
BIS
Department for Business Innovation & Skills
ANNUAL INNOVATION REPORT 2010
NESTA
Making Innovation Flourish
1996
1998
2000
2002
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2006

Foreword by David Willetts

Innovation is a key driver of economic growth. It is central to achieving the Government's economic policy objective of achieving strong, sustainable and balanced growth that is more evenly shared across the country. This Annual Innovation Report provides a snapshot of some of the key elements of innovation, its contribution to growth and the activities undertaken in business, the research base and government.

In this year's report we see some further effects of the economic downturn: business investment in R&D fell by 2.5 per cent between 2008 and 2009 and Venture Capital investment continued to decline. But importantly NESTA's Innovation Index suggests that ongoing private investment in innovation helped minimise the impacts of the downturn. Increasing and broadening these investments will be a key driver in delivering the private sector led economic growth central to Britain's future.

The report also highlights a number of positive elements: businesses are deriving more of their turnover from innovative products and knowledge exchange activities are increasingly important for universities.

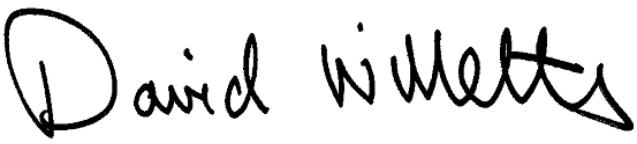
The findings in this report underline the need and desirability for Growth in the UK economy to be driven by innovation and private sector ingenuity. As part of our drive for growth the Government has initiated a Growth Review programme that will tackle barriers to growth, whether through structural reforms that improve our overall competitiveness and the business environment for all firms, or measures that make life easier for a particular sector of the economy.

The Government has also committed over £200 million for an elite network of technology innovation centres to be managed by the Technology Strategy Board. These centres will play a role in driving growth in the medium to long-term through business-led innovation and form a key part of our strategy to rebalance the economy.

This year's report also makes clear the important role played by the research base in encouraging innovation in addition to its other roles. The research base continues to be a strong source of knowledge through training and knowledge exchange activities and is a key driver of economic growth. The Government recognised this in protecting funding for science and research programmes in cash terms within a ring fence. Through efficiency, prioritisation and reform it should be possible to offset much of the inflationary effect. Capital investment will be delayed in order to maximise investment in research projects and in people undertaking research.

Finally, I would like to thank NESTA for its role in preparing this year's Annual Innovation Report. They have brought an understanding of innovation in its broadest sense to this year's report underpinned by their excellent work on the Innovation Index which is being released alongside the Annual Innovation Report.

Moving forward, we need to use the evidence in the Annual Innovation Report, the NESTA Innovation Index and a range of other sources to develop and fine-tune our innovation policies to ensure that innovation further underpins future economic growth in the UK. We will produce a new Innovation Strategy, founded on a range of these sources. It will focus on how the Coalition Government will support innovation activity across all the important sectors of the UK and in particular those that offer the greatest scope for boosting UK growth and productivity.



David Willetts
Minister of State for Universities and Science

January, 2011

Key findings

R&D intensity in the UK, overall and in business, has remained below many major developed economies and business R&D dropped by 2.5 per cent between 2008 and 2009 to £15.5 billion. Overall total R&D intensity has remained broadly stable at around 1.9 per cent of GDP from 1997 to 2008.

Business R&D intensity has also remained stable at just over 1 per cent of GDP.

Nominal investments in intangible assets have risen 4.6 per cent per year since 2000 to £140 billion in 2008. They account for 14 per cent of private sector output.

Innovation drives economic growth - it has accounted for 63 per cent of annual labour productivity growth since 2000, with investments in intangibles accounting for 23 per cent of productivity growth. Investment in intangibles in 2008 also helped reduce the negative impact on productivity of the start of the recession.

Venture capital investment continued to decline, most likely as a result of the downturn, from €1.53 billion in 2008 to €782 million in 2009.

The UK has seen a strong increase in science and technology human resources from 37 per cent of the labour force in 2001 to 44 per cent in 2009.

Turnover for UK businesses from innovation products increased from less than 8.5 per cent in 2006 to 10.5 per cent in 2008.

University knowledge exchange income, valued at £3 billion in 2008/09, increased by 6 per cent per year between 2003/04 and 2008/09.

Overall government investment in R&D, incorporating the science budget, higher education funding councils and direct government expenditure on R&D was valued at over £9.4 billion in 2008/09.

Contents

Annual Innovation Report

BIS prepared the 2010 Annual Innovation Report with the kind assistance of NESTA.

NESTA is the UK's foremost independent expert on how innovation can solve some of the country's major economic and social challenges. Its work is enabled by an endowment, funded by the National Lottery, and it operates at no cost to the government or taxpayer.

NESTA is a world leader in its field and carries out its work through a blend of experimental programmes, analytical research and investment in early-stage companies. www.nesta.org.uk

Part 1: Introduction

Innovation is a vital driver of economic growth and is therefore a high priority area for government policy. But to provide the best possible input to policy we need a strong basis on which to gauge performance. Much work has been and is being undertaken to improve our understanding and measurement of innovation in the economy within government, academia and business. In particular it is worth highlighting the work of NESTA, in developing the Innovation Index, and of the UK Innovation Research Centre, in bringing together academics, government and industry to consider these issues.

The Annual Innovation Report provides a small snapshot of our understanding. The 2010 Report is the third in the series and expands on the range of data included in previous editions. The indicators selected here by no means create a complete picture; innovation is complex and the incentives, activities and outcomes at play are difficult to capture through any selection of indicators. But it does provide a quick and condensed overview of who undertakes innovation, how much money is invested, some of the activities being undertaken – including investment in R&D - and some outcomes that are achieved.

The report is structured around four broad areas. Section 1 begins by considering a macro economy picture of investment in innovation and its outcomes in terms of productivity. In particular it considers the investment in R&D and broader types of innovation to consider their impact on productivity, drawing heavily on the NESTA Innovation Index.

Sections 2, 3 and 4 then turn to more detailed consideration of the roles played by different groups of actors in encouraging innovation and undertaking innovative activities.

Section 2 deals with business and the private sector and their role as major investors in innovation. Private sector investment makes up the largest component of investment in innovation in the UK and is vital if we are to reap commercial returns from our innovative capabilities.

Section 3 deals with the research base and higher education and their important role in both generating and disseminating knowledge and innovation. Much, although not all, of the investment in the research base comes from government but is undertaken at arm's length from government in universities and Research Councils. The research base remains a cornerstone of the UK's innovation performance and a key attractor for foreign investment.

Finally, Section 4 considers the role of central government more directly both in funding research but more particularly its direct investments in innovation and in business R&D. It focuses on government investments in R&D and the research base, the innovation infrastructure developed to support and underpin investment in innovation, and the role of public procurement in leading the demand for innovative solutions.

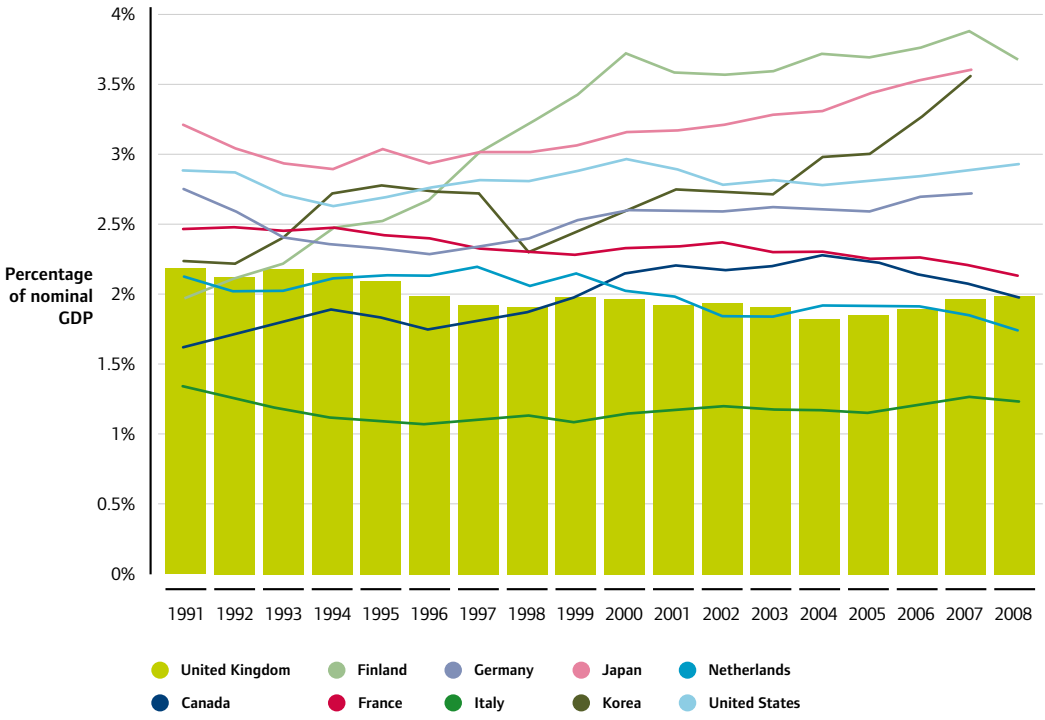
Part 2: Innovation in the macro economy

Innovation plays a well-documented role in driving growth. This first section presents a selection of metrics at a macro level, beginning with investments in innovation and finishing with a consideration of the impact of innovation on productivity growth.

2.1 Investment in innovation

R&D is the activity most usually associated with innovation and Figure 1 presents R&D intensity – the total level of expenditure[1] on R&D as a proportion of total GDP. R&D intensity in the UK has remained broadly stable at around 1.8 per cent from 1997 to 2008. This is down on the 2 per cent share over the first half of the 1990s. This represents a proportion lower than many major developed economies, although reflects the sectoral mix of the UK economy with services dominating.

Figure 1: Gross expenditure on R&D as a percentage of GDP, 1991-2008



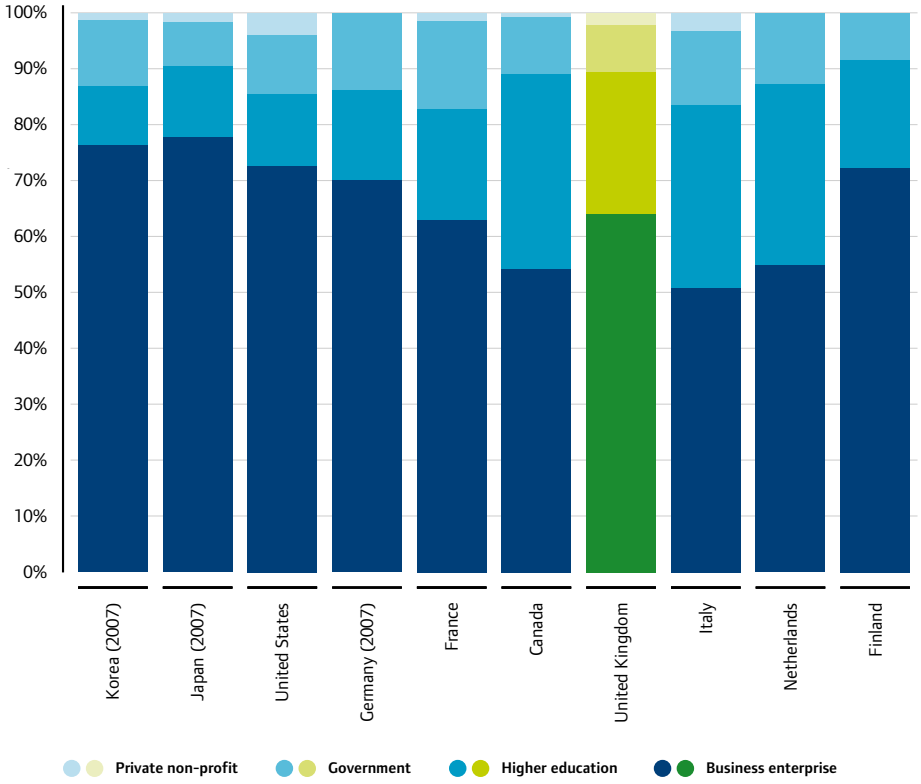
Source: OECD, MSTI May 2010[2]

1. Individual sectors – business, government and higher education are both purchasers of R&D and the providers of funds for others to purchase or undertake R&D. For example, government is both a provider of funding for R&D for business and higher education, but also spends money itself on R&D. Within the report the term 'expenditure' is used to refer to R&D undertaken in that sector or purchased or contracted by the sector but performed in another. When the term 'source of funds' is used this relates to the sectors that are providing funds subsequently used for expenditure.
2. OECD Main Science and Technology Indicators, May 2010. New data will be available in February 2011.

While general expenditure on R&D provides an aggregate measure, it may mask a number of contextual drivers; a more informed analysis can be made by examining the relative R&D expenditure undertaken by the key sectors – private, government and higher education.

Figure 2 presents the total expenditure on R&D in 2008[3] broken down by the share of each sector's expenditure to the total. Business expenditure on R&D in the UK is at 62 per cent of the total. The next largest component is expenditure within higher education at 26 per cent, followed by government at 9.2 per cent. A more detailed review of each of these components is provided in the sections that follow. Private non-profit organisations make up a smaller proportion (2.4 per cent) of funding, but in the UK they play an important role, particularly in medical research.

Figure 2: Gross expenditure on R&D by sector of performance, 2008



Source: OECD, MSTI May 2010

3. 2008 is the latest year data available for all sectors' expenditure. UK business expenditure data available for 2009.

While R&D is an important source of innovation, it is focused on only a subset of innovative activity. There is a growing recognition that innovation encompasses a wider range of activities and broader metrics are required to reflect this, including investment in intangible assets (Box 1).

Box 1: Intangible Investments

Investment in innovation includes a wide range of activities undertaken to develop new ideas, turn them into products and services, and take these to market. These include investments in some tangible assets such as scientific equipment for example, as well as investments in intangibles.

