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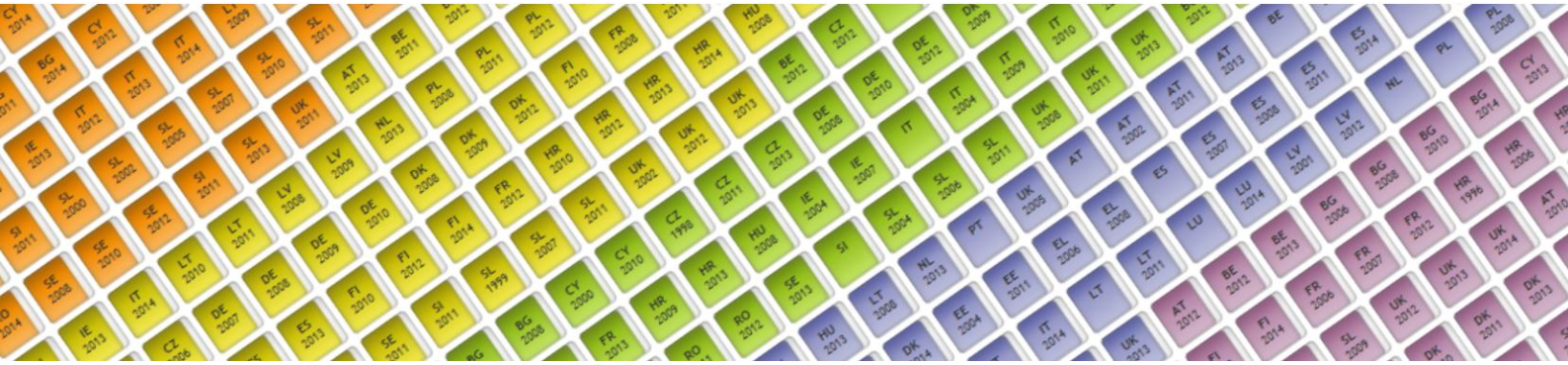

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Abstract

The report offers an analysis of the R&I system in the UK for 2014, including relevant policies and funding, with particular focus on topics critical for two EU policies: the European Research Area and the Innovation Union. The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The report identifies the structural challenges of the UK research and innovation system and assesses the match between the national priorities and those challenges, highlighting the latest policy developments, their dynamics and impact in the overall national context.

Acknowledgments

The report benefited from comments and suggestions by Brian Ditcham from the Department for Business, Innovation & Skills and by Jessica Mitchell from JRC-IPTS. The contributions and comments from DG RTD and JRC-IPTS are also gratefully acknowledged.

Executive summary

The report offers an analysis of the R&I system in the UK for 2014, including relevant policies and funding, with particular focus on topics critical for two EU policies: the European Research Area and the Innovation Union. The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The quantitative and qualitative data is, whenever possible, comparable across all EU Member State reports.

With a population of 64.3 million, the UK is the third largest of the EU Member States. In 2013, its per capita GDP was €29,600 compared to an EU-28 average of €25,700. GDP has grown by 7% from €1,770,909m in 2011 to €1,899,098m in 2013 and UK GERD now stands at €32,783m (around 11.9% of total EU-28 GERD). UK GERD has grown by 3.9% since 2011, compared to an EU-28 growth rate of 5.3%, while UK BERD has risen (consistently) by 5.4% to €21,149m. Although the ten-year Strategic Innovation and Investment Framework, 2004-2014 (BIS, 2011) set an ambition to reach a ratio of GERD to GDP of 2.5% by 2014, the effects of the economic recession reduced the probability of this being achieved. Nevertheless, recent figures have shown a better than anticipated growth for the UK economy although the ratio remains around 1.69%.

The Business Enterprise sector is the largest contributor to GERD, providing 64.5%. The Higher Education (HE) sector performs a further 26% and the Government sector 7% (although the government supports a significant proportion of HE R&D activities). The private not-for-profit sector performs the remaining 2%.

The UK research system is largely centralised, although regional autonomy for innovation policy has been increased in recent years. The Devolved Administrations of Scotland, Wales and Northern Ireland have responsibility for aspects of health and education funding. At the regional level in England, responsibility for innovation support has been assumed by Innovate UK (formerly the Technology Strategy Board) following the abolition of the Regional Development Agencies in 2011. The Devolved Administrations may operate versions of UK innovation support initiatives according to their specific strategic needs.

The Department for Business, Innovation and Skills (BIS) plays the lead executive role in research issues, and is the home of the Government Office for Science (GO-Science), headed by the Government's Chief Scientific Adviser (CSA). The CSA chairs the principal high-level national policy making and coordination body, the Council for Science and Technology (CST), which in turn draws on policy advice from a range of bodies both within and outside the Government structure. High-level UK science policy making also places particular emphasis on the use of systemic reviews and evaluations.

BIS is the major provider of research funds for the public sector and is also responsible for the allocation of the UK Science Budget. The Research Councils, which in turn support R&D and research training both in HEIs and their own institutions, provide research grants for programmes, projects and research centres. Substantial funds are also allocated in the form of block grants to UK universities from the Higher Education Funding Councils and their equivalents in the devolved administrations. The HE sector forms the largest performer of research in the UK. Due to successive governance changes, many public sector institutes and laboratories have undergone a shift from contractor status, through

'arms-length' executive agency status to full privatisation. As a result, several reside either partly or wholly in the private sector.

The UK Government also 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 Innovate UK.

Since 2008, the percentage of business R&D financed from overseas has remained above 20% and in 2011, expenditure on R&D in foreign-owned businesses overtook that in UK-owned businesses for the first time. In broad terms, in 2012, 72% of total UK business R&D spending was on manufacturing activity compared to 25% on services activity. Some £12.2bn (€15.25bn) was spent by UK businesses on manufacturing R&D in the UK in 2012. The largest expenditure was by the chemicals product group at £4.8bn (€6.0bn), 39% of the total.

Overall, economically, the UK appears to be recovering well from the effects of the 2008 financial crisis and Eurozone uncertainty. The UK is also benefitting from a low rate of inflation (1.5% in the year to August 2014), while employment has continued to rise and unemployment to fall, continuing a general trend since late 2011/early 2012. However, the positive growth in employment has not been matched by pay levels, suggesting that employment growth has been led by an increase in people in lower paid jobs and that the ongoing stagnation in productivity (itself a key economic challenge) has depressed the ability of employers to increase salaries.

According to the Budget statement by the Chancellor of the Exchequer in March 2014, and as reiterated in the Autumn Statement, 2014, the Government's tax and spending plans include the following actions to help support businesses: a doubling of the annual investment allowance to £500,000 until the end of 2015; improving the level of support for export finance; and measures to alleviate the energy costs faced by energy intensive businesses[1].

In terms of strategic direction, the long-term policy for UK science and innovation investment over the last four years has been defined through the Innovation and Research Strategy for Growth (IRS), published in December 2011, which has formed the central document for UK innovation. In parallel, a UK Industrial Strategy[2] (announced in September 2012), also formed a basis for strategic planning and included ten Sectoral Strategies. It also outlines a number of actions of relevance to the UK business sector and the role of Government support. A new strategy - "Our Plan for Growth: science and innovation" (HM Treasury and BIS, 2014)[3], was published on 17 December 2014. This confirms a number of science and innovation policy developments already outlined in previous Budget statements including the Chancellor of the Exchequer's Autumn Statement in November 2014.

Overall, it appears that the UK has achieved substantial progress against the actions and policies described in the 2013 and 2014 National Reform Programmes (NRPs), particularly when viewed in the broader economic environment of the financial downturn and the Commission's Recommendations for 2014 note that the UK has made some progress in addressing the 2013 country-specific recommendations, notably by taking various

[1] https://www.gov.uk/government/news/budget-2014-key-announcements
[2] https://www.gov.uk/government/policies/using-industrial-strategy-to-help-the-uk-economy-and-business-compete-and-grow
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387780/PU1719_HMT_Science_.pdf

appropriate policy measures to address youth unemployment, child care, welfare reform, financing of SMEs and its infrastructural needs.

In terms of progress towards the specified European Research Area (ERA) objectives, the UK has consistently performed well in terms of transnational co-operation and competition (ERA priority 2), in measures fostering an open labour market for researchers (ERA priority 3), in achieving optimal circulation and access to scientific knowledge (ERA priority 5). Similarly, it performs well against the Innovation Union criteria.

Regarding its performance against a range of selected indicators, the UK performs well in terms of Human Resources and scientific output, reflecting its long-established, strong and internationally well-regarded higher education sector. It also does well in terms of public-private co-publications indicating a reasonably high level of scientific dialogue between the public and private sector. The UK is below the EU average (and declining) in terms of R&D expenditure in the public sector (as %GDP), which may reflect the fact that much of the government research sector has undergone a process of privatisation (to varying degrees) over a number of years. The UK performs well in its support for start-ups and small companies, with an above EU average score for venture capital and seed capital as a percentage of GDP. However, UK investment in BERD as a percentage of GDP lies below the EU average, although it does better in terms of medium and high-tech product exports and in knowledge-intensive services exports. Its performance in license and patent revenues from abroad falls slightly below the EU average although this might reflect a stronger domestic revenue performance.

Despite its good overall performance, the UK's national R&I system continues to face a number of challenges, some of which have been in existence for some time. These concern: low levels of private sector investment in R&D&I; translation of the results of publicly supported R&D into commercial products, processes and services; maintaining the capacity of the national system of the science and research infrastructure; addressing the future skills needs of industry; continuing to support the specific needs of SMEs, especially high-growth innovative companies; and mobilising government resources for procurement in supporting demand-led innovation. However, on the positive side, a range of direct and indirect instruments are in place to deal with these challenges, together with policies to provide a supporting set of framework conditions for research and innovation. Overall, these instruments appear to be appropriate policy responses, and some have been positively evaluated. However, it is difficult to measure the direct effects of such microeconomic policy instruments in the broader economic environment which is dominated by a range of macroeconomic conditions.

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1. Overview of the R&I system

1.1. Overall position in the European RDI landscape

The UK has the third largest population among the EU Member States, with 12.67% (64.308 million) of the EU-28 total population of 507.4 million in 2014[4]. In 2013, it had a per capita GDP of €29,600[5] compared to an EU-28 average of €25,700. Since 2011, GDP has grown by 7% from €1,770,909m to €1,899,098m in 2013, although it has fallen slightly from a high (of €1,921,904m) in 2012. In 2013, UK GERD stood at €32,783m (around 11.9% of total EU-28 GERD), slightly down on 2012. From 2011, UK GERD has grown by 3.9%, compared to an EU-28 growth rate of 5.3%[6]. Over the same time frame (2011-2013), UK BERD has risen (consistently) by 5.4% to €21,149m (contributing about 12.1% of EU-28 BERD). This growth rate compares to a 6.3% increase in EU-28 BERD[7].

In its ten-year Strategic Innovation and Investment Framework, 2004-2014 (BIS, 2011) the UK expressed the ambition to reach a ratio of GERD to GDP of 2.5% by 2014. While the economic recession reduced the probability of this being achieved, recent figures have shown a better than anticipated growth for the UK economy although the ratio remains around 1.69%.

The Business Enterprise sector is the largest contributor to GERD, providing 64.5%. The HE sector performs a further 26% and the Government sector 7% (although the government supports a significant proportion of HE R&D activities). The private not-for-profit sector performs the remaining 2%.

