process and the monitoring of Member States efforts by DG Research in the context of the Lisbon Strategy. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This analytical approach has been tested in 2007 by applying it to six countries, one of which is the UK. The report is based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

How to obtain EU publications

Our priced publications are available from EU Bookshop (<http://bookshop.europa.eu>), where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents. You can obtain their contact details by sending a fax to (352) 29 29-42758.