Traditionally, investments in machines were counted as building a stock that yielded capital services and so contributed to output. By contrast, investments in innovation were

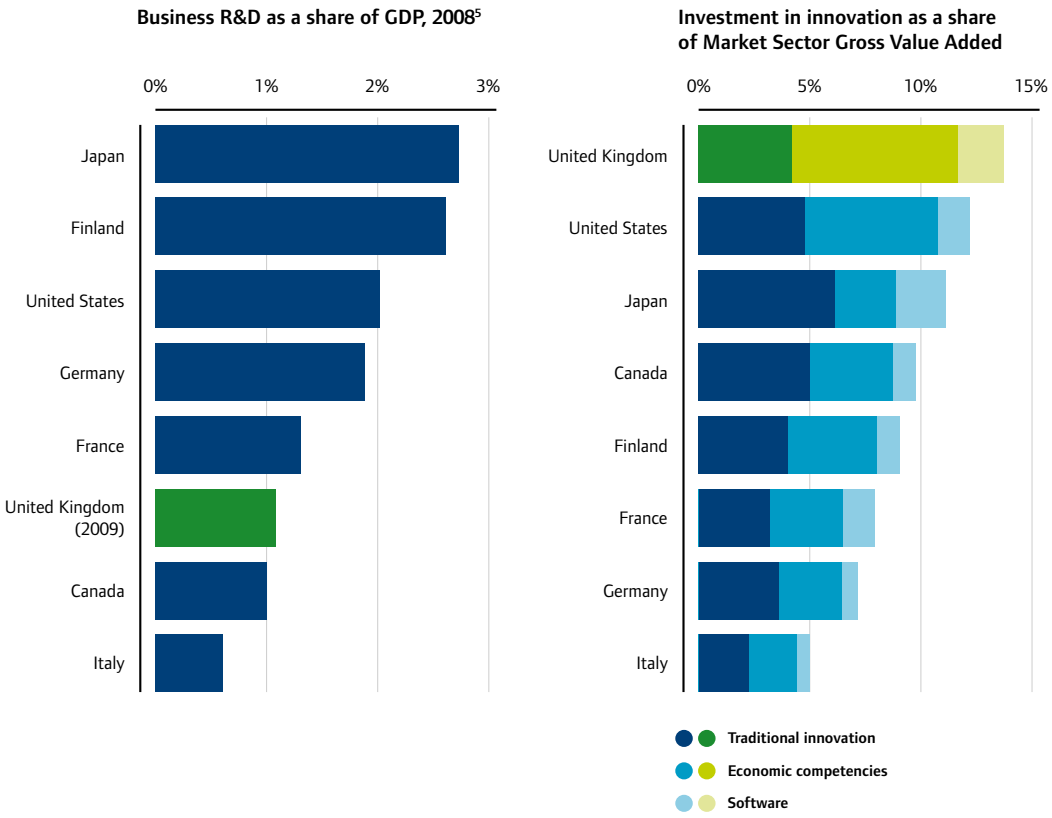
considered very risky and uncertain – they were counted as day-to-day spending, just like air-conditioning or photocopy paper. That means that when such investments translated into successful innovations, generating revenue, they appeared from thin air: that is, there seemed to be no corresponding accounting for an input that contributed to this new revenue stream.

The intangibles approach to innovation measures spending on a range of different knowledge assets drawing on survey evidence on such spending and its effectiveness in increasing productivity. These investments in intangibles can be put into three categories: traditional, which includes R&D, design and intellectual property; software development, which includes software and databases; and finally economic competencies, which includes investments in training, organisational development, marketing and branding. When incorporated with firm spending on tangibles, this provides a much more complete picture of both inputs and outputs in economies and the role of innovation. The method also provides a basis for understanding the impact this investment has on economic growth.

NESTA was requested by government to take forward research to advance the measurement in this area for the UK. A pilot Index was published in November 2009. The second instalment of the Innovation Index, prepared with Imperial College and the Office for National Statistics, is being released in parallel with the 2010 Annual Innovation Report. The Index is available at www.nesta.org.uk

When intangibles are taken into account, the UK compares more favourably to other economies (Figure 3).[4]

Figure 3: Investment in tangible and intangible capital as a share of GDP, 2008



Source: OECD, MSTI May 2010.
UK data sourced from ONS 2010.

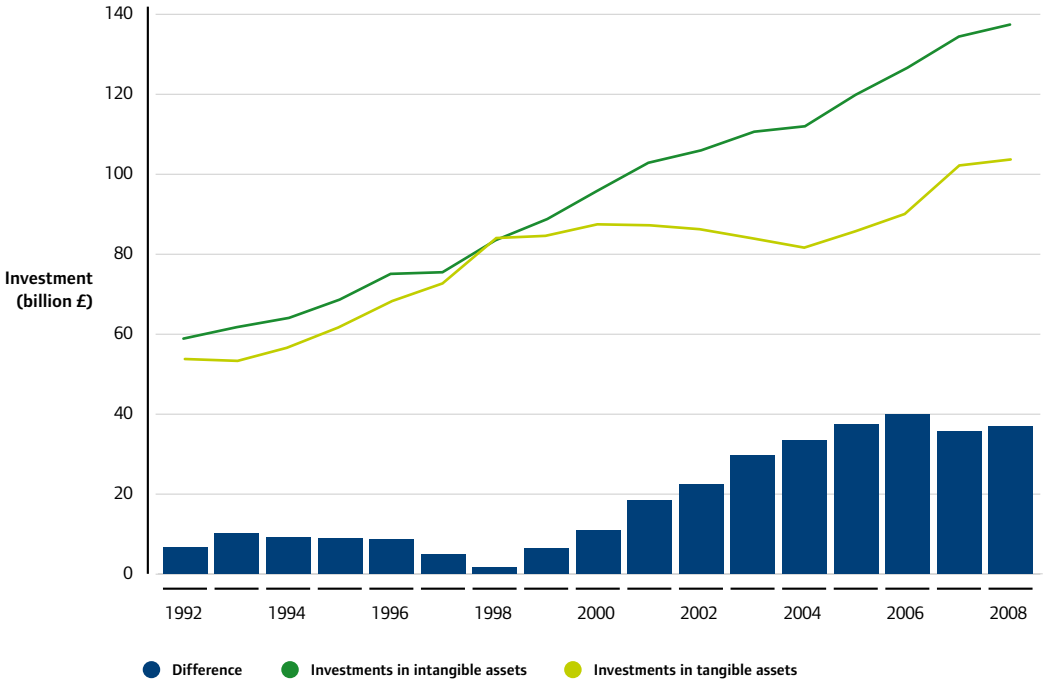
Source: UK data: NESTA's Innovation Index 2010.
Other countries: OECD based on national studies.

4. The figures on the right-hand chart have not been collected on a fully consistent basis and should therefore be interpreted with care. They do however provide a picture of the wider scale of investment in innovation than using R&D alone. Estimates refer to the total economy for Canada and Japan; the market sector for France, Germany, Italy and the United Kingdom; the non-financial business sector for Finland; and the non-farm business sector for the United States.
5. The latest UK data on business expenditure on R&D which covers the period to 2009 was published on 1st December 2010. While international data is only available to 2008 the latest UK data is presented when possible.

When investments in intangibles are included, albeit for businesses only, it highlights the large scale of investment in innovation. In the UK these investments totalled around £140 billion in 2008. Contrasting the R&D intensity of business with the investment in broader intangibles as a share of output gives a more balanced picture, capturing more of the UK service sector's investment in innovation that is less frequently undertaken through R&D.

Nominal investments in intangibles have increased at an average rate of 4.6 per cent since 2000, well above the growth seen in tangible assets at 2.1 per cent per year over the same period (Figure 4). The gap between these different types of investments has widened since 1998 such that by 2008 investments in intangibles were £34 billion higher than those of tangibles.

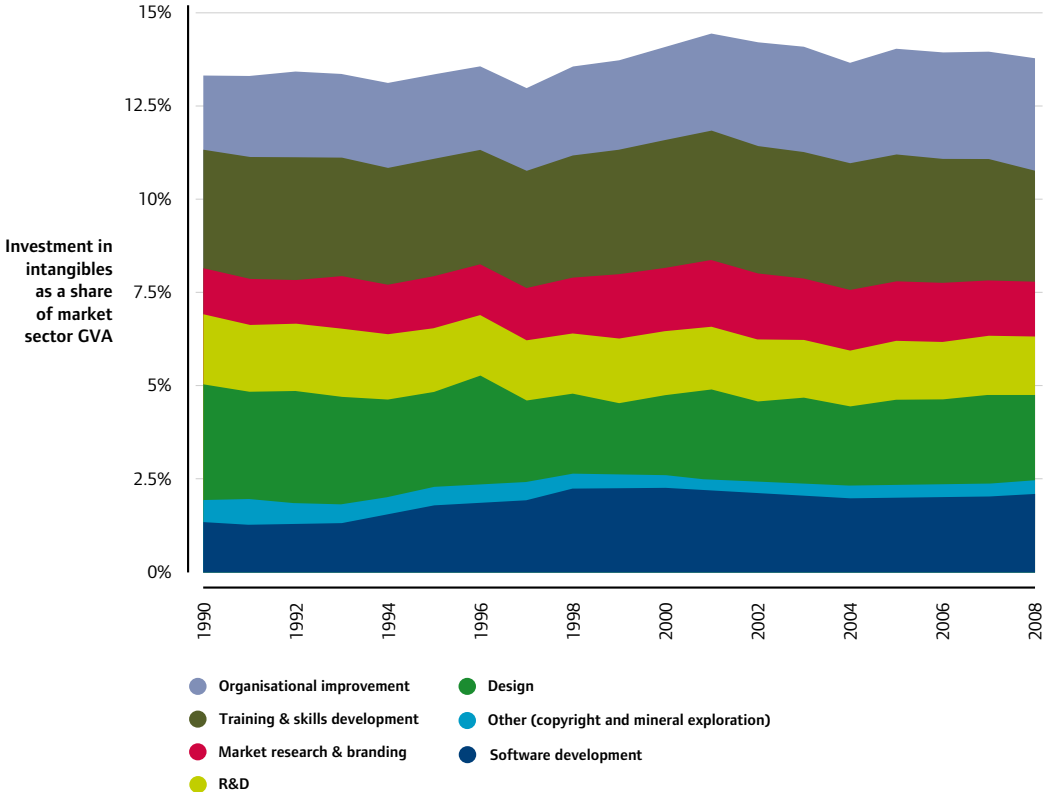
Figure 4: Investment by UK firms in intangible and tangible assets, 1990-2008



Source: NESTA Innovation Index 2010

Total investment in intangible assets as a share of market output (excluding government) remained at around 13 per cent during the 1990s, peaking at 14.5 per cent in 2001 before stabilising between 13.5 per cent and 14 per cent during the 2000s. The contribution of each of the asset categories to total intangible investment has also remained broadly stable between 2000 and 2008 (Figure 5). The largest component for UK intangibles investments is in economic competencies such as training, organisational capability, market research and branding, which accounted for 55 per cent of the total intangibles, the largest share among the comparator countries.

Figure 5: Investment by UK firms in intangible assets by category – share of market sector Gross Value Added, 1990-2008



Source: NESTA Innovation Index 2010

2.2 Impact on economic performance

Innovation is a significant driver of labour productivity growth and the Innovation Index provides a new way of measuring this impact (Box 2).

Box 2: Innovation and productivity growth

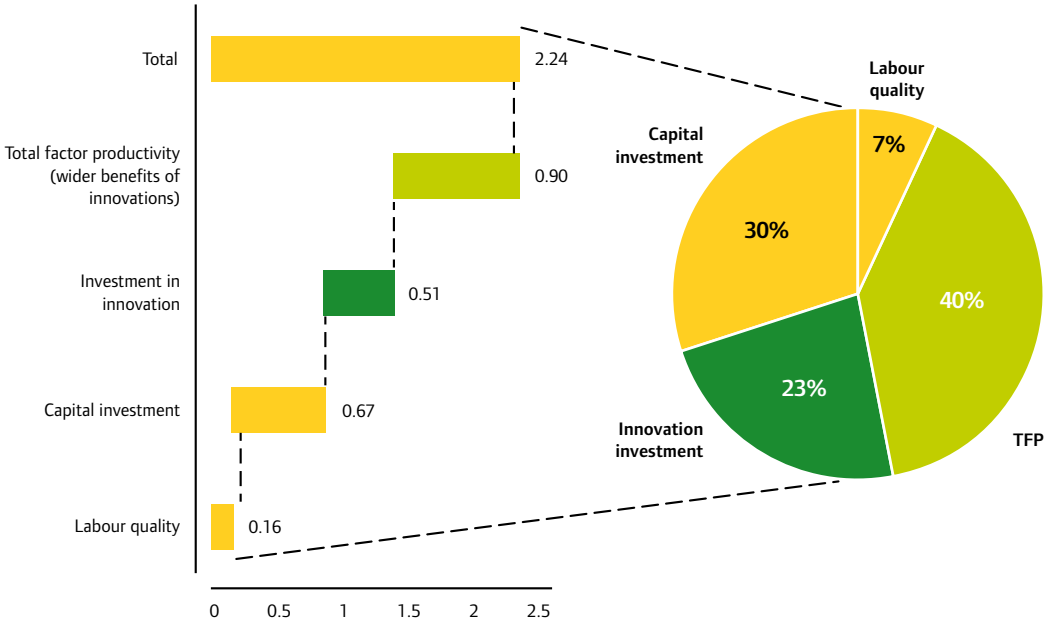
The Index calculates the impact of investment in intangibles on productivity by aggregating two components of economic change.

The first of these is the direct contribution of the investments in intangible assets – the investment in innovation.

The second is the measure of productivity growth that is not accounted for by the growth in economic inputs, such as physical capital or labour quality, and is generally attributed to better ways of doing things, including the broader benefits of technological advances and improved processes. This is called Total Factor Productivity (TFP). It includes the wider benefits to society and the spill-over benefits of new knowledge that other firms can acquire from innovation investments, including those in the public sector.

Using the investments in intangibles methodology, the Index estimates that UK private-sector labour productivity grew 2.24 per cent per year between 2000 and 2008, with innovation contributing 63 per cent of that productivity growth, adding an average of 1.41 percentage points to productivity growth per year over the period (Figure 6).