1.2. Main features of the R&I system

The UK research system is largely centralised, although regional autonomy for innovation policy has been increased in recent years. The Devolved Administrations of Scotland, Wales and Northern Ireland have responsibility for aspects of health and education funding. Block funding for higher education institutes is provided by separate higher education funding councils (or similar bodies) in each country, although the bulk of research funding comes via the Research Councils which have a UK-wide remit. At the regional level in England, responsibility for innovation support has been assumed by Innovate UK (formerly the Technology Strategy Board) following the abolition of the Regional Development Agencies in 2011. The Devolved Administrations may operate versions of UK innovation support initiatives according to their specific strategic needs (Cunningham, 2014).

[4] Eurostat: http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&language=en&pcode=tps00001&tableSelection=1&footnotes=yes&labeling=labels&plugin=1 (accessed 2/12/14).
[5] €1.00 = £0.80
[6] Eurostat: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do (accessed 2/12/14).
[7] Eurostat

1.3. Structure of the national research & innovation system and its governance

The Department for Business, Innovation and Skills (BIS) plays the lead executive role in research issues, and is the home of the Government Office for Science (GO-Science), headed by the Government's Chief Scientific Adviser (CSA). GO-Science plays the lead role in improving the quality of science in the UK. The CSA reports directly to the Prime Minister and the Cabinet. The CSA also chairs the principal high-level national policy making and coordination body, the Council for Science and Technology (CST), 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. High-level UK science policy making also places particular emphasis on the use of systemic reviews and evaluations.

BIS is the major provider of research funds for the public sector and is also responsible for the allocation of the UK Science Budget via the Research Councils and, to a lesser degree, the Royal Society and Royal Academy of Engineering. The Research Councils, which in turn support R&D and research training both in Higher Education Institutions (HEIs) and their own institutes, provide research grants for programmes, projects and research centres. In addition, some of the Councils maintain their own research facilities in the UK and abroad for university researchers. Substantial funds are also allocated in the form of block grants to UK universities (see Section 2.5) from the Higher Education Funding Councils and their equivalents in the devolved administrations.

The UK Government also 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 Innovate UK (formerly the TSB), which also has responsibility for the formulation and delivery of a national technology strategy. Innovate UK supports technology and innovation, mainly through collaborative work between businesses or between businesses and academia. Other Ministries and Departments, particularly the 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) or from outside sources, especially HEIs.

The HE sector forms the largest performer of research in the UK (see above). As of August 2013, there were 165 HEIs in the UK of which 115 were universities (this includes federal universities such as those of London and Wales, which are counted as a single entity). These employ over 122,000 full time academic staff (2012/13). They vary considerably in size from around 300 students to the University of Manchester with 38,430 students[8].

The UK HE sector received c. €9,014m of research support in 2012/13. Of this, c. €2,444m (27%) came from the Research Councils, c. €2,731m (30%) from the Higher Education Funding Councils and similar bodies, and c. €508m (6%) from government directly. A further c. €365m (4%) came from UK industry and business and c. €1,277m (15%) from

[8] https://www.hesa.ac.uk/

the private, non-profit sector (charities). Finally, c. €1,335m (15%) came from overseas sources (of which €750m came from EU sources[9]).

Due to successive governance changes, many public sector institutes and laboratories have undergone a shift from contractor status, through 'arms-length' executive agency status to full privatisation. As a result, several reside either partly or wholly in the private sector, under a variety of, often quite complex, contractual arrangements. This has led to a shift in the relationship between these agencies and their former parent departments or ministries and the latter have largely become customers (rather than sponsors) of the research and services these agencies undertake.

Despite this shift towards privatisation, a number of Government Departments have retained their intramural research capabilities in some form or other, to which can be added the institutes and centres maintained by the Research Councils. Collectively, these form an important component of the Science and Engineering base, alongside the (much larger) component represented by the HEI sector. Detailed figures on the allocations of the Research Councils to their own institutes and units and on departmental research spending at non-academic research performing organisations are not available.

In 2012, although just 1% of registered businesses in the UK Non-Financial Business Economy were foreign-owned, they contributed 29% of UK value added. Some 50% of these businesses were in the service sector, compared to 61% of UK businesses. A quarter of foreign-owned businesses were owned from the USA[10]. Since 2008, the percentage of business R&D financed from overseas has remained comfortably above 20 per cent. In 2011, expenditure on R&D in foreign-owned businesses overtook that in UK-owned businesses for the first time[9].

There were 2.26 million enterprises registered for VAT and/or PAYE (pay-as-you-earn) in March 2014, compared with 2.17 million in March 2013, a rise of around 96,000 (4.4%). In 2014, the professional, scientific and technical sector accounted for the largest number of businesses, with 17.5% of all registered enterprises in the UK. Wholesale, retail and repair of motor vehicles formed the second largest sector, with 16% of all enterprises registered. The third largest sector was construction, with 11.8% in 2014. Separate Office of National Statistics (ONS) data from March 2013 indicate that of a total of 1,765,860 registered companies (whose size was known), 85.7% had below 10 employees, 11.7% had 10-49 employees, 2% between 50 and 250 employees and 0.5% above 250 employees[11].

In broad terms, in 2012, 72% of total UK business R&D spending was on manufacturing activity compared to 25% on services activity. Some £12.2bn (€15.25bn) was spent by UK businesses on manufacturing R&D in the UK in 2012. The largest expenditure was by the chemicals product group at £4.8bn (€6.0bn), 39% of the total[12], of which Pharmaceuticals forms the largest contributor – see below).

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[9] http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html#tab-R-D-Expenditure-by-Funding-Sector

[10] http://www.ons.gov.uk/ons/rel/abs/annual-business-survey/business-ownership-in-the-uk--2012/sty-abs-business-ownership.html

[11] http://www.ons.gov.uk/ons/about-ons/business-transparency/freedom-of-information/what-can-i-request/published-ad-hoc-data/business-and-energy/october-2014/count-enterprises-in-the-uk---turnover---employment-size-band.xls

[12] http://www.ons.gov.uk/ons/rel/uncategorised/summary/changing-shape-of-uk-manufacturing/sty-facts-about-manufacturing-in-the-uk.html

According to ONS data[13], in 2012 the business enterprise sector accounted for £17.1bn (c. €21.37bn) of expenditure, representing 63% of total expenditure on R&D. This represented a decrease of 2% in current prices from £17.5bn (c. €21.87bn) in 2011 (and a larger increase in terms of real prices). Data compiled from the 400 largest business R&D spenders indicates that the product groups with the largest R&D expenditure in 2012 were:

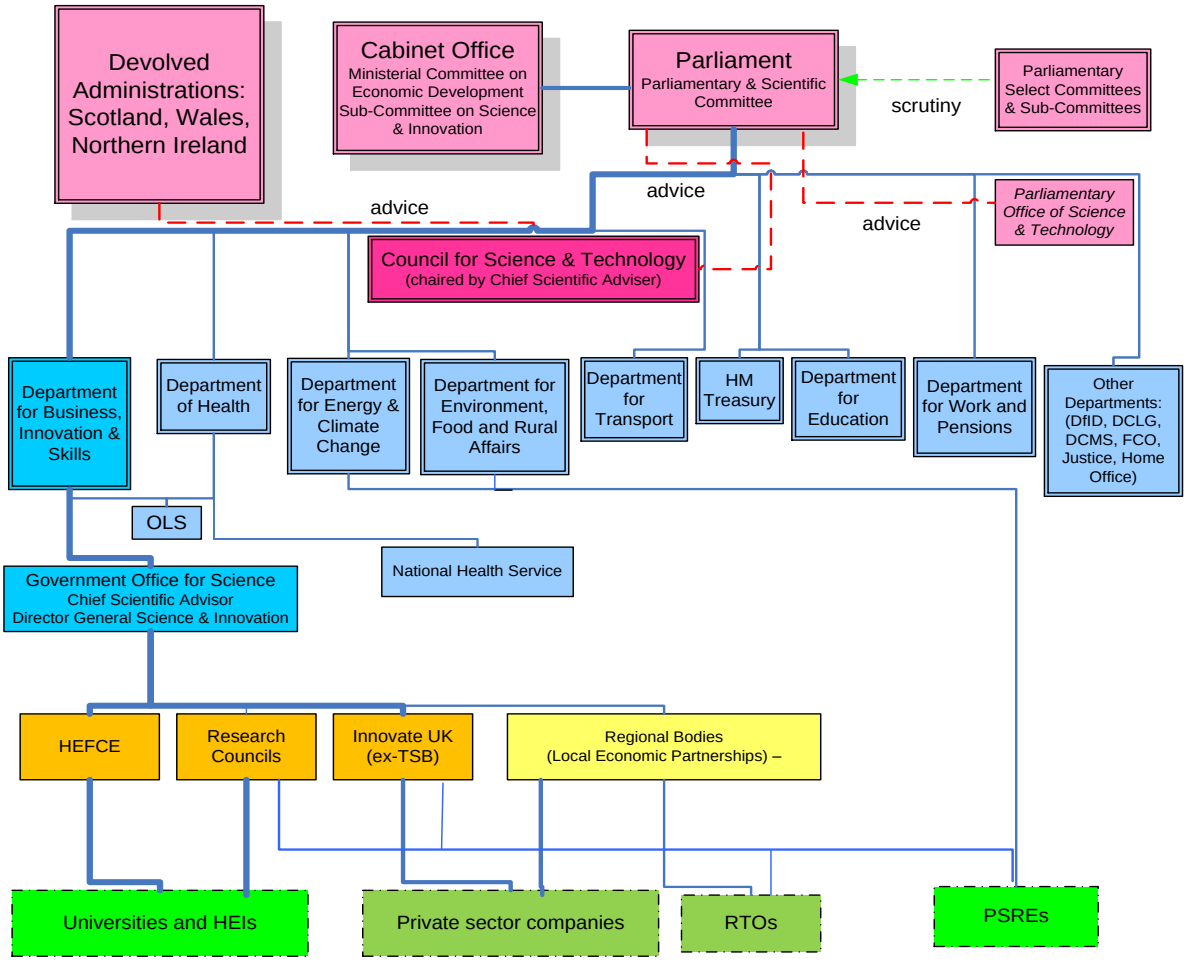
- Pharmaceuticals (£4.2bn: c. €5.25bn)
- Computer programming and information service activities (£1.9bn: c. €2.37bn)
- Motor vehicles and parts (£1.7bn: c. €2.1bn)
- Aerospace (£1.5bn: c. €1.87bn)
- Machinery and equipment (£1.0bn: c. €1.25bn)
- Telecommunications (£0.9bn: c. €1.12bn).

Over the last five years, the major structural or institutional changes that have been made include the amalgamation of the Department for Innovation, Universities and Skills (DIUS) with the Department for Business, Enterprise and Regulatory Reform (BERR) to create the Department for Business, Innovation and Skills (BIS) and the closure of the Regional Development Agencies (RDAs), which were tasked with economic development in the eight English regions. The responsibilities of the RDAs were transferred to the Technology Strategy Board which has developed over the period into the UK's 'Innovation Agency'. In addition, Local Economic partnerships began to be set up comprised of regional economic actors (but with no direct funding for innovation themselves). In 2011, a number of the new Catapult Centres began to become operational, a process that has continued over the last few years.