Figure 6: Breakdown of components for UK average labour productivity growth, 2000-2008

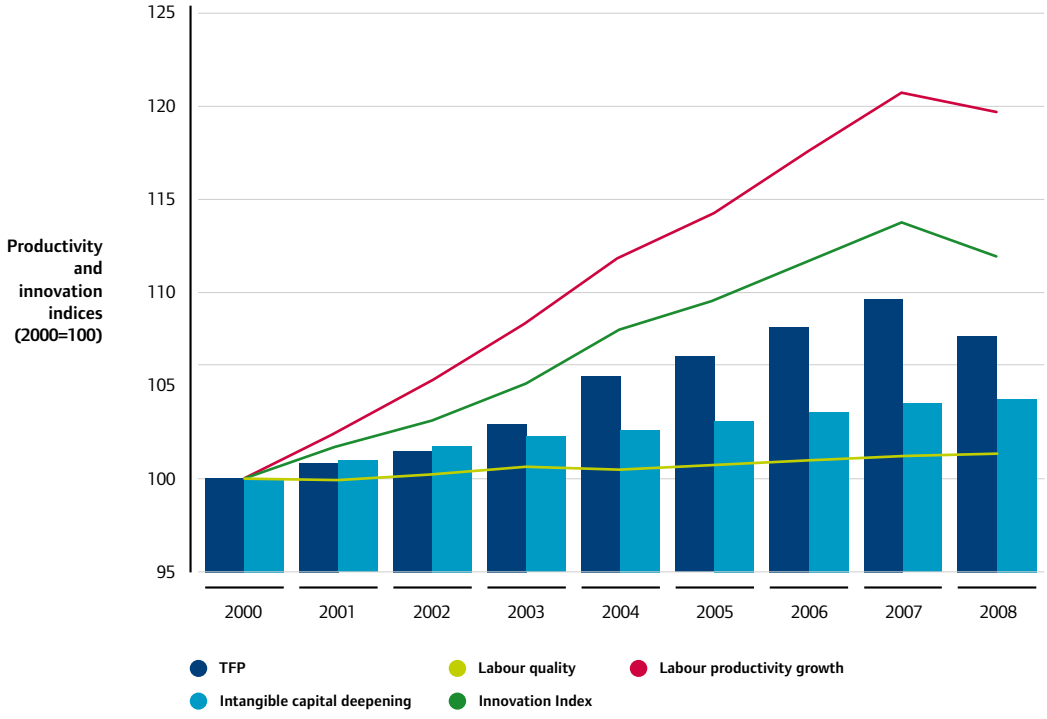


Source: NESTA Innovation Index 2010

The Innovation Index is intended to measure the impact of innovation on the longer run trend of labour productivity and will therefore show only broad trends. However, the latest Index data is beginning to reflect the first impacts of the economic downturn which began in the second half of 2008.

Labour productivity growth was 20 per cent higher in 2007 than in 2000 (Figure 7). However, the two quarters of negative growth at the end of 2008 resulted in negative labour productivity growth in 2008 reversing previous productivity gains by 1 per cent. Through 2008 businesses continued to invest in intangible assets and growth in intangible investments also continued but was slower than in previous years. These investments contributed to a softening of the impact of the decline in labour productivity. In other words, without the investments in intangibles, labour productivity is likely to have declined more sharply in the early stages of the downturn.

Figure 7: Innovation Index – components of annual labour productivity growth, 2000-2008



Source: NESTA Innovation Index 2010

Part 3: Innovation in business

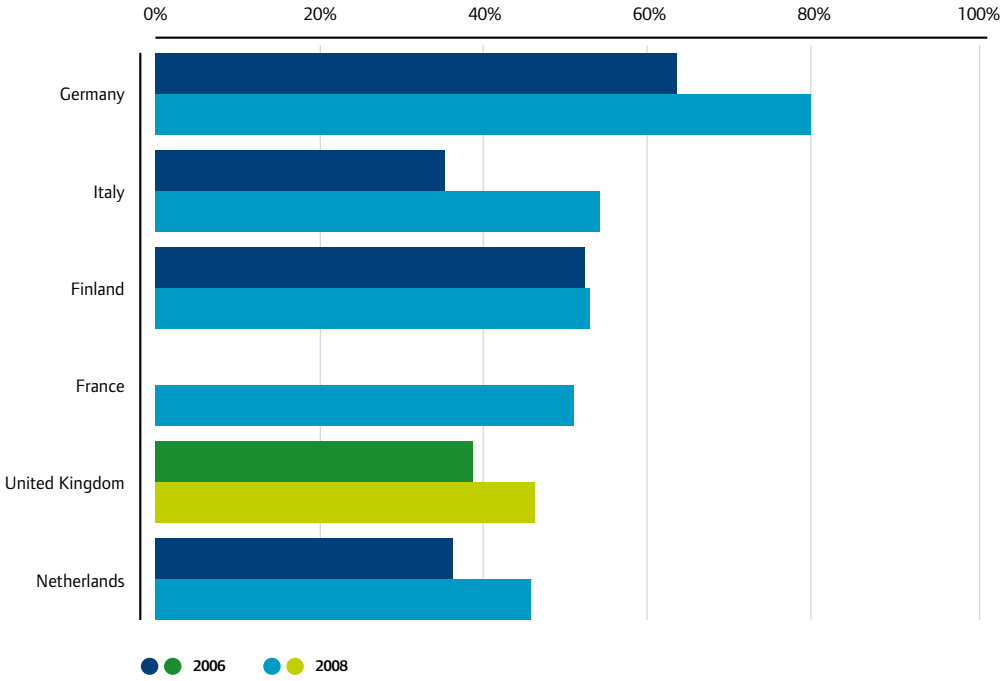
Businesses are key drivers of innovative activity providing finance, undertaking R&D and delivering innovations to the market. This section presents data on the role of business: the number of businesses considering themselves to be innovation active; business investment in innovation; employment of highly skilled people in business; and finally some of the outcomes generated.

3.1 Innovation activity

In the UK 46 per cent of firms are innovation active according to the Eurostat definition.[6] This is broadly on a par with the levels in most European countries although well below the levels reported in Germany at 80 per cent (Figure 8).

However this measure does not consider expenditure on innovation by business without contemporaneous product or process innovation. Taking these into account (e.g. investment in innovative activities such as R&D, training for innovation and design) brings the level of innovation active firms up to around 58 per cent in the UK.[7]

Figure 8: Innovation active firms



Source: Eurostat 2010

6. Eurostat defines innovation activity as firms who report a product, process innovation or with abandoned or continuing innovative activities.
7. Data sourced from UK Innovation Survey 2009.

Box 3: UK Innovation Survey

The UK Innovation Survey provides a key data set reflecting on innovation within UK businesses. The UK Innovation Survey 2009, part of the sixth Europe-wide Community Innovation Survey, was sent to 28,000 UK enterprises with ten or more employees and achieved a 50 per cent response rate. It provides the UK data covering the three-year period from 2006 to 2008. It provides a range of insights into the innovation process including: the factors that determine why firms innovate and how they innovate; the information sources and partners they use; the methods they use to protect their innovations; and the barriers they come across.

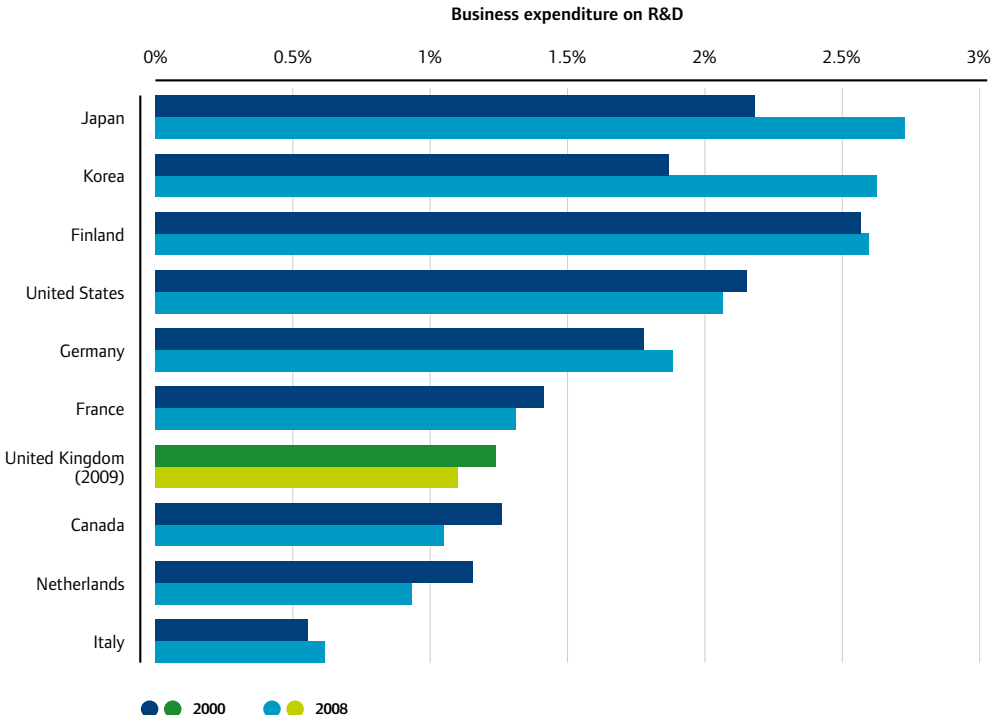
The Annual Innovation Report draws extensively from the Survey, but the Survey covers a far wider range of indicators than is possible to include here. Further details on the survey, including all of the datasets and a more detailed analysis of the 2009 results, can be found at http://www.bis.gov.uk/policies/science/science-innovation-analysis/cis.

3.2 Business investment in innovation

Like the total investment in R&D (Figure 1 above), business investment in R&D as a proportion of GDP in the UK has remained below a number of key countries for some time (Figure 9). This is largely due to the industrial structure of the UK economy, with the dominance of the services sector in the UK economy. The intangibles investment described above (Figure 3 & 4) demonstrates that this investment in R&D does not fully capture the investment in innovation undertaken by UK businesses.

UK businesses' expenditure on R&D grew at an average rate of 3.4 per cent per year from 2000 and was valued at just over £15.5 billion in 2009, a fall of 2.5 per cent on 2008. This investment as a share of GDP has remained at 1.1 per cent of GDP and slightly down on the share of 1.2 per cent of GDP in 2000.

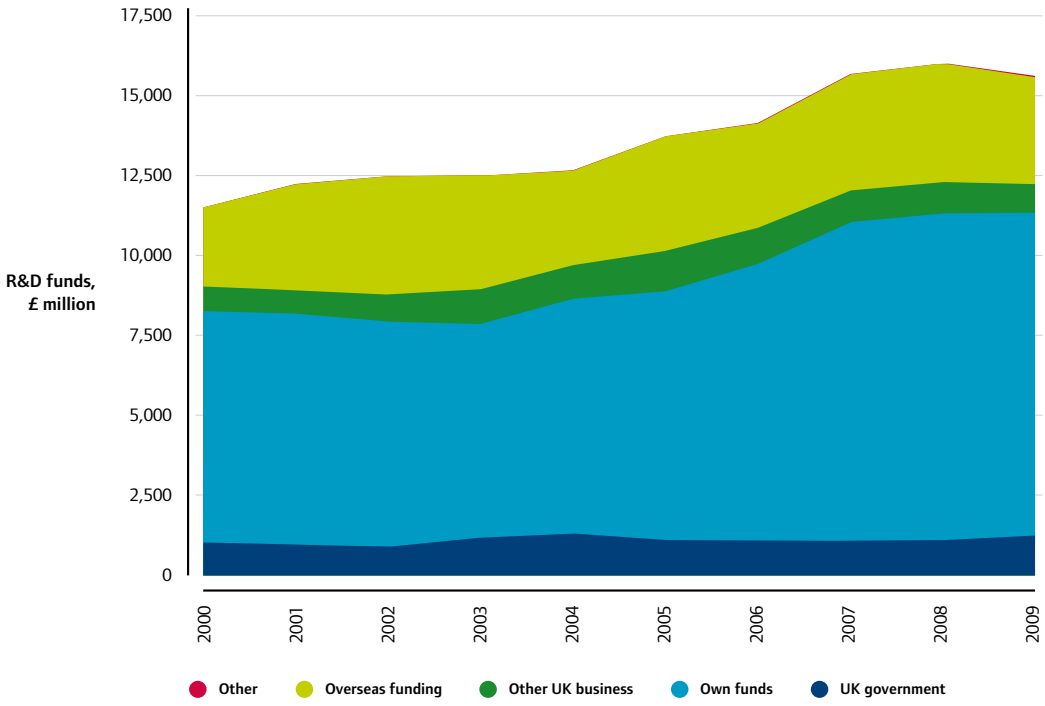
Figure 9: Comparison of business expenditure on R&D as a percentage of GDP, 2000 and 2008



Source: OECD, MSTI May 2010. UK data: ONS 2010.

While businesses fund a significant amount of R&D themselves (60-65 per cent), they also receive funding from a variety of sources (Figure 10). Domestic sources of funds from government (8 per cent) are also important, but inward investment in R&D is particularly important in the UK (over 20 per cent) as a sign of the attractiveness of the UK research base (Figure 10). This level of inward investment is higher than other comparative countries with Canada at 16.5 per cent and Italy at 13.3 per cent in 2008, the latest year available for other countries.

Figure 10: Sources of funds for UK business expenditure on R&D, 1990-2009

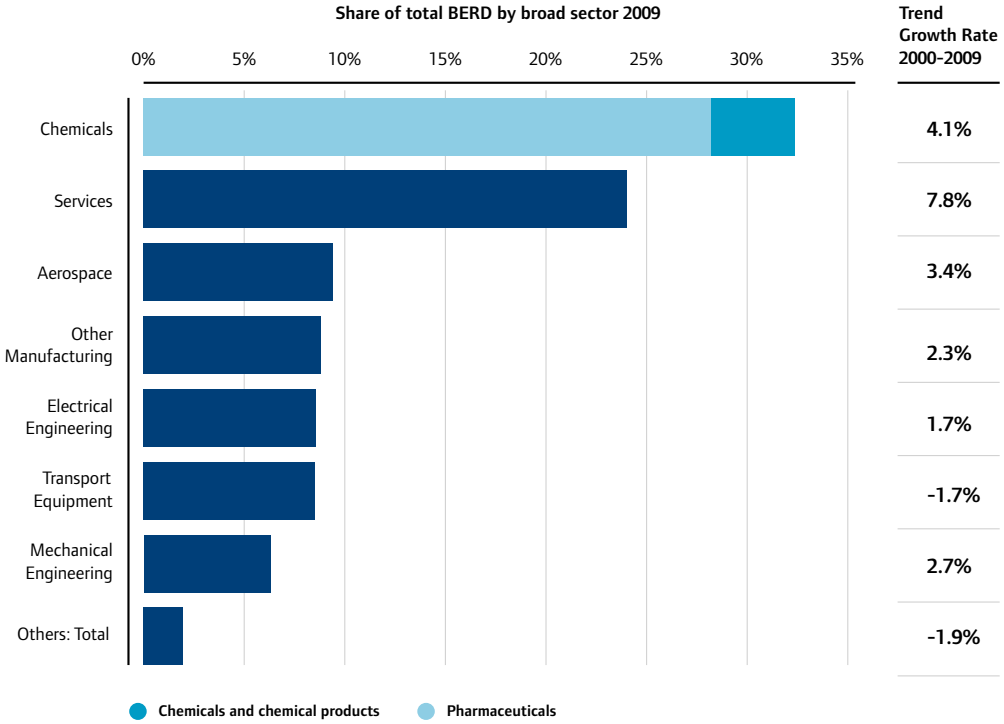


Source: ONS 2010

The overall trend in R&D expenditure will be shaped by the industrial profile of an economy with some sectors likely to have higher levels of R&D. Figure 11 shows the contribution by broad sectors. The chemical sector accounts for 32 per cent of total business expenditure on R&D, including 28 per cent of the total expenditure occurring within the pharmaceuticals sub-sector.

Figure 11 also shows the trend growth rate in sectors between 2000 and 2009. Expenditure on R&D by businesses in the chemicals sector grew by an average 4.1 per cent each year between 2000 and 2009. Businesses in the services sector are growing in importance for R&D investment. In 2009 the service sector accounted for 24 per cent of R&D while businesses in this sector increased their expenditure on R&D by an average 7.8 per cent per year since 2000. This may reflect a number of issues, including the service sector performing R&D on behalf of UK and international manufacturing businesses.

Figure 11: Share of total UK business expenditure on R&D by sector and trend growth rate, 2000-2008



Source: ONS 2010

Direct government expenditure on R&D is addressed in section 4.1 below, however government is also a key source of funding for business R&D. In Figure 10 it was shown that UK government's funding of businesses' expenditure R&D in 2009 was £1.2 billion, 8 per cent of the total, predominantly in the defence sector. However, government can also play a significant role in encouraging wider business R&D by providing incentives as well as investing directly. The use of tax incentives such as R&D tax credits can stimulate private investments to higher levels, generating wider spill-over benefits for the wider economy.

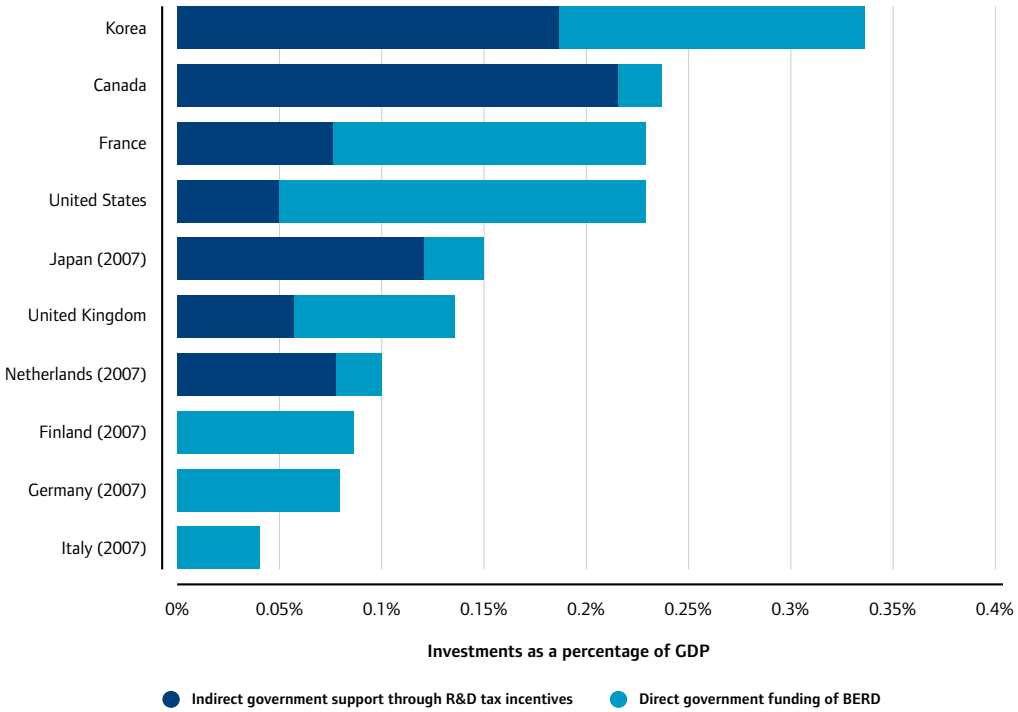
In 2008 direct and indirect support for UK R&D was around 0.14 per cent of GDP with 0.08 per cent of GDP being invested directly and 0.06 per cent stimulated through tax credits. The emphasis on direct and indirect support differs between countries. The emphasis in the USA is on direct funding with the equivalent of 0.18 per cent of GDP provided through direct government support compared to 0.05 per cent through indirect stimulation through R&D tax incentives (Figure 12).[8]

Venture capital is also a key source of market finance for innovative activites, particularly closer-to-market finance for commercially risky early-stage opportunities which may eventually redefine industries and sectors.

At the national level for the UK, venture capital investments in the UK represent 0.2 per cent of GDP (Figure 13).

8. The R&D tax expenditures do not cover sub-national R&D tax incentives.

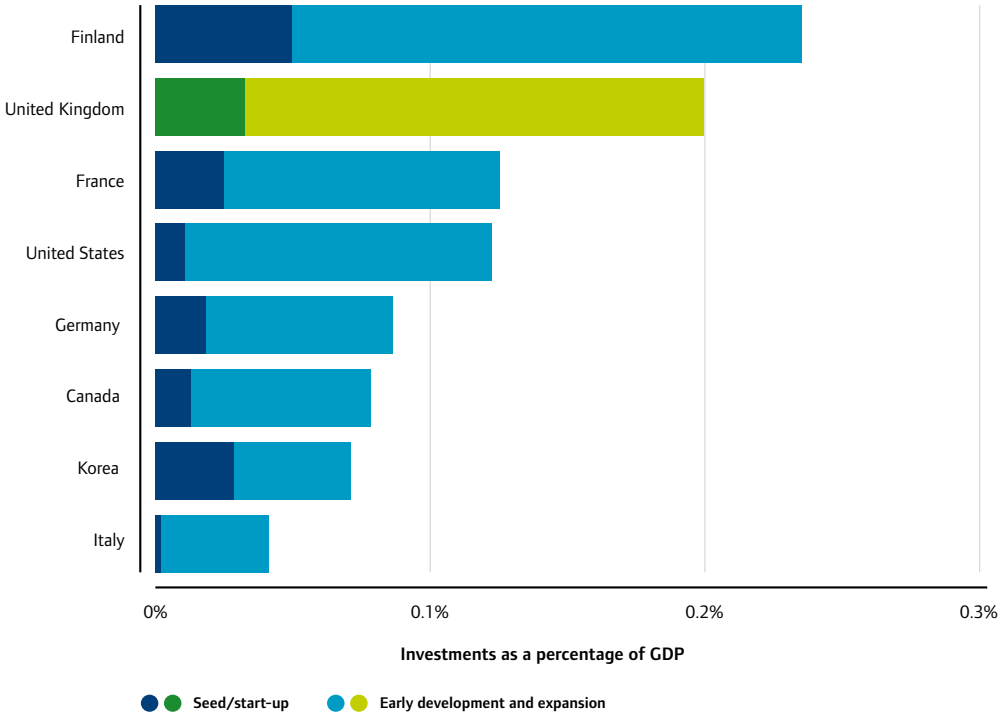
Figure 12: Direct and indirect government investment in R&D, 2008



Source: OECD 2010[9]

9. OECD, based on national estimates from the Working Party of National Experts in Science and Technology (NESTI) R&D tax incentives questionnaire January 2010; and OECD MSTI December 2009.

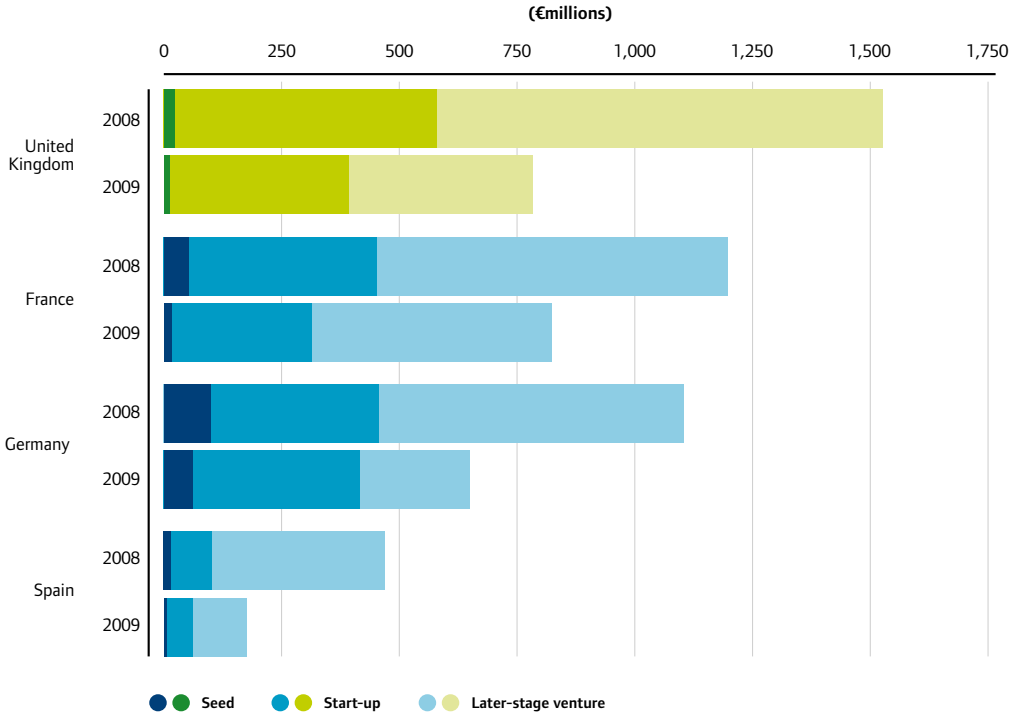
Figure 13: Venture capital investment by stage of financing as a percentage of GDP, 2009



Source: OECD 2010

Overall UK investments fell significantly during the recession (Figure 14). Total investments in venture capital fell 48 per cent in 2009, down from €1.53 billion in 2008 to €782 million in 2009, with similar drops experienced by other countries. The largest fall, 59 per cent, was in later-stage funding while seed and start-up investments fell 42 per cent and 32 per cent respectively.

Figure 14: Total value of venture capital investments by stage of financing (€m), 2008 and 2009



Note: No comparable data for Japan, USA, China, Korea, Sweden, Italy, Finland, Netherlands
Source: EVCA/PEREP_Analytics

3.3 Innovative people in business

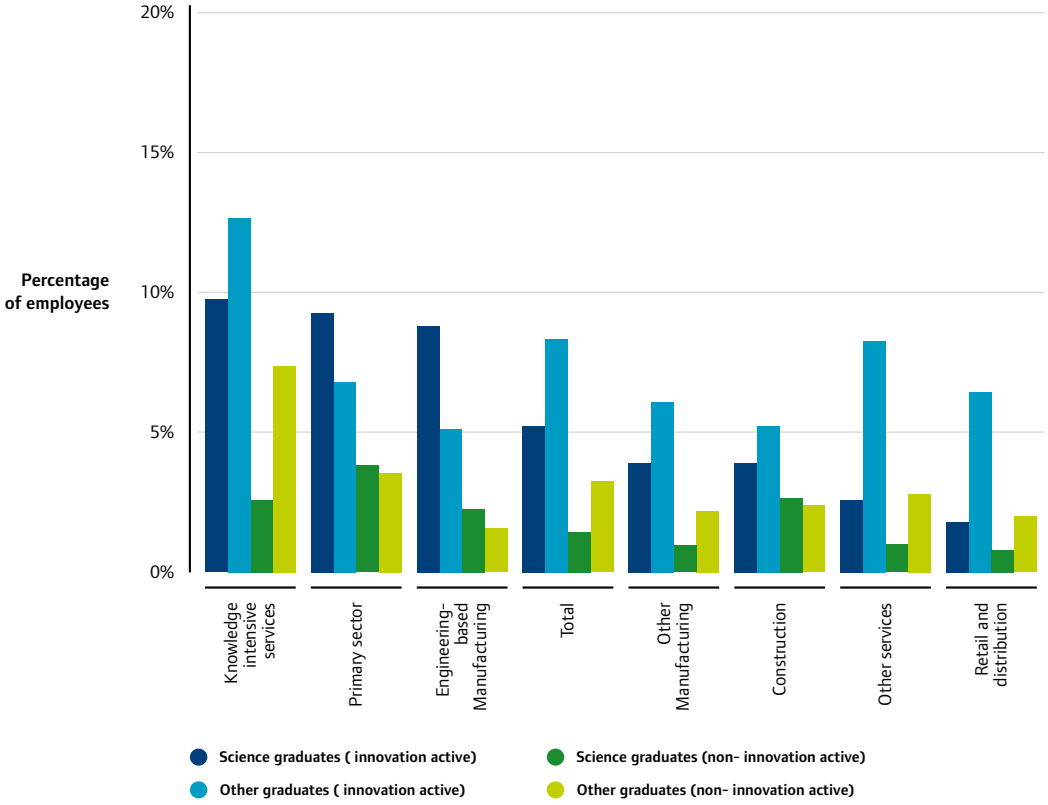
The skills and capabilities of staff are an important ingredient for successful innovation. Skills from all disciplines are important, given the structure of the UK economy, and are considered here, but for some sectors traditionally associated with innovation, science and technology are particularly important. Science and technology skills are associated with technological innovation and form the bulk of the consideration below.