[13] http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html#tab-Expenditure-on-R-D-Performed-in-the-UK-

Main changes in 2009
DIUS and BERR merge to form BIS
Closure of RDAs announced
Main Changes in 2010
General Election: Conservative-Lib Dem Coalition Government replaces Labour
RDA closure proceeds
Shift of regional responsibilities to TSB/Innovate UK
Main changes in 2011
New catapults begin to operate
RDA closure proceeds, establishment of Local Economic Partnerships
Main changes in 2012
Formal closure of RDAs, continued development of LEPS
TSB gains further responsibilities for innovation support
Main Changes in 2013
No major changes
Main Changes in 2014
Referendum on Scottish independence results in a 'no' vote – no immediate implications for UK STI system
New national innovation plan released – 'Our plan for growth: science and innovation'

Figure 1 UK research and innovation system



Key:

DCLG: Department for Communities & Local Government
DCMS: Department for Culture, Media & Sport
DfID: Department for International Development
FCO: Foreign & Commonwealth Office
HEFCE: Higher Education Funding Council
HEIs: Higher Education Institutes
OLS: Office of Life Sciences
PSREs: Public Sector Research Establishments
RTOs: Research & Technology Organisations

Political level and high level cross cutting policy level
Ministry mission centered coordination
R&D funding allocation
Research Performers

2. Recent Developments in Research and Innovation Policy and systems

2.1 National economic and political context

During the period from 2013 to 2014, the UK government has been led by the Conservative/Liberal Democrat coalition which entered office in May 2010 as the result of a hung parliament. The present government has a mandate until May 2015. At the regional level, a referendum on Scottish independence was held on 18th September, 2014. This resulted in an approximately 10% majority vote to remain in the United Kingdom. This result may lead to greater devolution of economic and political power among the constituent parts of the UK, although the full outcomes will not be known for some time.

Overall, economically, the UK appears to be recovering well from the effects of the 2008 financial crisis and Eurozone uncertainty. The most recent information from the Office for National Statistics[14] notes that in the ten years prior to the economic downturn, UK annual real GDP compared favourably with other G7[15] economies, averaging 3.2% (cf. G7 average of 2.5%), but fell by 7.2% between the beginning of 2008 and the middle of 2009, the joint second largest fall in the G7. After the downturn, UK GDP has grown slowly (just 1.2% per annum between 2009 and 2013) and remains 0.6% below its pre-downturn peak. Nevertheless, throughout 2013 and in the first quarter of 2014, the UK moved from having one of the slowest growth rates in the G7 to one of the fastest and GDP has risen by 3.1% over the year (cf. 2.3% in Germany and 2.0% in the US).

In terms of real GDP per capita, using an index where 2008=100, third quarter performance in 2013 was as follows: Euro Area = 96.78; Germany = 103.68; Spain = 92.72; France = 98.37; Italy = 90.62; Netherlands = 94.59 and UK = 95.51 (ONS derived from Eurostat)[16].

In terms of other gross economic indicators, the UK has also performed relatively well in recent months: the rate of inflation stood at 1.5% in the year to August 2014, down slightly from 1.6% in July and the latest information continues the trend of below 2.0% inflation during 2014 despite some recent volatility in the rate[17]: the latest figure for November 2014 puts it at only 1%. Similarly, estimates from May to July 2014 show that employment has continued to rise and unemployment continued to fall, continuing a general trend since late 2011/early 2012[18]. As of July 2014, there were 30.61m people in work and the proportion of people aged 16-64 in work (the employment rate), was 73.0%, slightly higher than for February to April 2014 (72.9%) and higher than for a year earlier (71.6%). At the same time, there were 2.02m people unemployed, 468,000 fewer than a year earlier, marking the largest annual fall in unemployment since 1988. The unemployment rate reached 6.2% for May to July 2014, the lowest since late 2008. However, the positive growth in employment has not been matched by pay levels, which (including bonuses for employees in Great Britain) was 0.6% higher than a year earlier, suggesting that employment growth has been led by an increase in people in lower paid jobs. Finally, according to Office for Budget Responsibility (OBR) estimates, the deficit

[14] http://ons.gov.uk/ons/rel/elmr/gdp-and-the-labour-market/q1-2014--may-gdp-update/sty-gdp-g7-economies.html
[15] Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.
[16] http://www.ons.gov.uk/ons/dcp171766_360847.pdf
[17] http://ons.gov.uk/ons/rel/cpi/consumer-price-indices/august-2014/consumer-price-inflation-summary--august-2014.html
[18] http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/september-2014/statistical-bulletin.html

(which stood at 11% of GDP in 2009-10) is now forecast to have fallen by half to 5.5% in the coming year and will be eradicated by 2018-19[19].

With regards to investment in research, the business sector performs the most R&D of any sector in the UK. According to ONS (2014)[20], in 2012 it accounted for £17.1bn (c. €21.37bn) of expenditure, representing 63% of total expenditure on R&D. This represented a decrease of 2% in current prices from £17.5bn (c. €21.87bn) in 2011. Data compiled from the 400 largest business R&D spenders indicates that the product groups with the largest R&D expenditure in 2012 were:

- Pharmaceuticals (£4.2bn: c. €5.25bn))
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- Aerospace (£1.5bn: c. €1.87bn)
- Machinery and equipment (£1.0bn: c. €1.25bn)
- Telecommunications (£0.9bn: c. €1.12bn).

According to the Budget statement by the Chancellor of the Exchequer in March 2014, the Government's tax and spending plans include the following actions to help support businesses: a doubling of the annual investment allowance to £500,000 until the end of 2015; improving the level of support for export finance; and measures to alleviate the energy costs faced by energy intensive businesses[21].

Lastly, in a July 2014 Cabinet reshuffle, David Willetts MP, who had a high reputation as a strong supporter of science, stepped down as Minister for Science and Universities and Minister of State at the Cabinet Office. He was replaced by Greg Clark, MP, who now occupies the position of Minister of State for Universities, Science and Cities. His somewhat wide-ranging responsibilities cover: Higher education; Science and research; Innovation and commerce; Local and regional growth and Cities. In addition, a new ministerial position has been created: Parliamentary Under Secretary of State for Life Sciences jointly at the Department for Business, Innovation and Skills and the Department of Health. George Freeman MP was appointed to this role in July 2014.

2.2 National R&I strategies and policies

The Department for Business, Innovation and Skills (BIS) plays the lead executive role in research and innovation issues, and is the major provider of research funds for the public sector. This provides funds for the seven Research Councils, each organised on a broad disciplinary basis, which in turn support R&D both in Higher Education Institutes (HEIs), independent research organisations and in their own institutes. Thus, BIS has oversight for the majority of R&D policy formulation, and forms the main author of strategic policies for UK R&D and innovation, while the Research Councils will develop their own specific R&D

[19] https://www.gov.uk/government/news/budget-2014-key-announcements
[20] http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html#tab-Expenditure-on-R-D-Performed-in-the-UK-
[21] https://www.gov.uk/government/news/budget-2014-key-announcements

strategies and policies. Support for innovation policies is provided vis BIS by Innovate UK (formerly the Technology Strategy Board – TSB).

BIS is the home of the Government Office for Science (GO-Science), headed by the Government's Chief Scientific Adviser (CSA). GO-Science plays the lead role in improving the quality of science in the UK. The CSA reports directly to the Prime Minister and the Cabinet. The CSA also chairs the principal high-level national policy making and coordination body, the Council for Science and Technology (CST), 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. High-level UK research and innovation policy making also places particular emphasis on the use of systemic reviews and evaluations.

BIS engages with a wide range of stakeholders, both inside and external to government, including those from the business and higher education sectors, and at a variety of levels in order to consult, debate and obtain a variety of views on the effects of R&I policies and on the requirements of these stakeholders. In this way, UK STI policy is coordinated across Government in order to ensure that public action in all relevant policy areas is designed and implemented in a strategic, coherent and integrated framework geared towards fostering innovation and strengthening the knowledge base and fundamental research.

In terms of strategic direction, the long-term policy for UK science and innovation investment over the last four years has been defined through the Innovation and Research Strategy for Growth (IRS), published in December 2011, which has formed the central document for UK innovation. As the UK takes a holistic view of innovation policy, its high level strategies and policies tend to encompass research, innovation and education aspects. They also include investment decisions for research infrastructures. Long-term financial expenditure across government as a whole is defined through a series of Comprehensive Spending Reviews (the latest was in July 2013). In parallel, a UK Industrial Strategy[22] (announced in September 2012), also formed a basis for strategic planning and included ten Sectoral Strategies. It also outlines a number of actions of relevance to the UK business sector and the role of Government support. Finally, in a speech in January 2013, the then Minister for Universities and Science, set out the so-called Eight (now ten) Great Technologies which would guide UK industrial investment (see below).

A new strategy - (entitled "Our Plan for Growth: science and innovation" (HM Treasury and BIS, 2014)[23], was published on 17 December 2014. The Plan has the ambition for the UK "to be the best place in the world for science and business" and comprises six elements:

1. Deciding priorities (a process supported by the Eight Great Technologies and the Industrial Strategy)
2. Nurturing scientific talent
3. Investing in our scientific infrastructure
4. Supporting research
5. Catalysing innovation
6. Participating in global science and innovation

[22] https://www.gov.uk/government/policies/using-industrial-strategy-to-help-the-uk-economy-and-business-compete-and-grow
[23] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/387780/PU1719_HMT_Science_.pdf

Underpinning these elements are five themes, perceived as critical to the success of the Plan:

- the importance of achieving excellence
- the imperative to operate at a quickening pace and show agility to seize new opportunities
- the need to accommodate and foster higher levels of collaboration between disciplines, sectors, institutions, people and countries
- the need to recognise the importance of place, where people and organisations benefit from mutual proximity
- the modern demand for openness and engagement with the world (BIS 2014c)

The Plan for Growth does not explicitly address or refer to EU priorities but does note that the UK is already the top beneficiary from the EU Framework Programme, particularly funding received via the European Research Council (ERC), and highlights the need to build on this success and increase SME access to Horizon 2020 funding. It also notes that the UK should seek to influence the new EU Commission and the European Parliament on the future of science, innovation and research policy, something in which the UK is already active, for example in driving the development of the ERA roadmap and, by setting out the priorities for deepening the ERA as a single market for research and Knowledge (by mid-2015).

As in previous cases, and following normal Government practice, the new strategy document was preceded by a number of reviews and consultations, for example "Insights from international benchmarking of the UK science and innovation system" (BIS, 2014)[24]. These examined a range of relevant conditions such as strengths and weaknesses, emerging opportunities and potential market opportunities. The overall positioning and performance of the UK in terms of innovation was also presented in the BIS Annual Innovation Report, the latest produced in March 2014[25]. This draws on various sources, such as the international benchmarking report noted above. More specifically, Our Plan for Growth was accompanied by an Evidence Paper[26] which provides background information on the underpinning rationale for the new strategy.

Briefly, the key announcements made in Our Plan for Growth are:

Under the topic of 'Nurturing scientific talent', the Government will:

- Take action to increase the quantity and quality of STEM teachers through £67m (c. €86m) of new programmes; training and recruiting new maths and physics teachers, up-skilling non-specialist teachers.
- Delivering more Higher Apprenticeships where need is greatest; establish National Colleges in key STEM sectors such as Digital Skills, Wind Energy, and Advanced Manufacturing.

[24] https://www.gov.uk/government/publications/science-and-innovation-system-international-benchmarking
[25] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293635/bis-14-p188-innovation-report-2014-revised.pdf
[26] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/388015/14-1247-science-innovation-strategy-evidence.pdf

- New support for those wishing to attain a postgraduate qualification (income contingent loans for the under 30s).
- A dedicated platform to match female STEM graduates to return to jobs in industry following career breaks, with advice and information.