The latest findings of the UK Innovation Survey highlight the importance of graduates (as an indicator of human capital intensity – it is not only graduates who innovate) for innovative businesses. Innovative businesses have more than double the share of employees with degrees than non-innovative businesses. Graduates are also important contributors to smaller innovative businesses: 5.7 per cent of employees in innovative small firms are science and technology graduates compared to 1.6 per cent in non-innovative small firms, while 9.4 per cent of innovative small firms' employees are graduates from other disciplines.

Across the economy, innovative firms employ a greater share of graduates: 5.2 per cent of employees in innovative firms are science and technology graduates compared to 1.4 per cent among non-innovating firms, while 8.3 per cent of employees in innovative firms have degrees in other disciplines.

Key business sectors employ a larger share of graduates (Figure 15). Nearly 10 per cent of employees in innovative knowledge-intensive services are graduates in science and engineering, while around 13 per cent are graduates in other disciplines. In the primary sector, which includes mining, science and technology graduates make up nearly 10 per cent of employees in innovative businesses. This underlines the importance of science and technology skills, but also the fundamental role of other types of advanced skills for innovative businesses.

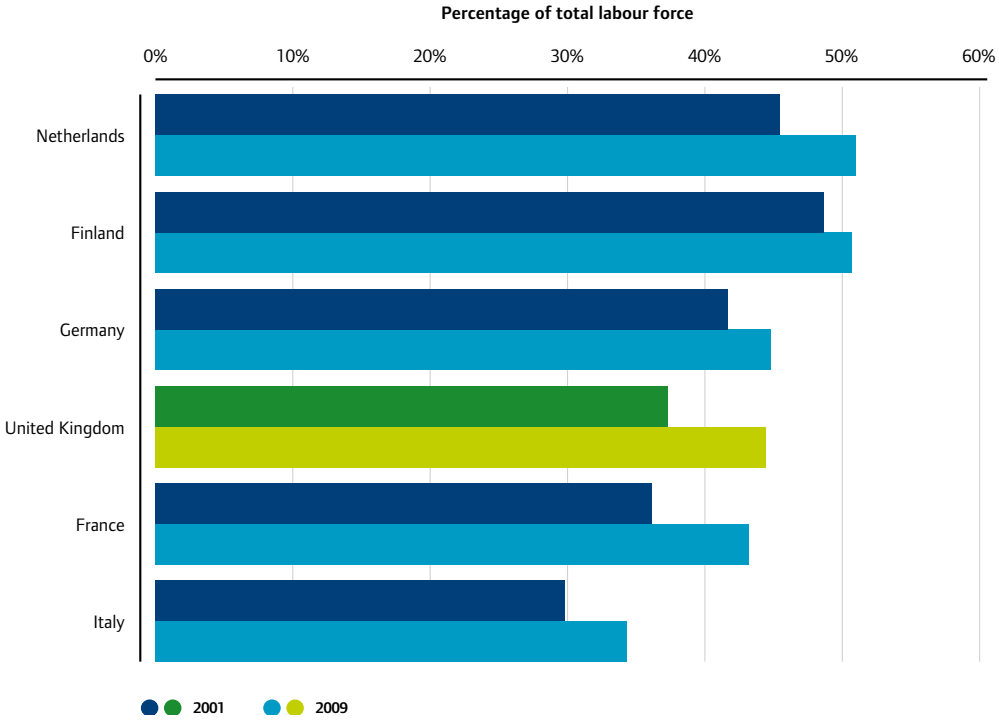
Figure 15: Employment of graduates by broad sector, 2008



Source: UK Innovation Survey 2009

Figure 16 presents European data on the proportion of science and technology workers in the labour force. The UK has seen a strong increase in science and technology human resources between 2001 and 2009.

Figure 16: Human resources in science and technology (HRST) as a percentage of the labour force, 2001-2009



Source: Eurostat 2010

3.4 Turnover from innovation

For businesses themselves the value of innovation is in the commercial opportunities from new and improved products and services. The CIS asks businesses what share of their turnover comes from new products and services (Figure 17). Data for the UK includes comparative results for 2006 and the latest findings of the UK Innovation Survey 2009, which covers the period 2006 to 2008.

Focusing on new goods and services, in 2006 less than 10 per cent of UK firms' turnover comes from new innovative products, with the largest portion of this coming from products (both goods and services) that are new to the firm but not new to the market (Figure 17). More recent data for the UK shows an increased share of turnover in 2008 with 10.5 per cent, of which 4.9 per cent came from new-to-market products and 5.6 per cent from products new to the firms.

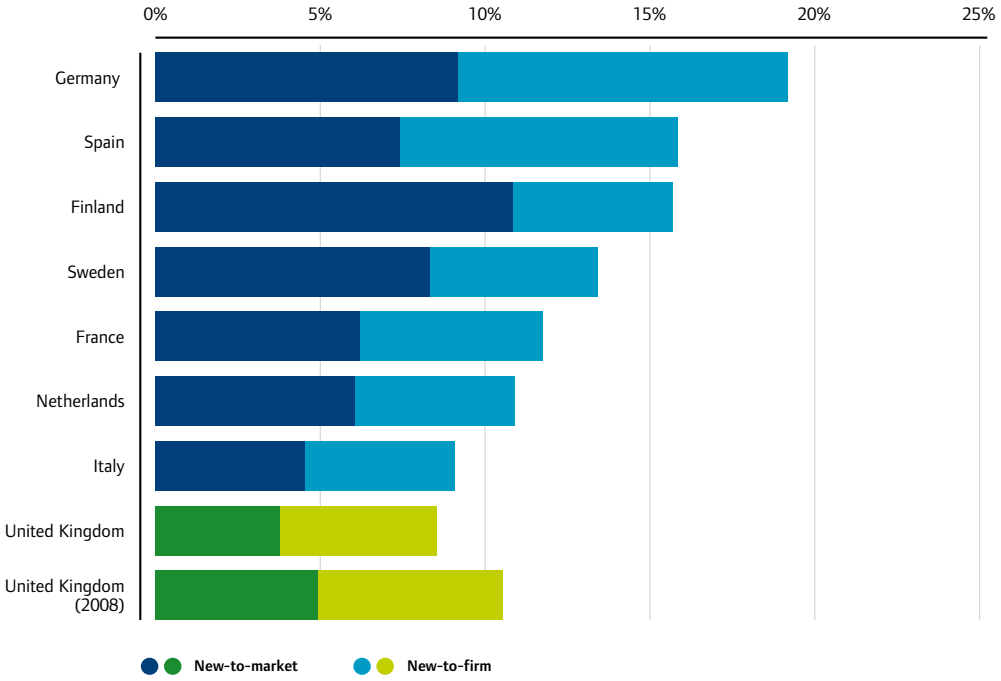
The focus above is just on new products. When the analysis is extended to include significant improvements in existing products, UK businesses' share of turnover increases to 20 per cent. (This is more directly comparable to the results for other countries where the categories of new and significantly improved are usually combined.)

3.5 Intellectual property

Intellectual property, and in particular patents, are a long-standing measure of the outputs of innovation. In terms of the number of patents granted by the USPTO (Figure 18), the UK ranks 4th among the G7 countries with 8,762 in 2009.

There is limited comparison data from innovation surveys on protection methods for our chosen countries. However, the latest findings from the UK Innovation Survey show that under 3 per cent of UK businesses apply for patents.

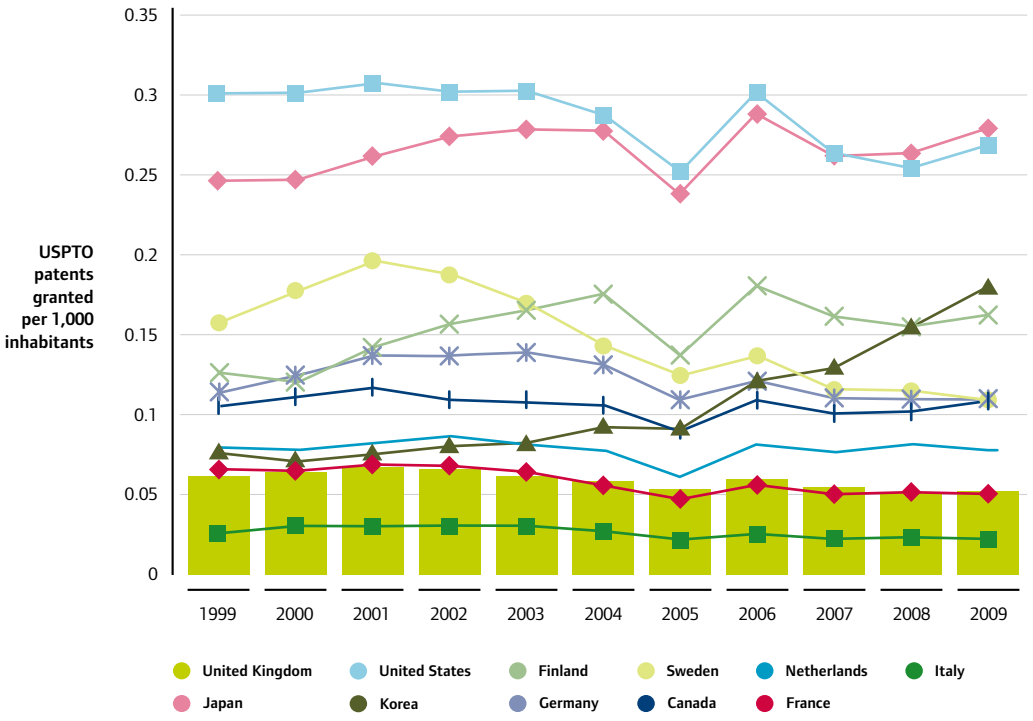
Figure 17: Share of turnover from new product innovation by businesses, 2004-2006, and in the UK during 2008



Source: Eurostat 2010, UKIS 2010

10. This is likely to overstate the patenting performance of the US due to "home country bias", but allows a fair comparison of the patenting performance of EU countries. This measure and the levels of patenting activity may reflect variations in the administration of patent applications, such as the time taken to grant patents, the costs, or the breadth of coverage for appointed exclusive rights.

Figure 18: Patents granted by USPTO per 1,000 of the population, 1999-2009[10]



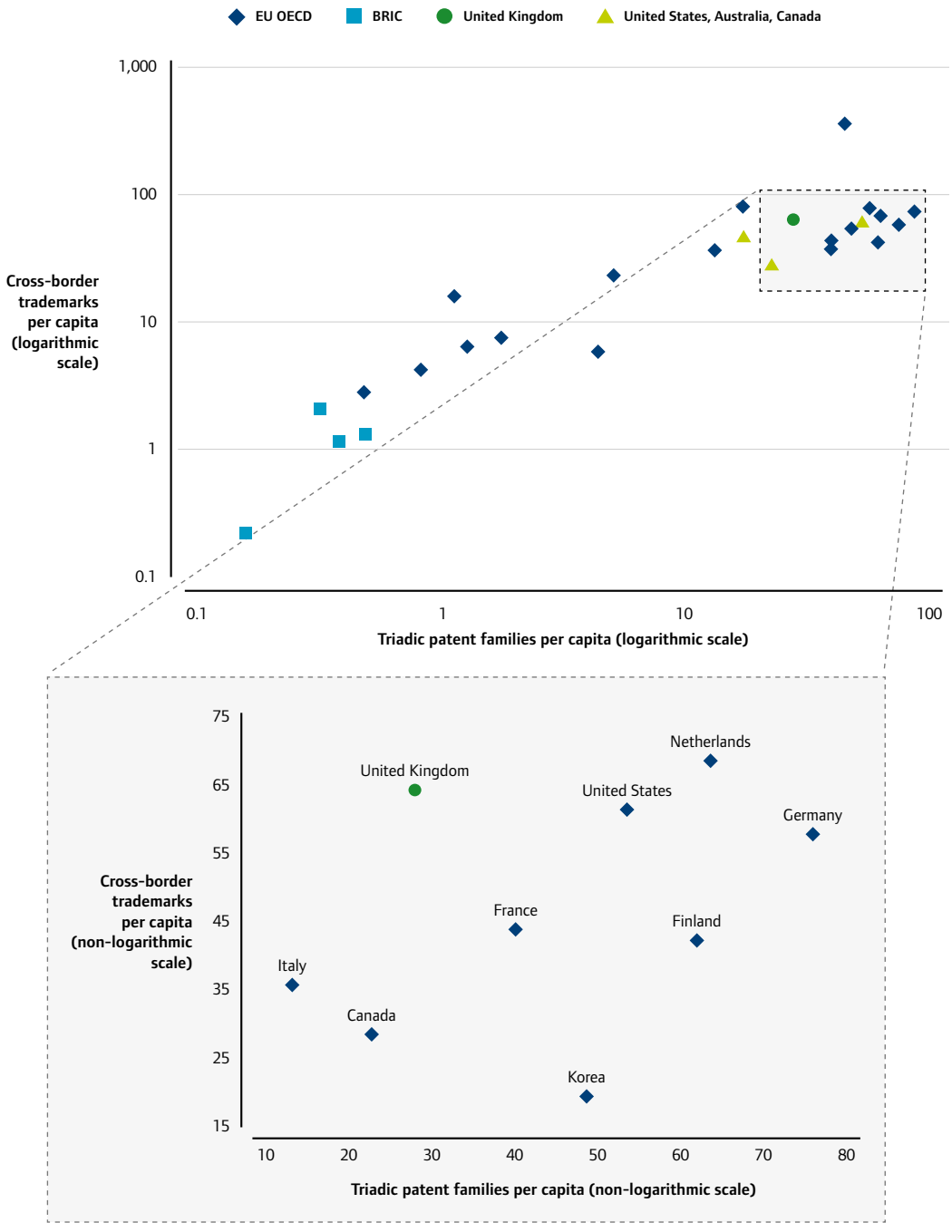
Source: USPTO 2010

A broader framework of intellectual property protection, encompassing trademarks and copyright protection as well as patents, is equally important for innovation and helps present more of the IP activity occurring in the UK.

Trademarks, while not tied to specific innovative products, reflect businesses' valuable assets often generated by the marketing and branding of intangible investments that firms find worth protecting.

Figure 19 shows the relationship between international trademark activity and triadic patents. When it comes to trademarks the UK is more active: 16 per cent of businesses applied for a trademark which is close to the average across EU member states. But the UK is less active in terms of triadic patents.[11]

Figure 19: Comparison of trademarks and international patents per capita, 2005-2007[12]



Source: OECD 2010

11. Triadic Patents are a special type of patent family where patents have been filed in Europe, the USA and Japan for the same invention.
12. Caution should be taken when comparing triadic patents as they may reflect a bias for countries that are more active internationally, and particularly overemphasise the performance of Japan.

Part 4: The research base and higher education

The research base, incorporating Research Councils, their institutes and higher education institutions, is an integral component of the UK innovation system. World-class research and innovation is crucial for maintaining economic prosperity and responding to the challenges and opportunities of globalisation. Public sector funding, both direct and indirect, is a significant source of R&D expenditure (Section 4 below) but importantly this investment serves multiple purposes – it contributes to innovation and economic growth; but it also has an inherent value in creating and disseminating knowledge and understanding that is not easily understood in economic terms. This section considers a range of indicators of inputs from the research base to innovation through investment by various sources, before considering the research base's contribution to knowledge exchange and skills in the workforce.

13. Note these figures are indicative for the three years from 2012-13 to 2014-15.

4.1 Research base investment in innovation

The UK's world-class research base is a key driver in promoting economic growth. Investment in science and research creates new businesses and improves existing ones; brings highly skilled people into the job market; attracts international investment; and improves public policy and services.

Despite enormous pressure on public spending, funding for science and research programmes has been protected in cash terms in the recent spending review. For the first time higher education research funding in England has been included within this ring-fence.

In addition to the £4.6 billion per annum of programme funding for science and research, £1.9 billion of capital over the four years of SR10 has been allocated to science and research (Table 1).[13]

Table 1: BIS Allocation of Science and Research Funding 2011/12 to 2014/15

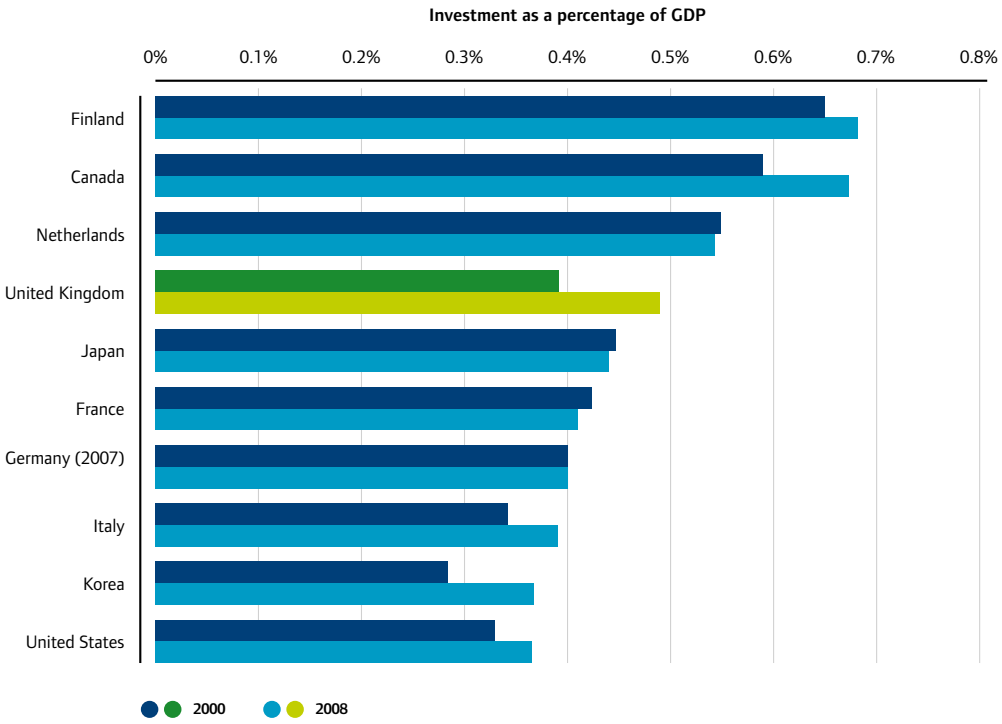
	2011/12	2012/13	2013/14	2014/15	Total over the spending period
Research Councils	2,596,196	2,573,678	2,586,641	2,599,812	10,356,327
HEFCE	1,662,112	1,699,578	1,685,689	1,686,321	6,733,700
National Academies	87,465	86,547	86,547	86,547	347,106
UK Space Agency	205,637	191,963	192,864	179,221	769,685
Capital	514,000	449,000	416,000	517,000	1,896,000

In addition, efficiencies of £324 million will be achieved by 2014-15. All these savings will be reinvested in science and research, within the ring-fence.

Previous funding for science and research is detailed in the 2009 Annual Innovation Report.[14]

Higher education institutions are major recipients of funding through the science budget, including through Research Councils' grants and through the Higher Education Funding Councils. The UK invested 0.5 per cent of GDP in R&D through higher education in 2008, up from 0.4 per cent in 2000 (Figure 20).[15]

Figure 20: Higher education expenditure on R&D as a share of GDP, 2000 and 2008

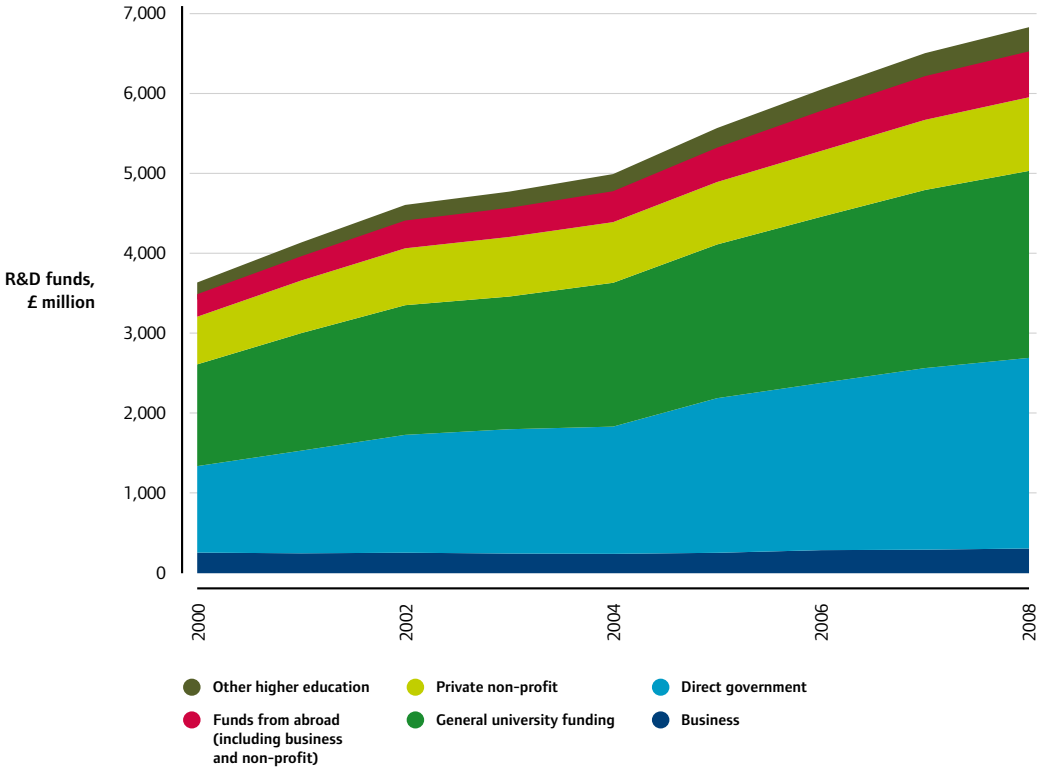


Source: OECD MSTI May 2010

14. 2009 Annual Innovation Report http://www.bis.gov.uk/policies/innovation/annual-innovation-report
15. These figures from the OECD are for total investment in Higher Education across the UK and therefore include investments in the Devolved Administrations. Figure 20 above, includes only investments made in England.

While universities undertake the R&D, the main source of funding to support this expenditure comes from government (Figure 21). In 2008 government funding for higher education expenditure on R&D accounted for 69 per cent of total funds for R&D in the higher education sector, up from 65 per cent in 2000. The increase in the share from government stems from an increase in direct funding, for example through Research Council grants, which grew from 30 per cent of total higher education funding for R&D in 2000 to 35 per cent in 2008, overtaking general university funding for research, for example through the higher education funding bodies of 34 per cent in 2008. Businesses' share of funding has declined from 7 per cent in 2000 to 4.5 per cent in 2008.

Figure 21: Source of funds for UK higher education R&D, 2000-2008



Source: OECD 2010[16]

16. Data drawn from OECD database http://stats.oecd.org.

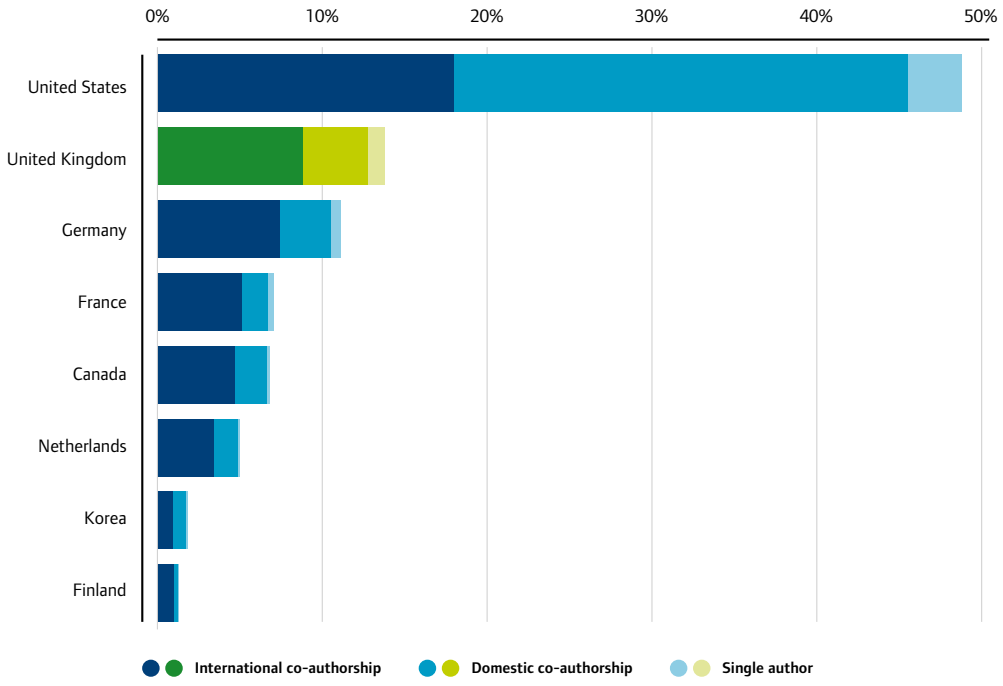
4.2 Sharing knowledge and building capacity

The UK academic research community is acknowledged as one of the best in the world, on the basis of widely used bibliometric measures including numbers of publications and the citations of UK publications – the more citations a scientific publication achieves, the bigger is its impact and relevance.

The UK produces 8 per cent of the world's scientific papers, but of the most widely cited scientific papers, UK authors account for 14 per cent. The majority of these papers, 9 per cent, are co-authored with international researchers – the highest percentage outside the US – while 4 per cent are joint publications with other UK researchers (Figure 22).

In terms of innovation more directly, the research base plays a fundamental role as a source of knowledge, new ideas and skills. Both indirect spillovers of knowledge and direct collaboration between universities and businesses for example are important and are valuable sources for new ideas. Building networks of collaboration with universities and government research organisations provides business with access to new knowledge,[17] often at a direct cost to the business below that available through market transactions. Research-based publications are widely read by innovating businesses, and university researchers publish many joint papers.

Figure 22: Authorship of most cited 1 per cent of published scientific articles, 2006-2008



Source: OECD 2010

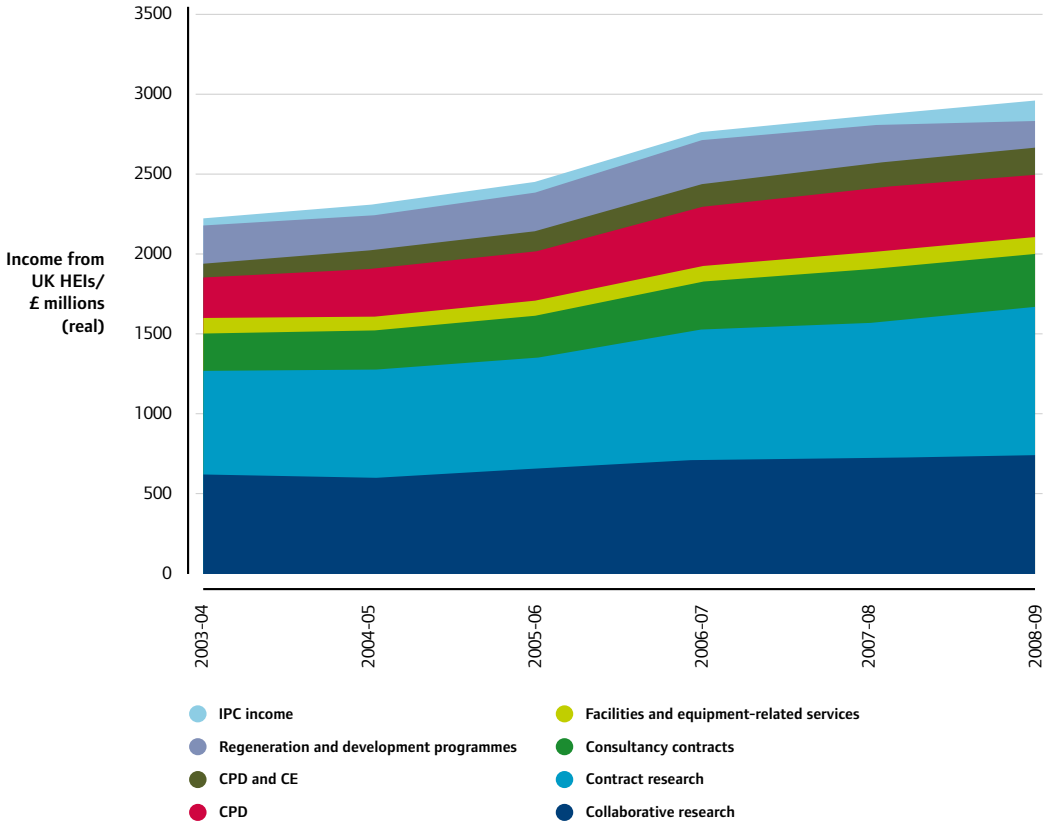
17. Kitson, *et al.* (2009) The Connected University: Driving Recovery and Growth in the UK Economy. NESTA, UK.