Concerning 'Investing in our scientific infrastructure', overall, £5.9bn (c. €7.5bn) will be committed to science capital from 2016 to 2021, including £2.9bn (c. €3.7bn) towards scientific grand challenges. New projects include:

- £235m (c. €301m) for the Sir Henry Royce Institute for advanced materials
- £113m (c. €145m) towards big data at the Hartree Centre, Daresbury
- £95m (c. €122m) for European Space Agency programmes
- £31m (c. £40m) for a new Energy Security and Innovation Observing System
- £60m (c. €77m) to extend the capabilities of the National Nuclear Users Facility
- £20m (c. €26m) towards a centre for ageing science and innovation in Newcastle

Further identified capital proposals will be subject to a process of international peer review and funding decisions will be taken at the 2015 Budget. £900m (c. €1.15bn) will be allocated to a capital agility fund, to respond to grand challenges as they emerge.

£3bn (c. €3.8bn) will be provided to support individual research projects, research in institutional' laboratories, and to provide funding for international subscriptions. Over half of this will be subject to competition.

In terms of 'supporting research', a number of reviews have been set in place:

- An assessment (by HEFCE) of HEIs' performance in knowledge exchange activities to identify examples of good practice.
- A review of the Research Councils in order to evolve their support for research in the most effective ways.
- A review by HEFCE to consider how to reward open data as part as part of the future REF assessments subject to the evaluation of the REF 2014 review.
- An examination of R&D spending by Government departments to ensure it is properly prioritised against other capital investment spending.

Announcements concerning the element 'Catalysing innovation' include:

- Continued expansion of the Catapult network, with two more Catapults (Energy Systems and Precision Medicine) due to open in 2015.
- £61m (c. €78m) to the High Value Manufacturing Catapult to meet increasing demand and provide outreach and technical support to SMEs.
- £28m (c. €36m) in a new National Formulation Centre as part of the High Value Manufacturing Catapult.
- Additional expansion of the network if financial recovery allows.
- As noted in the recent Autumn Statement, a new commitment of £400m (c. €513m) over three years to extend the British Business Bank's flagship venture capital programme, Enterprise Capital Funds.
- An additional £9m (c. €11.5m) towards driverless car test beds.

Finally, regards 'participating in global science and innovation', continued support (£375m – c. €480m, over five years) will be provided for the Newton Fund to support the development of scientific excellence and build scientific partnerships. UK participation in the European Research Area, the G7, G7+5, G20 and its Presidency of the EU in 2017 will be utilised to demonstrate UK leadership on topics such as open access and infrastructure. Further support will be offered to UK universities and research institutions to access some of the research elements of the $140bn international aid funding from multilateral banks, UN agencies and other donors.

With regard to the Devolved Administrations, the Scottish Government is responsible for all devolved issues such as education and health. Its objectives and priorities for STI issues are given in the most recent policy paper, Science for Scotland (2008). Policy advice for science, technology and innovation is provided by the Scottish Science Advisory Council (SSAC). Although science policy and funding is not devolved in Wales, in 2006, the Welsh Assembly published "A Science Policy for Wales?", outlining its strategic vision for science, engineering and technology. Its three priorities were: health/life sciences, the low carbon economy and sustainable economic and social regeneration. A new policy, Science for Wales, was published in early 2012.

Research programmes (as distinct from innovation support programmes) are operated by the seven UK Research Councils. The UK tends not to prioritise specific areas of research (themes), but rather applies horizontal (generic) support to maintain the overall performance of the research system, particularly in terms of ensuring the production of high quality, world-leading research, maintaining and developing research infrastructures (such as universities and public laboratories) and ensuring a constant supply of scientists, engineers and technologists.

As noted above, the UK Government has identified 'eight great technologies' (to which two more have been added) which are considered to be key to further growth in the UK economy. These are:

1. the big data revolution and energy-efficient computing;
2. satellites and commercial applications of space;
3. robotics and autonomous systems;
4. life sciences, genomics and synthetic biology;
5. regenerative medicine;
6. agri-science;
7. advanced materials and nanotechnology;
8. energy and its storage;
9. quantum technologies;
10. the internet of things.

A BIS Ministerial Statement in January 2013 explained how £600m (€730m) of extra science funding that was committed from the Autumn Statement in 2012 would be allocated. It includes:

- £189m (€230m) for big data
- £25m (€30m) for space
- £35m (€43m) for robotics and autonomous systems

- £88m (€107m) for synthetic biology
- £20m (€24m) for regenerative medicine
- £30m (€37m) for agri-science campuses
- £73m (€89m) for advanced materials
- £30m (€37m) for energy

In broad terms, the priorities are intended to serve as a strategic signal to guide funding allocations across the range of UK R&I policy areas, including R&D, research infrastructures and facilities and research training.

This generic support is also coupled to the objectives of making the science base responsive to the needs of the economy and both increasing the level of business investment in R&D and the level of engagement with the science base. Thus both thematic/sectoral research policies are operated largely through government expenditure via ministries' and departments' research in support of their specific policy portfolios, either as in-house research or through commissioned research from the public sector (Higher Education) or private sector, including Research and Technology Organisations. However, certain fields of research funded through Government sources, by virtue of the scale of demand, tend to attract larger budgets than others. One example is Health research, while defence R&D spending also represents a major destination for government support. The latter represents the largest single thematic outlay and much of this, particularly development, is commissioned from the private sector.

The allocated spend on the Science Budget (2011/12-2014/15) which includes the budgets of the Research Council is given in Table 1 below[27]. In addition to the £4.6bn per annum of programme funding for science and research, £1.9bn (c. 2.4bn) of capital over the 4 years of the Spending Review was allocated to science and research. As can be seen, the Science Budget has been frozen in absolute terms since 2010-11, thus is prone to some real terms erosion, despite very low rates of inflation. Within these figures, some areas have received funding increases (such as the Science and Technology Funding Council cross-Council facilities), whilst others had suffered declines (e.g. the Evidence and Evaluation programme). Funding for the next five-year spending cycle will be decided under the next Comprehensive Spending Review.

There are a number of cross-Research Council research programmes which receive substantial financial support: Lifelong health and wellbeing; Digital Economy; Energy; Global Food Security; Global Uncertainties (security) and Living with Environmental Change. These have been identified as broad generic areas of research (with significant socio-economic potential) which span the remits of several Research Councils and require cross-disciplinary attention. To these can be added the priority areas of Innovate UK (formerly the Technology Strategy Board), many of which focus on societal challenges that demand a cross-disciplinary, collaborative approach to finding solutions to major societal challenges or industrial bottlenecks/opportunities: Agriculture and food; Built environment; Digital economy; Emerging technologies; Enabling technologies; Energy; Health and care; High value manufacturing; Resource efficiency; Space applications; Transport and Urban living. These priorities are addressed by the range of competitions and funding tools run by

[27] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32478/10-1356-allocation-of-science-and-research-funding-2011-2015.pdf

Innovate UK. Both the cross-Research Council research programmes and the Innovate UK exhibit a good degree of overlap with the societal challenges identified in Horizon 2020[28].

Table 1: Science Budget allocations, 2011/12 to 2014/15.

	Baseline 2010-11 £'000	2011-12 £'000	2012-13 £'000	2013-14 £'000	2014-15 £'000	TOTALS £'000	Final Year to Baseline
Research Councils	**2,549,353**	**2,596,196**	**2,573,678**	**2,586,641**	**2,599,812**	**10,356,327**	**101.98%**
AHRC	100,717	99,881	98,370	98,370	98,370	394,993	97.67%
BBSRC	362,341	370,306	359,471	351,471	351,471	1,432,718	97.00%
EPSRC	771,289	759,720	748,150	748,150	748,150	3,004,171	97.00%
ESRC	158,061	155,690	153,319	153,319	153,319	615,648	97.00%
MRC	545,585	536,172	546,243	559,894	574,641	2,216,950	105.33%
NERC	298,071	298,600	297,129	300,129	289,129	1,184,987	97.00%
STFC - Core Programme	177,519	190,060	172,200	172,200	172,190	706,650	97.00%
STFC - Cross-Council facilities[1]	66,800	77,170	79,280	81,410	89,470	327,330	133.94%
STFC - International Subscriptions[2]	68,970	108,598	119,515	121,697	123,071	472,881	178.44%
HEFCE	**1,731,300**	**1,662,112**	**1,699,578**	**1,685,689**	**1,686,321**	**6,733,700**	**97.40%**
QR Research	1,618,300	1,549,112	1,586,578	1,572,689	1,573,321	6,281,700	97.22%
HEIF[3]	113,000	113,000	113,000	113,000	113,000	452,000	100.00%
National Academies	87,832	87,465	86,547	86,547	86,547	347,106	98.54%
Royal Society	48,558	47,830	47,101	47,101	47,101	189,133	97.00%
British Academy	26,448	27,001	27,005	27,005	27,005	108,015	102.10%
Royal Academy of Engineering	12,826	12,634	12,441	12,441	12,441	49,957	97.00%
Other Programmes	43,616	24,496	24,140	24,165	24,005	96,805	55.04%
Science & Society	15,441	13,000	13,000	13,000	13,000	52,000	84.19%
International	5,104	5,095	4,740	4,765	4,605	19,205	90.22%
Foresight	2,800	2,800	2,800	2,800	2,800	11,200	100.00%
Evidence & Evaluation	20,271	3,600	3,600	3,600	3,600	14,400	17.76%
UK Space Agency	163,805	205,637	191,963	192,864	179,221	769,685	109.41%
Total S&R Resource	**4,575,906**	**4,575,906**	**4,575,906**	**4,575,906**	**4,575,906**	**18,303,622**	**100.00%**

Note: owing to currency fluctuations, amounts have been left in pounds sterling. For reference, as of 29/09/14, £1.00=€1.28051.

It is difficult to indicate the balance between generic and thematic funding, since much Research Council funding is not allocated on a rigid thematic basis, but on a responsive mode basis, whilst university block grant funding for research is allocated by individual HEIs according to their own internal priorities and structures. Therefore, the best overview is perhaps provided by figures relating to the distribution of GBAORD by specific thematic objectives, as shown in Table 2.

[28] http://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges

Table 2: United Kingdom: Distribution of GBAORD by specific thematic objectives.

Thematic Objective	Expenditure (€m) 20132	%
Exploration and exploitation of the earth	344.5	3.2
Environment	305.8	2.8
Exploration and exploitation of space	376.1	3.5
Transport, telecommunications and other infrastructure	124.1	1.1
Energy	128.9	1.2
Industrial production and technology	109.7	1.0
Health	2,265.2	20.9
Agriculture	454.4	4.2
Education	40.0	>0.1
Culture, recreation, religion and mass media	210.3	1.9
Political and social systems, structures and processes	162.7	1.5
General advancement of knowledge financed from General University Funds	2,623.2	24.2
General advancement of knowledge financed from other than General University Funds	1,945.7	17.9
Defence	1,769.2	16.3
TOTAL	**10,859.9**	**100.00**

Source: Eurostat, 2014[29].

2.3 National Reform Programmes (NRPs) 2013 and 2014

The 2013 and 2014 NRPs report on progress against actions and policies[30] many of which are defined in The Innovation and Research Strategy for Growth (IRS) and the UK Industrial Strategy, announced in September 2012, which includes ten Sectoral Strategies. Both also outline a number of actions. In addition, the NRPs describe investments in R&D . The main points include: provisions for addressing youth unemployment (apprenticeships, skills and training); improving (bank and non-bank) financing to companies, particularly SMEs; and improve investment and strategies for the development of energy and transport networks.

Overall, it appears that substantial progress has been achieved, particularly when viewed in the broader economic environment of the financial downturn: "growth forecasts for the UK have been revised upwards and activity has expanded across all sectors of the economy, with a marked increase in both business investment and confidence. The performance of the UK labour market has continued to improve..., while unemployment has fallen sharply.... A record number of people are in work, and all nations and regions of the UK have seen an increase in employment"[31]. In part, this can be attributed to a recognition that austerity and debt reduction must be balanced by opportunities for future growth and that research and innovation have a critical role in driving such economic growth and recovery.