The university sector earns £3 billion annually from knowledge exchange activities (Figure 23) reflecting the extent of this important activity. On average, income grew by 6 per cent per year (real terms) between 2003/04 and 2008/09 but this was mainly due to the jump (13 per cent) in income between 2005/06 and 2006/07.[18] After this annual growth continued, but at a more moderate pace.

As discussed in section 2.1, innovation involves a broad range of intangible activities. Effective innovation involves knowledge, technology, skills and adaptability to implement it, which is not always embodied in an easily transferable form through technology.

Knowledge developed or improved in academic institutions may need extensive or intensive adaptation to particular business applications. A qualified person with a direct link to the academic source is the ideal transfer agent. Knowledge Transfer Partnerships (KTP) are an initiative to provide businesses with partnerships with higher education institutions or other research centres to help identify innovative solutions that can help businesses increase growth.

Figure 23: Breakdown of HEI knowledge exchange income by source, 2003/04 to 2008/09



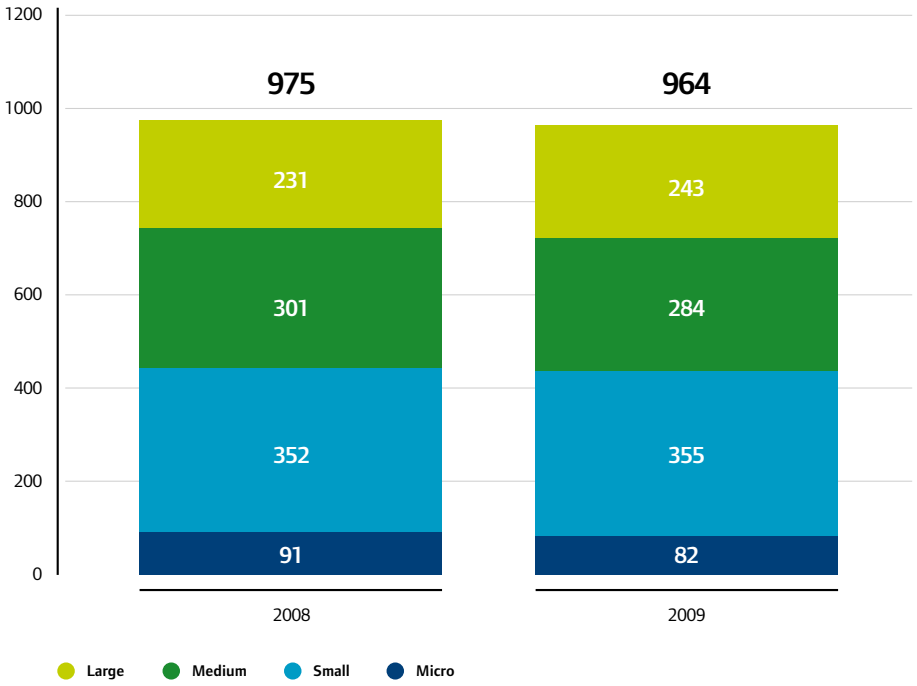
Source: HE-BCI

18. Data available from HEBCI survey at http://www.hefce.ac.uk/econsoc/buscom/hebci/

In 2009 nearly 1,000 businesses were part of a KTP. Figure 24 shows the distribution of businesses involved by size. Small businesses with between ten and 50 employees are the most engaged, representing 37 per cent of KTPs in 2009. Micro businesses with fewer than ten employees account for less than 10 per cent of partnerships, while the share of medium size businesses of between 50-250 employees declined from 31 per cent to 29 per cent.

Market-based knowledge exchange transactions reflect only part of universities' value in terms of innovation. Through training skilled graduates they also play a key role in equipping the UK economy with the necessary skills to innovate and grow, generating countless spill-overs in the process. Continued growth in innovative activities in research institutes and businesses will depend significantly on a continued supply of qualified staff, in science and engineering as well as other disciplines.

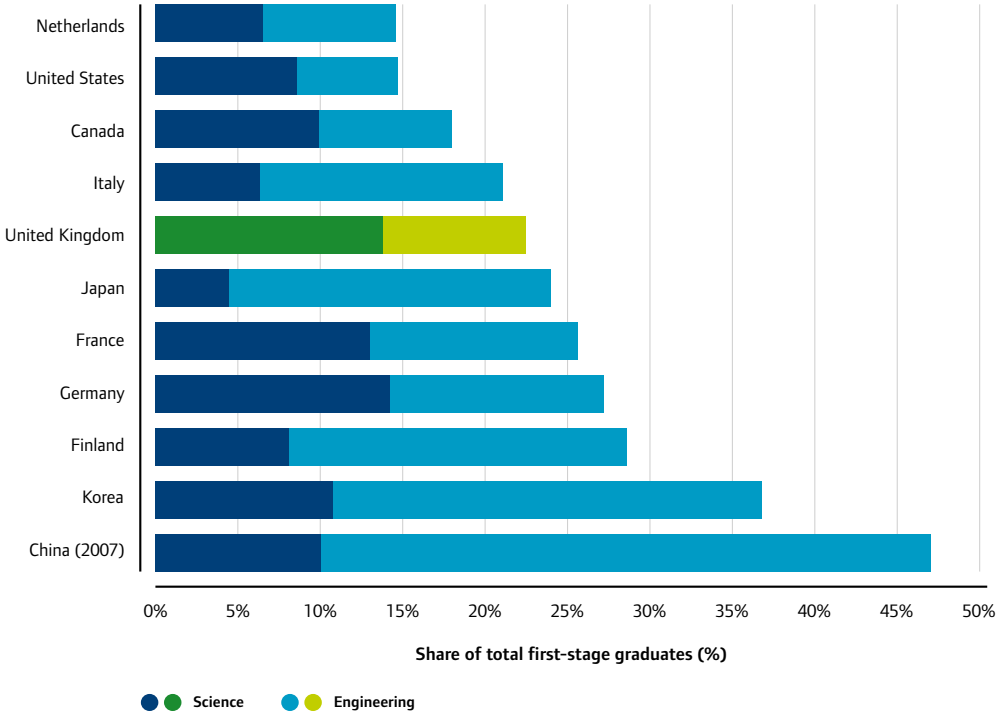
Figure 24: Business involvement in Knowledge Transfer Partnerships, 2008-2009



Source: Technology Strategy Board 2010

The UK graduate rate for science and engineering at 22.5 per cent in 2007 is low in comparison to some countries (Korea at 37 per cent, Finland at 28.7 per cent and Germany at 27.2 per cent) but well above the USA (14.7 per cent) (Figure 25). Like investments in R&D this reflects the structure of the UK economy where services are more dominant.

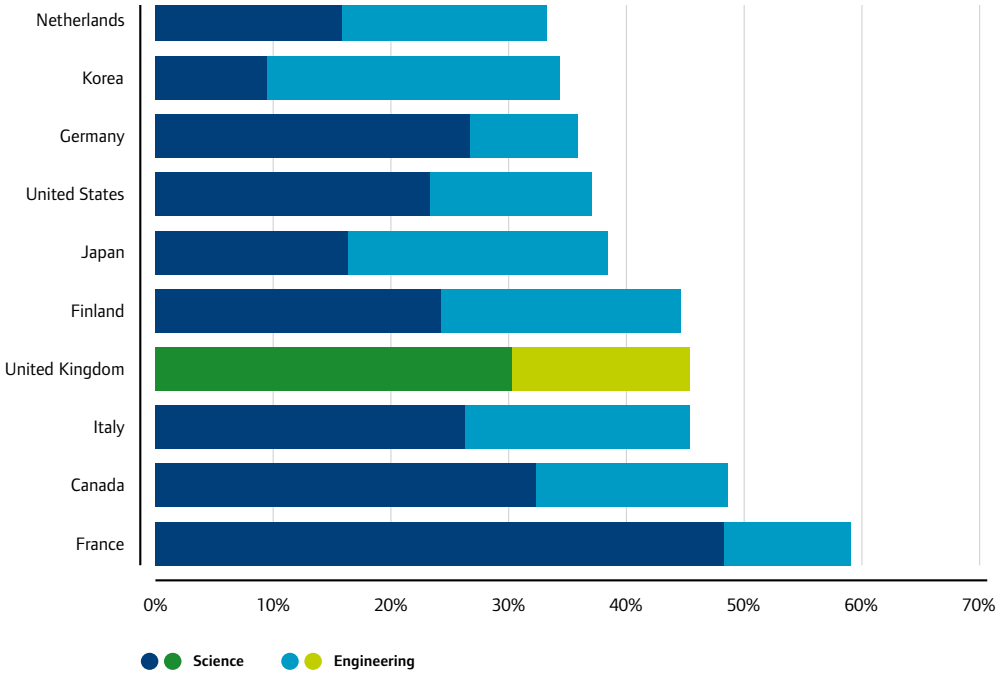
Figure 25: Percentage of total first-stage graduates with science and engineering degrees 2006



Source: OECD 2009

At the highest level, graduates with doctorate degrees can form an important source of new innovations. Comparing the supply of new doctorates in science and engineering fields, the UK has a relatively large proportion with 45 per cent of new doctorates in these areas (Figure 26).

Figure 26: Science and engineering doctoral graduates, 2007



Source: OECD 2010

Part 5: Government as a catalyst for innovation

The UK government plays multiple roles in encouraging innovation. It is a significant funder of R&D through the science budget and the higher education funding councils, but also through direct departmental spending on R&D. But government also plays a significant role in supporting and enabling innovation outside of its R&D investments. This section outlines government's expenditure on R&D, the infrastructure developed to enable and facilitate innovation and how public procurement is being used to encourage innovation.

5.1 Government investment in innovation

Table 2 outlines net government outturn expenditure on R&D in 2008/09 for the Research Councils, higher education funding councils, Civil Departments and defence. At around £9.4 billion in 2008/09 (the most recent year for which outturn data is available), overall government expenditure on R&D is significantly more than just its investments in the research base. Government expenditure on R&D continues to be an important contribution to stimulating long-term growth.

This data is compiled by the Office for National Statistics (ONS) and then published in the Science, Engineering and Technology (SET) Statistics. This latest update was published on the BIS website in November 2010. Various issues, such as machinery of government changes, have affected the consistency of data reported and presented in the SET Statistics. In addition, ONS has been refining the questionnaire issued to departments to improve the accuracy of reporting of departmental expenditure against the Frascati Definition of R&D. This has improved reporting but means that showing trends at departmental level could be misleading.

5.2 Government support for innovation

In addition to supporting R&D, government in the UK also plays a role in supporting and underpinning innovation through a range of organisations often referred to as the innovation infrastructure or ecosystem. This infrastructure includes direct support to business, intellectual property protection, measurement, standards, accreditation and design.

Technology Strategy Board
The Technology Strategy Board has now been established as the prime channel through which the Government incentivises business-led technology innovation. It is a business focused organisation with a leadership role to stimulate and accelerate technology development and innovation in the areas which offer the greatest potential for boosting UK growth and productivity.

Table 2: Net government expenditure on R&D (Research Councils, Higher Education Funding Councils, Civil Departments and Defence) in cash terms, 2008/09 (1)

2008-09	£ million
Research Councils	**2,984**
Higher Education Funding Councils	**2,227**
Civil Departments	
Department of Health (DH) (including NHS)	783
Department for Innovation, Universities and Skills (DIUS) (2)	680
Department for Environment, Food and Rural Affairs (Defra)	187
Department for International Development (DFID)	149
Scottish Government (SG)	140
Department for Transport (DfT)	60
Department for Culture, Media and Sport (DCMS)	47
Home Office (HO)	43
Other departments (3)	37
Department for Children, Schools and Families (DCSF)	33
Department for Communities and Local Government (DCLG)	27
Department of Energy and Climate Change (DECC) (4)	27
Northern Ireland departments	22
Department for Work and Pensions (DWP)	19
Ministry of Justice (MoJ)	12
Health and Safety Commission (HSC)	12
Food Standards Agency (FSA)	11
Welsh Assembly Government (WAG)	10
Department for Business, Enterprise and Regulatory Reform (BERR) (ex DIUS and Launch Investment (5))	1
Net Launch Investment (5)	-128
Total	**2,171**
Defence	**1,991**
GRAND TOTAL	**9,373**

Notes:
1. See http://www.bis.gov.uk/policies/science/science-funding/set-stats for further explanation of the data included in this table.
2. Spending by DIUS includes: Science Programme Spend (for example on the Research Capital Investment Fund (RCIF)), Technical Infrastructure and Space.
3. This includes, for example £12 million by the Forestry Commission.
4. DECC was created in October 2008.
5. Reypayable launch investment is a risk-sharing investment in the design and development of civil aerospace projects in the UK. The investment is repayable at a real rate of return, usually via levies on the sales of the product.