The Commission's Recommendations for 2014 note that the UK has made some progress in addressing the 2013 country-specific recommendations, notably by taking various appropriate policy measures to address youth unemployment, child care, welfare reform, financing of SMEs and its infrastructural needs. No specific challenges relating to RD&I policy are highlighted, although the UK Government needs to address long-standing structural challenges in relation to skills and education.

[29] http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do Accessed 05/12/2014
[30] HM Government, Europe 2020: UK National Reform Programme 2014, April 2014.
[31] http://ec.europa.eu/europe2020/pdf/csr2014/nrp2014_uk_en.pdf

However, the Government has set out an 'ambitious programme' for RD&I which, according to NRP 2014 is based on measures relating to:

- It's Industrial Strategy (September 2012)
- The eight-great technologies (see above) and accompanying capital fund allocations
- Implementation of the 2011 Innovation and Research Strategy
- Maintenance of the resource funding for its science and innovation-spend
- Continuing to make progress against the 5 priority areas for implementing the European Research Area framework
- Improving business support through R&D Tax Credits
- Continued support for international engagement.

2.4 Policy developments related to Council Country Specific Recommendations

There are no recommendations on R&D for the UK.

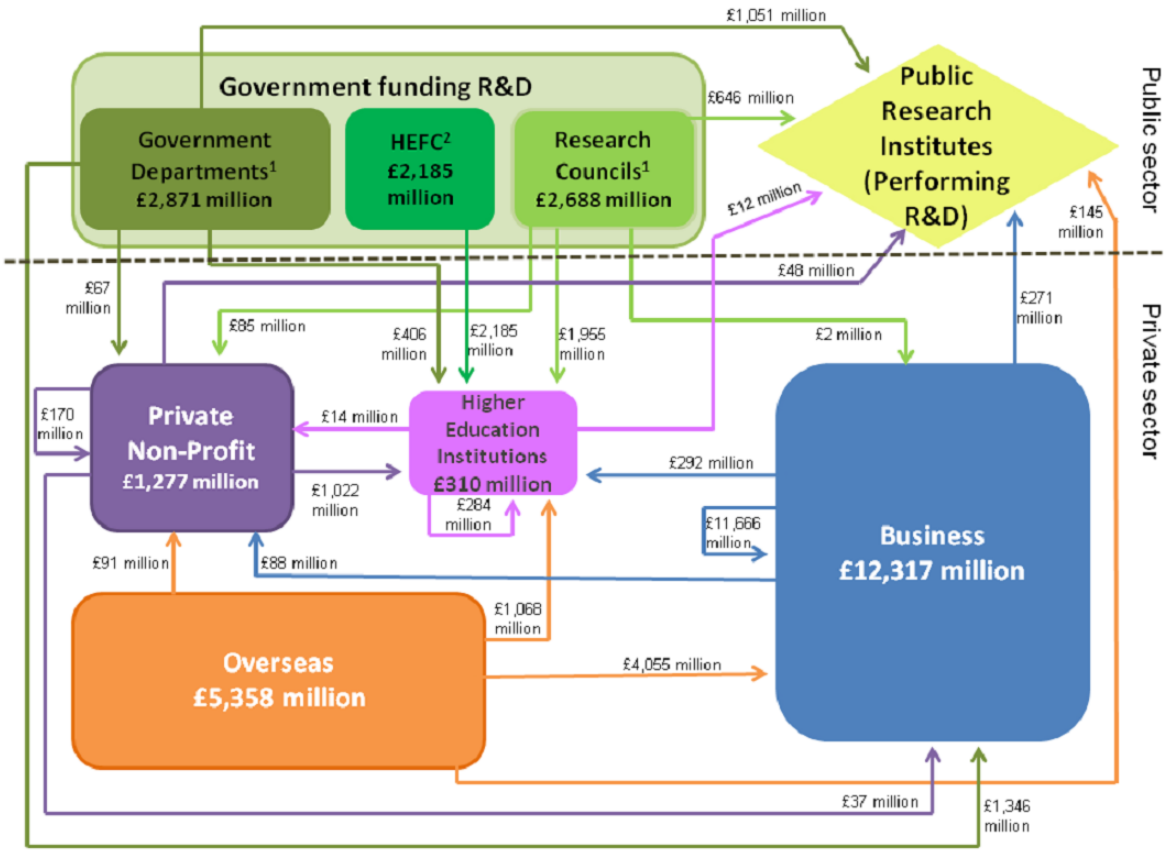
2.5 Funding trends

2.5.1 Funding flows

The UK does not have a specific R&D investment target, rather its sets the operational aim to "promote excellent universities, research and increased business innovation". Basic indicators for R&D investments are presented in Table 3.

The Department for Business, Innovation and Skills (BIS) is the major provider of research funds for the public sector. It is also responsible for the allocation of the UK Science Budget via the Research Councils and, to a lesser degree, the Royal Society and Royal Academy of Engineering (see Table 1). The Research Councils, which in turn support R&D and research training both in HEIs and their own institutions, provide research grants for both programmes, projects and research centres. In addition, some of the Councils maintain their own research facilities in the UK and abroad for university researchers. Substantial funds are also allocated in the form of block grants to UK universities from the Higher Education Funding Councils and their equivalents in the devolved administrations (see below). These block grants are made on the basis of an allocation exercise (the Research Excellence Framework - REF) based on a peer review process which assesses the research outputs and research impacts of university 'research-active' staff. A comprehensive overview of the flows of UK government funding for R&D is provided in figure 1

Figure 2: Flows of R&D funding in the UK, 2012: Source: ONS, 2014[32].



The overall size of the Science Budget[33] is confirmed through the Chancellor of the Exchequer's Spending Review announcement. Following this, the Research Councils, HEFCE, the UK Space Agency and the National Academies are required to set out delivery plans for the CSR period, taking account of BIS priorities for science and research funding. Ministers' decisions on the allocations of science and research funding took account of the extent to which the Delivery Plans met the BIS priorities and also took account of views expressed in a wide-ranging consultation process on science spending.

The UK Government also 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 Innovate UK (formerly the TSB), which also has responsibility for the formulation and delivery of a national technology strategy. Largely through its Technology Programme, Innovate UK will deliver over €500m of funding in 2014-15 to support technology and innovation, through collaborative work between businesses or between businesses and

[32] http://www.ons.gov.uk/ons/rel/rdit1/gross-domestic-expenditure-on-research-and-development/2012/stb-gerd-2012.html#tab-R-D-Expenditure-by-Funding-Sector

[33] That is, the Government's funding allocation to the Research Councils, Higher Education Funding Council for England, the Royal Society, the British Academy, the Royal Society for Engineering and a number of cross-cutting programmes (Science and society, Foresight, International activities and Evidence and evaluation).,

academia[34]. Other Ministries and Departments, particularly the 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) or from outside sources, especially HEIs.

The private sector is also both a major funder and performer of R&D. In 2012 the sector´s total expenditure on R&D was €21.96bn. The majority of this (€14.39bn) came from the business sector itself, with €1.66bn from Government sources (mainly on defence) and €4.19bn from overseas sources. UK GOVERD for 2012 was €9.63bn.

Table 3: Basic indicators for R&D investments

	2009	**2010**	**2011**	**2012**	**2013**	**EU28 (2013)**
GDP growth rate	-5.2%	+1.7%	+1.1%	+0.1%	+1.7%	+0.1%
GERD (% of GDP)	1.75	1.69	1.69	1.63	1.63	2.02
GERD (euro per capita)	468.2	491.9	500.6	523.9	513.1	539.2
GBAORD - Total R&D appropriations (€ million)	10,518	10,793	10,438	11,235	10,859	90,505
R&D funded by Business Enterprise Sector (% of GDP)	0.78	0.75	0.78	0.74	0.76	1.1 (2012)
R&D funded by Private non-profit (% of GDP)	0.09e	0.08e	0.08e	0.08e	0.08e	0.03e (2012)
R&D funded from abroad (% of GDP)	0.29	0.3	0.3	0.32	0.34	0.2e (2011)
R&D funded by Framework Programmes (€ million)	FP6 (2002-2006): 2,526.6		FP7 (2007-2013): 6,990.4			
R&D funded (allocated) by the Structural funds (€ million) 2007-2012[35]	1,074.9					
R&D funded (implemented) by the Structural funds (€ million) 2007-2013[27]	718.5					
R&D related FDI (€ million)	9,038++	8,170++	10,975+ + 3,803+			
R&D performed by HEIs (% of GERD)	27.9	27.0	26.0	26.5	26.3	23.2%
R&D performed by Government Sector (% of GERD)[36]	9.2	9.5	8.6	8.2	7.3	12.2%

[34] Innovate UK Delivery Plan 2014-15. Available at: https://www.innovateuk.org/documents/1524978/2138994/Delivery%20Plan%202014-15

[35] The data on Structural Funds (RIO elaboration of DG REGIO data) is low in comparison to data reported elsewhere, such as in last year's Country Report. One explanation for this difference is the definition adopted: the data presented here refers to Core RTD (see Annex for categories included), whereas the information provided elsewhere adopts a broader definition of RTDI and linked activities. In addition, the data reported here refers to ERDF funding only and does not include Cohesion Funds.

[36] http://www.oecd-ilibrary.org/sites/msti-v2014-1-en/table-19.html?contentType=%2fns%2fTable%2c%2fns%2fStatisticalPublication&itemId=%2fcontent%2ftable%2fmsti-v2014-1-

	2009	2010	2011	2012	2013	EU28 (2013)
R&D performed by Business Enterprise Sector (% of GERD)[37]	60.4	60.9	63.6	63.4	64.5	63.7%
Share of competitive vs. institutional public funding for R&D	n/a	n/a	n/a	n/a	n/a	n/a
Employment in high- and medium-high-technology manufacturing and knowledge intensive service sectors as share of total employment	3.8	3.9	3.7	3.8	3.7	5.6%
Turnover from Innovation as % of total turnover	7.3% (2008)	5.2	n/a	n/a	n/a	13.4% (EU-27, 2010)

+ Eurostat data
++ OECD data

From the above Table, it is clear that the overall effect of the financial crisis has been to some extent reversed, with an increase in the rate of growth of GDP (recent estimates indicate that the rate of recovery and GDP growth is exceeding earlier forecasts). Due to the variations in GDP, it is difficult to assess any significant trend in research intensity although GERD seems to have been steadily rising (at least until 2013), alongside an overall upward, yet erratic, trend in GBAORD. Business sector R&D expenditure also seems to be slowly picking up, with a good increase in terms of its ratio to GERD. Similarly, R&D funded from abroad continues to increase steadily, reinforcing the picture that the UK is an attractive base for research. However, Government sector funded GERD is continuing to decline and R&D performed in the HE sector has yet to attain the level achieved in 2009.

Total Venture Capital provision also seems to have been adversely affected by the financial crisis and is yet to show signs of recovery (although the effects of GDP increases may blur this picture): However, since this is provided through both public and private sector routes, it does not specifically reflect a change of government investment. The share of the workforce in the high- and medium-high-technology manufacturing and knowledge intensive service sectors appears to be relatively stable, but since total employment has been steadily increasing, these figures may mask an absolute increase in this indicator.