Source: Science, Engineering & Technology Statistics, Table 2.1 Net government expenditure on R&D by departments in cash terms (November 2010 update).

It does this through establishing technology priorities and areas of focus, such as around societal challenges, and providing support and funding to enable technology development and innovation in those areas for the benefit of UK business.

The Technology Strategy Board undertakes its role using a range of different approaches and activities. It promotes innovation in many ways, including knowledge transfer and support for R&D to bringing people together to solve challenges and using procurement to drive innovation such as

through SBRI. The overall payback across the portfolio of the Technology Strategy Board's activities is in the region of 10:1.

Moving forward, the Technology Strategy Board will establish a network of elite Technology and Innovation Centres, the first of which will be in the area of High Value Manufacturing, and will take on responsibility for delivering Grant for R&D.

By applying technical understanding, seeing the 'big picture' and mobilising resources, the Technology Strategy Board makes innovation happen.

Intellectual Property Office

The Intellectual Property Office (IPO) promotes innovation in the UK by providing a clear, accessible and widely understood IP framework that enables creators, users and customers to benefit from knowledge and ideas.

The IPO forms an integral part of BIS' efforts to promote innovation by protecting and helping to build on UK strengths in knowledge-intensive industries such as design, the creative industries and innovative manufacturing. The IP system also supports knowledge-based service industries in which the UK has a strong export advantage.

IP is a key currency of the knowledge economy. It allows businesses and individuals to retain the gains from commercialising their ideas and innovations, providing an incentive to the creation and dissemination of knowledge, culture and products that create value for consumers.

The UK IP system was judged the most effective in the Taylor Wessing Global IP Index at the end of 2009, based on the views of users of all types of rights, with the importance of IP and innovation expected to expand in the 21st century.

National Measurement Institutes

The UK's scientific and legal measurement infrastructure supports innovation and fair competition, promotes international trade, and protects consumers, health and the environment. At the core of the infrastructure are the primary and national measurement standards that underpin the system of traceable measurements in the UK.

Advances in measurement science and new techniques are made by leading edge measurement research programmes commissioned by the National Measurement Office and delivered by the National Measurement Institutes (NPL, LGC Ltd and TUVNEL). Economic growth is achieved by helping businesses through collaborations, specialist services, new knowledge and advice on good measurement practice. Better measurement techniques lead to improved design and instrumentation, which in turn stimulate innovation in products and processes.[19]

Standards and accreditation

Standards are agreed codes of best practice that improve safety, efficiency, interoperability and facilitate trade, while accreditation is part of an overall system that assesses and ensures conformity with applicable requirements, focussing on providing an independent evaluation of an organisation's technical competence, thus maximising the value of standards. Standards reduce the costs to businesses and consumers allowing them to adopt products and processes with confidence that they reflect an agreed standard. Standards have contributed 12 per cent p.a. of UK productivity growth and one tenth of the UK's average economic growth rate of about 2.5 per cent p.a. The use of standards has also been shown to help increase innovation in firms. Accreditation reduces bureaucracy by moderating the need for legislation; enhances efficiency by helping businesses to meet standards in efficient and cost effective ways; and engenders trust through identifying organisations that meet and maintain high standards. Together, standards and accreditation facilitate innovation in a number of ways, including: enabling higher value innovation; facilitating knowledge transfer; reducing risk/enhancing quality assurance; increasing speed to market; and helping deliver innovation in the public sector.

The British Standards Institution (BSI) and the UK Accreditation Service (UKAS) have been working together with BIS to provide information to help policy makers identify how and where standards

19. The National Measurement Office has assembled evidence of the economic impact of the National Measurement System which can be found at http://www.nmo.bis.gov.uk/content.aspx?SC_ID=507.

and accreditation can be used as alternatives to regulation, enabling government to use a lighter, less burdensome touch to achieve policy objectives.[20]

Design Council
Design is an important tool for innovation and economic growth. The use of design can be transformative for companies, for the commercialisation of science, as well as for the delivery of public services. The UK design sector is one of the largest in Europe, with a world-wide reputation for creativity and innovation. Design Council research indicates that £15 billion was spent on UK design in 2009 via in-house design teams and freelancers and consultancies.

During the year, BIS commissioned a review of the role and status of the Design Council as the national strategic body for design. Martin Temple's review, which reported in September 2010, found a compelling case for continued government support for design and for the continued existence of the Design Council to champion design, continuing its mission to place design at the heart of social and economic renewal in the UK.[21]

NESTA
NESTA is the National Endowment for Science, Technology and the Arts – an independent body with a mission to make the UK more innovative. NESTA invests in early-stage companies, informs and shapes policy, and delivers practical programmes that inspire others to solve the big challenges of the future.

NESTA's policy and research work has focused on the role of innovation in answering two pressing questions: How can the economy return to growth? And how can we deliver better public services at less cost? To address these questions, NESTA works with leading experts in these fields across business, academe and the public sector. The findings of NESTA's research on innovation and economic growth are influencing policy while the advances in developing innovation metrics included in this report are advancing the evidence to support the role of innovation in economic growth.

NESTA has a specific programme testing different methods for stimulating growth in young creative businesses including pioneering support programmes for creative entrepreneurs and an ongoing pilot programme designed to test the impact of providing creative credits, redeemable with a range of creative businesses, on direct and indirect business growth.

NESTA's Public Services Lab is designed to test radical new ideas for delivering better public services in the UK for less cost. The Lab's work focuses on the different ways people use and interact with their public services as users, frontline workers, communities and as new, technology-enabled social and professional networks.

NESTA Investments provides a valuable network of entrepreneurs, angels and venture capital co-investors to complement the policy research work. In the financial year 2009-10 the portfolio of investee companies stood at 44 and NESTA made 15 direct investments totalling £4.9 million which went to support the growth and development of new and existing companies within the portfolio.[22]

The Public Sector Innovation Unit in BIS
The Public Sector Innovation Unit in BIS is helping to build capability and a culture for innovation across the public sector in order to support fresh thinking in both public sector policy making and service delivery. Its approach to this is to champion innovation and to act as an intermediary, facilitating the transfer of knowledge about methods and best practice, and providing 'brokerage' between government departments needing support on innovation and those able to provide it. The Public Sector Innovation Unit is based in and runs The Innovation Space in London. We can provide facilitation and space to help with creative thinking, team building days and customer insight.[23]

5.3 Harnessing demand to drive innovation

Public demand through government and public sector procurement can be an important catalyst for innovation. However, data reflecting the link between public procurement and innovation is limited and there is a strong demand for more effective measures. Work is currently underway

20. Evidence on the role of standards in economic growth can be found at http://www.bis.gov.uk/assets/biscore/innovation/docs/e/10-1135-economics-of-standardization-update.
21. Evidence underpinning the importance of a national design policy can be found at http://www.bis.gov.uk/assets/biscore/economics-and-statistics/docs/B/10-1112-bis-occasional-paper-02.
22. To find out more, go to: www.nesta.org.uk
23. To find out more visit http://publicsectorinnovation.bis.gov.uk/the-innovation-space

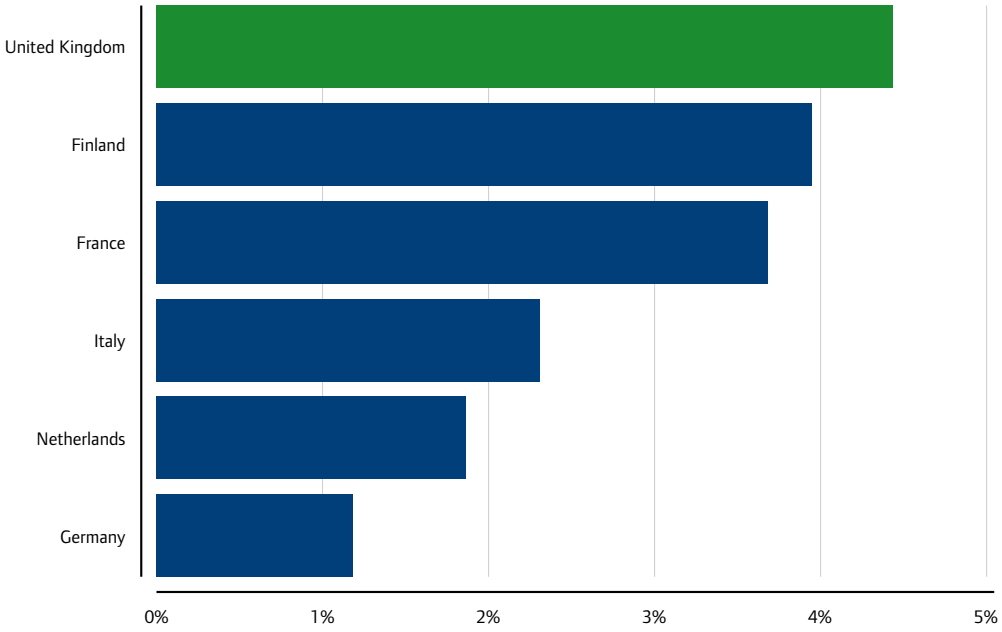
through academic research in the UK to develop more effective data on contribution of public procurement and innovation.

The UK government openly advertises a high proportion of its procurement opportunities relative to GDP (Figure 27). In 2008 the figure was 4.4 per cent of GDP. Public procurement was valued at over £236 billion in 2009/2010, and represents a large potential base from which to develop innovative solutions through public demand.

The Small Business Research Initiative (SBRI) provides a mechanism by which the public sector can act as an intelligent lead customer seeking innovative solutions to its challenges and engaging with entrepreneurial businesses in bringing them to market. SBRI issues R&D procurement contracts to businesses to develop new and innovative products and services. It brings innovative solutions to the public sector and provides R&D financing and a route to market for business.

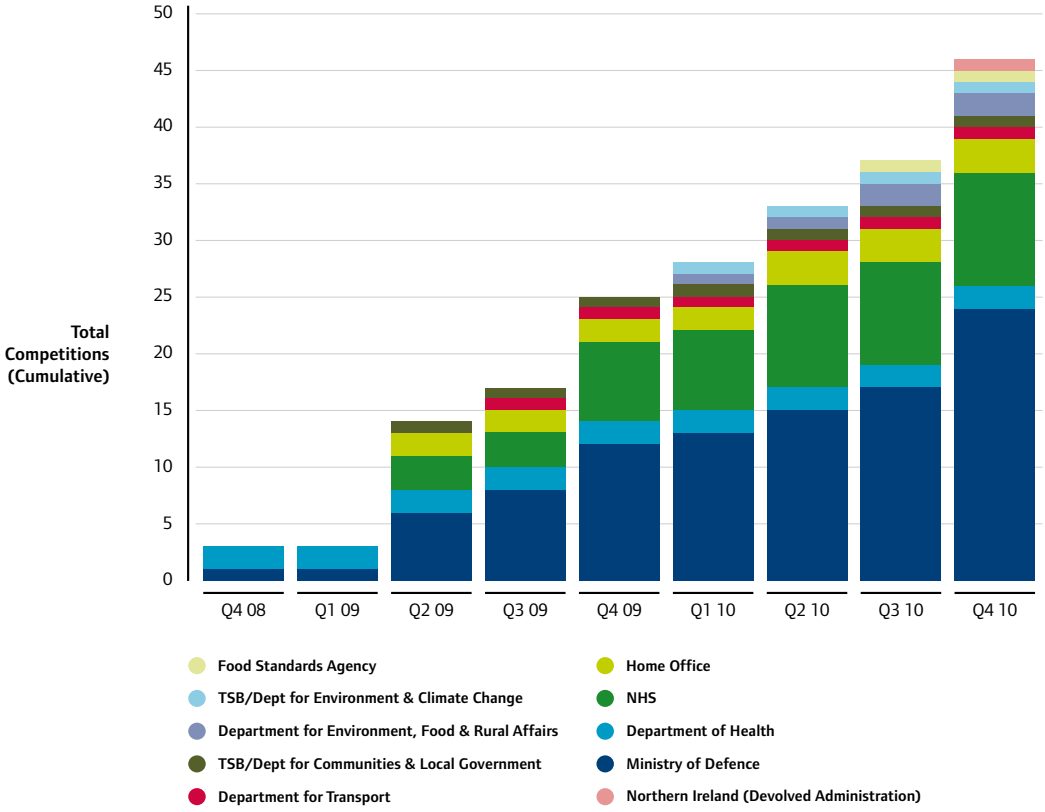
Since the re-launch of the SBRI in April 2009 to end-December 2010 there have been 46 competitions resulting in 519 contracts awarded to the value of £35.6 million. The competitions have helped small and micro businesses to engage with government departments and the validation effect of having a government contract has helped a number to raise venture capital or other additional financing (Figure 28).

Figure 27: Value of public procurement openly advertised as a percentage of GDP, 2008



Source: Eurostat 2010

Figure 28: SBRI competitions by government institution, April 2009-Sept 2010



Source: Technology Strategy Board 2010

Box 4: Measuring public sector innovation

In addition to more accurately measuring private sector investments in innovation, NESTA is developing a framework for measuring innovation across public sector organisations. The impacts of successful innovations within the public sector tend not to be reflected in immediate financial outputs. This, combined with the diversity of public sector organisations and services, makes measuring these innovations extremely challenging.

The potential for public sector innovation to contribute to efficiency, effectiveness and value for money is increasingly recognised in a range of countries. Initiatives to develop metrics for such innovation are underway in the OECD's working group of national experts on innovation measurement and in the OECD Education Committee. A group of Nordic countries are also engaged in a major pilot study, whose results will be available shortly. These initiatives, plus NESTA's, will lay the groundwork for bringing the public sector into the innovation measurement picture.

There is a growing international recognition of the importance of effective metrics of innovation in the public sector. A long-standing survey project has been underway across the NORDIC countries, while the OECD has a project led by The National Experts on Science and Technology Indicators (NESTI) examining methodological considerations for measuring public sector innovation. The European Commission has also undertaken a project to survey public sector organisations across the EU. The European Commission has also recently published Innovation Union as part of the Europe 2020 Strategy, with a proposal for developing a public sector innovation scoreboard.

This publication is also available on our website at **http://www.bis.gov.uk**

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