Overall, since the UK Government allocates funds within a strategic framework for research and innovation investment, funding is somewhat insulated by the effects of the financial downturn. Moreover, the government has adopted an 'investment for growth' approach to economic recovery (as again emphasised in the title of its most recent strategic document – 'Our Plan for Growth').

table19-en&mimeType=text%2fhtml&containerItemId=%2fcontent%2fserial%2f2304277x&accessItemIds=%2fcontent%2fissue%2fmsti-v2014-1-en

[37] http://www.oecd-ilibrary.org/sites/msti-v2014-1-en/table-17.html?contentType=%2fns%2fStatisticalPublication%2c%2fns%2fTable&itemId=%2fcontent%2ftable%2fmsti-v2014-1-table17-en&mimeType=text%2fhtml&containerItemId=%2fcontent%2fserial%2f2304277x&accessItemIds=%2fcontent%2fissue%2fmsti-v2014-1-en

2.5.2 Project vs. institutional allocation of public funding

The largest performer of research in the UK is the Higher Education Sector. This receives funding via a mix of institutional block grants, competitive 'responsive mode' grants and through the Higher Education Innovation Fund which encourages knowledge transfer activities. The second largest public research budget is that disbursed via the Research Councils. The private sector also receives substantial R&D support, via a range of innovation support measures, rather than direct state aid for research: the largest single instrument being the combined R&D Tax Credit schemes, which account for some 75% of the public support for innovation.

UK funding of research takes a variety of forms and routes. The largest single budget is probably that allocated to defence R&D although a substantial proportion will be dedicated to development and demonstration purposes rather than research. Much of this budget will go to the private sector, not only in the UK. Other thematic areas, notably health and environmental funding will also attract significant budgets, via the responsible ministries, and again to a variety of research performers, although the Public Sector Research Establishments will take the majority.

According to EC figures[38], the share of responding funders' total budget allocated as project-based funding was 80% in 2013 higher than the EU average), compared to 20% of the total budget allocated as institutional funding based on institutional assessment and/or evaluation (below the EU average). No trend data are available on these figures. A further proxy indicator may be derived from GBAORD expenditures:

- General advancement of knowledge financed from General University Funds = €2,623.2
- General advancement of knowledge financed from other than General University Funds = €1,945.7

However, these figures do not align closely with the data derived from Higher Education funding councils and the research Councils provided below.

Institutional funding

Institutional funding in the UK is almost always allocated based on institutional assessment. The main stream of support is that allocated to the universities in the HE Sector, in the form of a block grant from the Higher Education Funding Council for England (HEFCE) and its equivalent bodies in the devolved administrations. This is allocated on the basis of a mechanism known as the Research Excellence Framework (formerly the Research Assessment Exercise – RAE), a peer review process which produces 'quality profiles' for each submission of research activity made by HEIs. There were four RAEs (in 1992, 1996, 2001 and 2008). Once funding levels for institutions (which are actually made on a subject oriented 'cost-centre' basis and which may apply at a sub-departmental level) have been set, these are used for the annual allocation of funding until the next round of assessment One of the major criticisms of the process is the enormous amount of staff time and resources that HEIs have to devote to the process of preparing submissions. After a series of extensive consultations and reviews, the Higher Education Funding Councils replaced the RAE with the new REF, which is more "metrics-based" and

[38] European Research Area Progress Report 2014 {COM(2014) 575 final}. Available at: http://ec.europa.eu/research/era/pdf/era_progress_report2014/era_fiches_eu-3_2014.pdf

which also takes the notion of research 'impact' into account. The first REF took place in 20013/14.

University block funding supports research infrastructure costs. Total research funding from the four UK HEFCs in 2011/12 was £2.2bn (c. €2,752m). This was provided by the Scottish Funding Council (SFC) in Scotland, Higher Education Funding Council for Wales (HEFCW) in Wales and Department of Education and Learning Northern Ireland (DELNI) in Northern Ireland.

Project funding

The largest category of project-oriented, competitive or 'responsive mode' funding is that provided via Research Council grants and programmes. In 2011-12, the Research Councils provided research funding amounting to £3.19bn (around €3.8bn).

Research Council funds are awarded on the basis of applications made by individual researchers, which are subject to independent, expert peer review. Awards are made on the basis of the research potential and are irrespective of geographical location. Responsive mode funding is very flexible and supports projects ranging from small travel grants to multi-million pound research programmes and from one-month to six years. The funding covers a wide range of activities, including research projects, feasibility studies, instrument development, equipment, travel and collaboration, and long-term funding to develop or maintain critical mass. The major beneficiaries of responsive mode funding are individual researchers or research teams at Higher Education Institutes. This type of funding may be categorised as 'bottom-up' or 'free funding'.

Each Research Council funds research and training activities in a different area of research ranging across the arts and humanities, social sciences, engineering and physical sciences and the medical and life sciences. RCUK supports over 50,000 researchers including 19,000 doctoral students, around 14,000 research staff, and 2,000 research fellows in UK universities and in their own Research Institutes[39].

A significant amount of R&D is commissioned by the Government through the form of contracts. These may be extramurally with the higher education sector, the private sector, and Research and Technology organisations, or intra-murally with Non-Departmental Public Bodies and Public Sector Research Establishments.

The majority of the remaining forms of research funding fall within the broad area of innovation support and include various knowledge transfer support mechanisms and tax credits for R&D. These target a mix of research performers. Other than the tax credits for R&D (which provides indirect support), the main competitive support scheme for companies to carry out R&D is the Smart programme (formerly Grant for R&D) which targets SMEs and is funded through BIS . A large number of schemes are aimed at linking the public and private sectors (which may therefore be categorised as 'research networks'), thereby promoting the flow of new research ideas into new technologies and commercialised products, processes and services: examples include several of Innovate UK's schemes such as Knowledge Transfer Networks, Collaborative R&D and Knowledge Transfer Partnerships – all funded through the Technology Strategy Board, and the Research Councils' CASE awards.

[39] http://www.rcuk.ac.uk/

Other allocation mechanisms

Another major performer of research comprises the Public Sector Research Establishments i.e. government laboratories and the institutes of some of the Research Councils. These receive funding from the Government in order to undertake research relevant to the respective policy needs of their sponsoring department or Research Council. The size of this sector has been considerably reduced in recent years through the privatisation or semi-privatisation of government laboratories. In addition, and partially as a consequence of this reduction, civil spending on R&D by Government departments has declined over recent years but remains substantial although it is now disbursed primarily on a competitive basis. Detailed figures on the allocations of the Research Councils to their own institutes and units and on departmental research spending at non-academic research performing organisations are not available.

Assessment

Overall, the UK research system appears to function in an efficient manner. Given that the mechanisms by which institutional and project funding are allocated have been in place for considerable time and have remained relatively stable over that time, it may be assumed that they operate in a satisfactory manner. The recent review of the RAE which led the development of the REF (which is overall a very similar mechanism) addressed a number of concerns with regards to the allocation mechanism itself – it did not affect the balance between project and administrative funding. It can also be noted that, where, appropriate, the UK uses an international dimension in its processes of review, peer review and evaluation.

2.5.3 R&I funding

As noted above, UK public funding supports the entire R&DI process from fundamental research to market innovation, through a mix of direct and indirect measures, and through initiatives to improve the overall framework for innovation and research (such as improving access to capital, standards, regulations, etc.).

Encouraging private sector involvement forms part of the Government's overall strategy for innovation. For example, the British Business Bank is in the process of being established as a state-backed economic development bank to ensure the effective operation of finance markets for SMEs. A range of programmes are being delivered through private sector partners, working with the market, rather than replacing it, in order to generate longer term impacts[40]. Government figures state that SMEs received £660m (€825m) in 2013, an increase of 73% on 2012, with 25,000 businesses benefitting from British Business Bank programmes at the end of 2013. Programmes run by the British Business Bank include a number of initiatives across start up, venture capital finance and lending, for example:, Enterprise Capital Funds (private and public equity investments); Investment Programme (investments into providers of debt finance); Enterprise Finance Guarantee (EFG) (encourages lending institutions to lend to viable smaller businesses)[41].

[40] UK NRP 2014
[41] Ibid.

The R&D tax credits are the largest single source of government support for business R&D. These provided almost £1.2bn (€1.5bn) of relief to in excess of 12,000 companies in the financial year ending March 2012. This supported around £11.9bn (€14.9bn) of expenditure, an estimated two-thirds of all business R&D revenue expenditure, reducing the cost of the qualifying expenditure by around 25% for SMEs and around 8% for large companies. In addition, as of 1 April 2013, companies have been able to apply for a lower rate of Corporation Tax on profits earned on patented inventions and certain other innovations. This scheme is being introduced progressively over 5 years: a further cut will be made to the main rate of corporation tax from 23% to 20% in April 2015. Most recently, in the Autumn Statement 2014, it was announced that government will increase the rate of the 'above the line' credit from 10% to 11% and will increase the rate of the SME scheme from 225% to 230%, from 1 April 2015

As noted in Cunningham 2014[42], precise figures are unavailable to be able to provide a clear picture of any trends in the balance of direct versus indirect funding over time, although since there is some evidence that companies, at least in the early stages of the schemes, increased their uptake of the R&D Tax Credits, it is likely that the balance of expenditure has slightly increased in favour of indirect schemes since the introduction of the tax credits. However, as no major new measures have been introduced in recent years and no significant funding increases made to direct measures, it is likely that the overall balance has remained more or less static for the last three years.

The major funding streams and types of innovation funding are presented in the following table.

Table 4: Main innovation funding streams

Type of funding	Scheme	Notes
Stimulation of investment	R&D Tax Credits	see text
Commercialisation of research outputs/Knowledge Transfer	Catapults	Centre bringing business and public sector researchers together to work on late stage R&D projects. 7 open (High Value Manufacturing; Cell Therapy; Offshore Renewable Energy; Satellite Applications; Connected Digital Economy; Future Cities; Transport Systems); 2 due to open 2015 (Energy Systems; Precision Medicine).
	Catalysts	Run jointly by Innovate UK and Research Councils. Cover: Agri-Tech, Biomedical, Energy and Industrial Biotechnology.
	Collaborative R&D	Long-standing TSB/Innovate UK scheme – promotes industry/academia links
	Knowledge Transfer Networks	Long-standing TSB/Innovate UK scheme - addressed to businesses and higher education and research institutes in order to build partnerships and stimulate active participation in the technology transfer network.
	Knowledge Transfer Partnerships	Long-standing TSB/Innovate UK scheme, involving 12 other supporting bodies. – person focused collaborative projects between academic and business partner.

[42] Cunningham, P. (2014) ERAWATCH Country Report 2013: United Kingdom.

Type of funding	Scheme	Notes
	Innovation & Knowledge Centres	Based in universities, these are centres of entrepreneurial excellence which aim to create early stage critical mass in an area of disruptive technology. Seven IKCs have received funding (for 5-years) since 2007.
	Higher Education Innovation Fund	HEFCE (and versions supported by Devolved Administrations) – promotes third mission activities by universities
	CASE awards	Research Council-funded postgrad studentship in partnership with businesses and public sector bodies.
	Knowledge Transfer Accounts	EPSRC scheme, used flexibly by universities, aimed at better exploitation of EPSRC-funded research. [Relatively small scale scheme]
	Knowledge Transfer Secondments	EPSRC - support secondment of EPSRC-funded staff into organisations or to host researchers from industry. [Relatively small scale scheme]
Research infrastructure support	UK Research Partnership Investment Fund	Funding with industrial co-investment for large, long-term capital investments. Extended to 2016-17 with additional £100m per annum.
SME growth support	Innovation Vouchers	Over 1,000 awarded by December 2013 – grants up to €6,250
	Smart	Supports R&D projects in SMEs. Funding doubled in 2012.
	Launchpads	Help technology-themed clusters of young, early-stage companies to develop and grow. 7 set up, 3 more planned in 2014-15.
	Small Business Research Initiative (SBRI)	Use expanded by 6 government departments and the target for the value of contracts is set to increase from £40m in 2012-13 to £100m in 2013-14 and to £200m in 2014-15.
	Manufacturing Advisory Service (MAS	Delivered by consortium, offers a range of assistance from experts to enable SME manufacturers to improve productivity, through a network of regional centres for manufacturing.
Public procurement and demand led innovation	Enterprise Capital Funds	

Type of funding	Scheme	Notes
Financing	UK Innovation Investment Fund	
	Enterprise Finance Guarantee	
	Venture Capital Trusts	
	Business Angel Co-Investment Fund	
	Leveraging of ERDF funding for innovation	

Source: various[43]

2.6 Smart Specialisation (RIS3)

The concept and the fundamentally 'local – global' character of Smart Specialisation have both been acknowledged and accepted by a range of national agencies in the UK. However, it is recognised that an effective system of coordination is required both from the top-down and from bottom up. This involves government working with local partners, such as the Local Enterprise Partnerships (LEPs) (in England) to develop mechanisms for aligning national/local leadership team(s) and decision-making, to ensure that national funding initiatives complement and are complemented by any devolved activities at the local level and that national and regional strengths and challenges are addressed equally.

Many existing UK innovation support activities already fit broadly within the concept of Smart Specialisation and the Government is seeking to identify and fill any gaps or disconnections. In order to provide a framework for these and related activities, the UK Government has published a "Smart Specialisation in England" (BIS, 2014d). Although this document relates only to England, similar documents have been prepared in Scotland, Wales and Northern Ireland. However, the UK Government's view is that, at the UK level, the real value of Smart Specialisation is as an ongoing process of learning, continually driving more productive and sustainable investments in innovation at all levels.

In this context, the role of the UK Innovation and Research Strategy (IRS) acts as a sound base with strong political, institutional and financial backing. These will also be significant partners in terms of matched funding in relation to the EU SIF Funds. Also, in the national context, the UK Industrial Strategy and the recently published Sector Strategies acknowledge the importance of the spatial dimension in influencing growth and innovation policy and the means of its delivery.

The purpose of "Smart Specialisation for England" is five-fold:

- To identify the policies and range of public support available at national and local levels to help businesses invest in innovation, and why and how specific priorities for investment have been made;

[43] In particular, see: https://www.innovateuk.org/our-tools-a-z and Cunningham (2013).

- To help Local Enterprise Partnerships (LEPs) and their partners to identify opportunities to benefit from, and to contribute to, national policies and funding programmes supporting innovation; and to help them identify opportunities to collaborate with other places across England and beyond with similar investment priorities for innovation;
- To inform businesses, universities and others involved in wider research and innovation programmes e.g. Horizon 2020 about the priorities identified by LEPs for the use of European Structural & Investment Funds (ESIF) for England for the period 2014-2020 so that potential opportunities to align activity can be identified
- To support the work of the National Growth Programme Board to oversee the management of the ESIF; and
- To fulfil the requirements of Annex X1 of Regulation (EU) 1303/2013 (BIS, 2014d).

The document makes it clear that different aspects of Smart Specialisation need to be delivered at both national and local levels, for example, measures to increase levels of private sector investment are operated primarily at the national level through the taxation system but LEPs have an important role to play in stimulating involvement and participation from local firms. Collaborative leadership for innovation is also needed at both levels.

Other elements of Smart Specialisation can only best be delivered at the local level. These include:

- strengthening of local innovation 'ecosystem(s)' and building local capabilities;
- supporting local supply chains to invest and collaborate;
- catalysing and leveraging the differing opportunities of social innovation; and
- branding and positioning places as credible centres of smart specialisation.(BIS, 2014d)

LEPs and their partners are strongly encouraged to be part of this strategic policy framework, since this will facilitate access to support from the EU SIF funds (currently over €6.2bn for England for the period 2014-20) for activities that aim to add value to, and also benefit from, nationally funded activities whenever these are delivered at the local level. Other relevant actors at the regional/local level are universities, councils, and various sub-national networks, clusters and alliances – often focusing on particular sectors, functions or client/member groupings. Hence, the recognised need for coordination and capacity at national and local levels and between these levels. Part of the Government's assessment process for local funding will seek to assess the extent to which LEPS have sought to establish strong collaborative leadership. In particular, LEPs have been asked by Government to prepare Strategic Economic Plans which include proposals to support innovation.

As noted elsewhere (section 2.7), the UK already undertakes a range of reviews, monitoring and evaluation procedures at various levels. The complex nature of the 'policy mix' encompassed by the Smart Specialisation concept militates against an overall evaluation framework by which the implementation of Smart Specialisation activities may be assessed. Nevertheless, the current processes of review and evaluation can be utilised to provide evidence on how aspects of Smart Specialisation are progressing. In addition, the Government has set up an Advisory Hub for Smart Specialisation which will gather evidence and help to improve the use of it; share and disseminate best practice, improve

connections between different partners, advise on compliance with ESIF procedures and, through this, support LEPs in delivering stronger collaborative proposals (BIS, 2014).

2.7 Evaluations, consultations, foresight exercises

The UK is recognised internationally as having a well-developed culture of evaluation. This was partially driven by a historical need to apply a greater level of selectivity and prioritisation in the allocation of research funding in the 1970s and 1980s (and to demonstrate efficiency, effectiveness and value-for-money), but it is also coupled to the broader issues of governance such as review and the desire to ensure that policies are appropriate to (and address the issues posed by) the problem for which they have been designed (Cunningham, 2013).

Of particular relevance to the broader context within which evaluation takes place is the underlying performance monitoring system of Public Service Agreements (PSAs) put in place by the Treasury. This serves as a broader mechanism for performance measurement and for monitoring progress against targets. Failure to meet PSAs can affect future budgetary allocations (allocated through three-year Spending Reviews); hence it is in the clear interest of ministry officials to ensure that their policies are designed to effectively and efficiently meet these targets.

In terms of the evaluation of innovation support programmes (including R&D funding programmes) the lead in developing evaluation practice was taken by the DTI, with supporting interest from HM Treasury (the UK's ministry of finance) and the National Audit Office, the Government's financial 'watch dog'. DTI also developed a system of guidance (ROAME-F) as a tool for programme managers which made the provision of advanced plans for monitoring and evaluation a prerequisite for departmental programme support. Thus evaluation became a strongly entrenched policy tool within BIS and the Research Councils. Numerous programmes (either singly or as groups of related programmes) were and are subject to evaluation, either by dedicated bodies within the funding agencies or by external consultancies. A range of stakeholders may be consulted on the technical and operational details of policy measures, depending on the type of measure being designed. For example, fiscal measures will involve major inputs from HM Treasury and the Inland Revenue, while technology transfer measures will take account of the views of business representatives, universities, intermediary organisations, employers' representatives, etc. The way in which this involvement is handled will vary on a case by case basis (Cunningham, 2009).

Since BIS has oversight of the core range of innovation support policies implemented (at least in England), responsibility for oversight of the evaluation of these innovation support instruments now also resides with BIS.

Generally, most evaluations are performed on an interim basis as the primary aim is to gain lessons and feedback on programme performance with a view to making any appropriate changes to their structure and management. Fewer programmes tend to have a restricted lifetime, although these are generally subject to ex post evaluation in order to develop evidence based policy making. As a general rule of thumb, the evaluation budget is around 0.5-1.0% of the total programme budget but this may be higher for smaller programmes (to meet minimum budgetary requirements) and vice versa (as evaluations of large, expensive programmes do not necessarily require higher budgets).

In the definition of research priorities, the Government ensures that it takes the views of a large range of stakeholders (including the private sector) into account. This may be done through foresight exercises (which are now more specific than the broad Foresight exercises of the 1990s), through 'horizon scanning' activities or through invited consultations on a range of documents, such as draft strategies. The Government also consults extensively with a range of stakeholders in the preparation of its STI policies - an example being the recent consultation in advance of the publication of the new 'Our Plan for Growth in December 2014 and the accompanying evidence paper.

The Government adopts an open approach to the publication of the majority of its evaluation activities. many government commissioned evaluations may be located on the Inside Government website, while HM Treasury produces guidelines on evaluation and assessment practice across Government, for example in its Green Book[44].

The March 2014 Innovation Report from BIS contains the latest evidence on innovation activities, compares UK performance against other economies and highlights policy[45]. It draws on a number of sources, including the results of an International Benchmarking of the UK Science and Innovation System[46] published in January 2014. This provides an extensive review of main relative strengths and weaknesses of the UK's science and innovation system.

In February, 2014, BIS published its report into a review of the balance of competences between the European Union and the United Kingdom in the area of research and development[47].

The Director General for Knowledge and Innovation at BIS launched a consultation on the key priorities and challenges for the science and research budget in forthcoming spending decisions for the 2015 to 2016 financial year[48]. Various stakeholders were invited to respond, including the Confederation of British Industry (CBI), the Chief Scientific Advisers Committee, Council for Science and Technology, and the National Academies, together with any further interested bodies. The consultation closed in May 2013.

Following up on the publication of a capital investment framework by the UK Research Councils in 2012, the Government is carried out a consultation with the research community and other stakeholders to identify priorities for investment to 2021. This included both institutional and regional based infrastructures but also where the UK could collaborate on an international basis, either as a host or part funding a facility based elsewhere. The outcome of the consultation was published by BIS in December 2014[49]. The 2014 Science and Innovation Strategy (BIS, 2014) refers to the consultation and notes that £5.9b (c. €7.9b) has been allocated to science capital from 2016 to 2021, marking the

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[44] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

[45] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293635/bis-14-p188-innovation-report-2014-revised.pdf

[46] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277090/bis-14-544-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-bis-analysis-paper-03.pdf.

[47] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/279331/bis_14_592_balance_of_competences_review_government_reponse_to_the_call_for_evidence.pdf

[48] http://www.aab.org.uk/images/sir_john_oreilly_letter%20from_bis.pdf

[49] Outcome of consultation: Creating the future: a 2020 vision for science and research - government response to consultation on proposals for long-term capital investment in science and research: https://www.gov.uk/government/consultations/science-and-research-proposals-for-long-term-capital-investment

"longest commitment to science capital in decades". This will include investment of £2.9b (c. €3.87b) towards scientific grand challenges, including £1b (c. €1.3b) to projects such as a new Polar Research Ship and the Square Kilometre Array. A further £800m (c. €1,067m) will fund new projects, which include the Sir Henry Royce Institute for advanced materials; big data at the Hartree Centre, Daresbury, the European Space Agency programmes (including Britain's lead role in the next European Rover mission to Mars), a new Energy Security and Innovation Observing System, extending the capabilities of the National Nuclear Users Facility, an innovation centre on ageing, in Newcastle and the Alan Turing Institute.

The Government has asked the leading technology entrepreneur Hermann Hauser to undertake an independent examination of how the government's network of elite technology and innovation centres (Catapults) can be fully exploited to benefit the economy in the long term. The review was completed in May 2014 and its findings published[50]. Essentially, the review calls for continued Government commitment, including increased funding, to the Catapults and to their expansion (to a target population of 30 by 2030), while the catapults should seek further integration with regional innovation actors and develop improved sets of key performance indicators by which their progress may be assessed.

In the Devolved Administrations, Scotland launched a new framework for Entrepreneurship and Innovation in November 2013: "Scotland Can Do" sets out the priorities to become a world-leader in entrepreneurship and innovation, including a commitment of £3m (€3.75m) for projects to accelerate economic growth.

In July 2013 the Welsh Assembly launched Innovation Wales, a strategy produced according to the principles of 'Smart Specialisation'. This underwent international peer review by members of the Smart Specialisation Platform at a meeting in Brno in July 2013.

[50] https://www.gov.uk/government/publications/catapult-centres-hauser-review-recommendations

3. National progress towards realisation of ERA

Information on ERA Priority 1 is provided in Chapter 2

Information on knowledge transfer and open innovation (part of ERA Priority 5) is provided in chapter 4.

3.1 ERA priority 2: Optimal transnational co-operation and competition

The UK is an active and leading participant in several transnational initiatives that aim to promote information sharing, the development of joint research agendas, joint calls and joint programming. Examples include its participation in Joint Programming Initiatives (JPIs) and ERA-NET activities. These align closely to national programmes, some of which address grand challenge issues and which are operated by the UK Research Councils, although the latter are more fully tailored to the national research capability and to priority UK concerns. UK Government representatives and other interested parties are active participants at a number of levels of EU policymaking concerning the complementarity of EU and national activities. Examples here include representation on bodies/initiatives such as the Open Research Area in Europe for the Social Sciences (ORA), where national proposals are administered by the ESRC, membership of Science Europe (with representation from all the UK Research Councils) and of the Global Research Council (again through UK Research Council participation).

The UK government is also participating in discussions towards increasing international participation in European initiatives and in evolving mechanisms for the interoperability of non-EU or Associated country participation in national programmes. In addition, the UK has several bi- and multi-lateral S&T agreements with global partners.

National funding is allocated according to a number of strategic criteria, largely defined by nationally-oriented priorities and demands, although the presence of European funding opportunities and activities will be taken into consideration, particularly when formulating the modalities through which funding to UK researchers may best be undertaken.

International peer review and best practice is already fully integrated into the evaluation and assessment systems and processes operated by the range of funding agencies in the UK, including those in the not-for-profit sector. However, national funding in the UK is allocated only on the basis of evaluations conducted at the behest and under the frameworks prescribed by UK funding bodies. Possible exceptions to this include international programmes which may require partial co-funding by UK bodies but where external evaluation processes are accepted (e.g. EU funding).

3.2 ERA priority 3: An open labour market for researchers. Facilitating mobility, supporting training and ensuring attractive careers

3.2.1 Introduction

The UK is characterised by a high degree of institutional autonomy with regard to the mobility, appointment, training and career enhancement of researchers.

There were 259,347 full-time equivalent (FTE) researchers in the United Kingdom in 2013. This represents 8.6 researchers per 1000 labour force compared with an EU average of 7.4. The total number of researchers has grown steadily for several years, although it fell slightly in 2008 and again in 2011 (ONS).

3.2.2 Open, transparent and merit-based recruitment of researchers

UK HEIs have full autonomy in the design and implementation of their recruitment policies, although they are required to publish all relevant policies on their websites. Recruitment for new staff follows institutional guidelines and any additional stipulations set by the funding source (for example, Research Council grants). The UK higher education funding bodies encourage action to ensure openness and competitive recruitment processes – e.g. the Higher Education Funding Council for England (HEFCE) encourages institutions to have formal human resources strategies and provides funding to support these strategies under the Rewarding and Developing Staff in HE initiative. HEFCE also encourages institutions to develop recruitment and retention schemes.

The UK research base is very open and has been visibly successful in attracting researchers from both EU and other countries. For example, 12.9% of those studying at doctoral (research) level in the UK are from EU Member States and 28% are from other countries. There are also significant numbers of early career researchers, academic post holders and research fellows from other countries. Overall student numbers for 2010-11 show that there were 2,061,410 from the UK, 132,550 from other EU member states and 302,680 from the rest of the world (over half of these – 188,525 – coming from China or India) (European Commission, ERA Communication Fiche 2014).

In addition, the UK approach to open appointments, support for career development and other matters recognised as making a research career more attractive generally constitutes best practice. This approach is set out in the UK's Concordat to Support the Career Development of Researchers, which is referenced in the ERA Communication as an example of a Member State transposing the Charter and Code into their national contexts with notable results. Other measures include the dedicated web-based recruitment site (www.jobs.ac.uk): posted advertisements are accessible worldwide and the site is subscribed to by the major research actors in the UK, as well as European, North American and Commonwealth Universities. Many UK research institutions also advertise vacancies through the EURAXESS jobs website[51].

The UK meets the majority of the criteria for Transparent, Open and Merit-based recruitment, the only exceptions being the publication of the composition of selection

[51] http://ec.europa.eu/euraxess/index.cfm/jobs/

panels (although, where such publication does not occur, information would be made available to the applicant) and the right to appeal (which is nonetheless granted in the case of alleged discrimination).

UK HEIs and Public Sector Research Establishments (PSREs) are also afforded the necessary autonomy to organise their activities in the areas of education, research, and innovation. They are able to draw on a number of income streams that includes alternative sources of funding such as philanthropy (the UK medical charities represent a major source of research funding) and commercial activities, together with income from endowments and investments.

There are no major apparent institutional barriers that hinder access to the labour market by foreign researchers and language barriers tend to be minor: in fact, the English language is seen to be an attractant for researchers from overseas. While calls for greater restrictions on the granting of visas for foreign workers and students, prompted both by concerns over terrorism and levels of immigration have led to debate over their implications for UK university recruitment, UK universities have emphasised the value of both overseas students and staff in order to ensure that potentially deleterious effects of any policies for visa restrictions are ameliorated[52]. In addition, since April 2014, Research Councils UK has been cooperating with the Royal Society, British Academy and Royal Academy of Engineering, in the piloting of a streamlined endorsement process in order to make it easier for outstanding international researchers who have been awarded Research Councils funded fellowships to obtain a Tier 1 Exceptional Talent visa[53].

An international benchmarking report from BIS (2014) notes that "the UK's main strengths include an ability to attract international students, a large number of doctorate holders and a rapidly growing population with tertiary education. This suggests good availability of human capital at the high end of the educational spectrum". In addition, the UK National Action Plan on researcher mobility and careers within the ERA (2009) points out that the UK research base is already one of the most open in the world both as regards recruitment of researchers and scientific collaborations (over 40% of UK scientific papers now have one or more non-UK co-authors)[54] and the UK Government funds a number of dedicated fellowship schemes which seek to attract the best early career researchers from around the world to UK institutions. The majority of the fellowships are open to UK and overseas candidates regardless of nationality, and candidates are assessed in competition with each other (Deloitte, 2014).

In terms of outward mobility, many of the UK Research Council fellowships have a strong international element and international collaboration is actively encouraged as part of the process of building an international reputation. Many awards include the option of undertaking research training outside the UK.

Figures from the Higher Education Statistics Agency (HESA)[55] note that while a large proportion of students studying in the UK (2012/13) were domiciled in the UK before they entered Higher Education (81.8%), a further 5.4% were from other countries within the EU

[52] For example, see: http://www.universitiesuk.ac.uk/highereducation/Pages/PresidentsAddress2013AnnualConference.aspx
[53] http://www.rcuk.ac.uk/media/news/140403/
[54] International Comparative performance of the UK research Base – Elsevier. Available at: http://www.bis.gov.uk/assets/biscore/science/docs/i/11-p123-international-comparative-performance-uk-research-base-2011
[55] https://www.hesa.ac.uk/content/view/3129/#eth

and 12.8% were from countries outside the EU. The proportion for postgraduate students is higher: "over half (57.2%) were from outside the UK, with 45.6% of full-time postgraduates coming from outside the EU. Non-UK postgraduate students were prominent on full-time research degree courses (48.6%) and even more so on full-time taught higher degree courses (71.1%)".

Finally, in 2012, 28% of UK researchers were employed on fixed-term contracts, compared to an EU average of 34.3% (Deloitte, 2014). HESA data indicates a slightly different picture within the HE sector: 119,595 (64.4%) of UK academic staff were employed on open-ended or permanent contracts in 2012 compared to 115,680 (63.8%) in 2011 and 35.6% were employed on fixed term contracts compared to 36.2% in 2011[56].

According to a survey (MORE 2 Survey, 2012), 78 % of university-based researchers were satisfied with the extent to which research job vacancies are publicly advertised and made known by their institution[57].

3.2.3 Access to and portability of grants

With regards to access to cross-border grants, the majority of the Research Council and other fellowships are open to UK and overseas candidates regardless of their nationality: applicants are assessed in competition with each other (Deloitte, 2014).

Regarding the portability of grants, researchers of all nationalities, who have been appointed to an eligible research post at a UK University, can apply for a Research Council grant. Grant portability is a matter for the individual UK funding agencies in collaboration with their partners elsewhere. Individual UK Research Councils have bilateral arrangements which allow for grant portability with specific partner research funding bodies both within Europe and beyond. Individual UK Research Councils have signed the EUROHORCS 'Money follows researcher' letter of intent, which allows them to create bilateral arrangements with foreign universities within Europe and beyond, and accept grant portability with homologous research funding bodies[58]. In addition, the Academic Visitor Visa programme allows academics from overseas to travel to the UK for up to 12 months (including multiple entries) when taking part in formal exchange agreements with UK counterparts or carrying out research whilst on sabbatical leave from their home institution.

3.2.4 EURAXESS

The UK Government supports the development of the EURAXESS web portal and network as a source of information and services to researchers across Europe and beyond. The EURAXESS-UK portal provides practical information for researchers moving to the UK and is managed by the British Council and funded by the Department for Business, Innovation and Skills (BIS). The UK portal offers specific reports and guidance to assist foreign researchers in making their choices on UK research careers and study. It offers a range of online services including:

- Current research vacancies in the UK

[56] https://www.hesa.ac.uk/sfr198

[57] European Commission, European Research Area, Facts and Figures 2013.

[58] As EUROHORCS no longer exists, Research Councils are in the process of signing up to the Science Europe Money follows researcher letter of intent.

- Links to further online job websites
- Searchable funding opportunities database
- Information on living in the UK (healthcare, accommodation, legal issues, etc.)
- Guides to the UK research landscape
- Guidance on leaving the UK
- Guidance for international researchers
- Other useful links.

Although the UK has no Euraxess Service Centres, a network of EURAXESS Local Contact Points is being developed to provide assistance and support to staff coming to or leaving their local institution. Twenty-six of these contact points are so far in operation in HEIs across England, Scotland, Wales and Northern Ireland (European Commission, ERA Communication Fiche, 2014).

In 2013, the number of researcher posts advertised through the EURAXESS Jobs portal in the public sector was 54.8 per thousand researchers in the public sector in the United Kingdom compared with an EU average of 43.7. The UK is the top country in terms of jobs published on EURAXESS, and the total number of jobs posted was 8,668 over the whole of 2013, a slight decrease compared to 2012, when the total number of vacancies published was 9,354 (Deloitte, 2014).

3.2.5 Doctoral training

All UK Research Councils base the allocation of funding for doctoral training on the quality of applications. This is a result of the need for prioritisation and a firm policy objective of improving the quality of doctoral training in the UK and striving for excellence. The umbrella body for the UK Research Councils, Research Councils UK, has developed a Statement of Expectations for Doctoral Training[59] which lays out common principles for the support of all Research Council students. These principles are aligned with the seven principles for Innovative Doctoral Training[60] (Deloitte, 2014).

Although there are no specific individual measures that address the principles for Innovative Doctoral Training as stipulated by the ERA Communication, the practices and principles espoused by the Research Councils for the recruitment and training of researchers (for example, the Terms and Conditions of Research Council Training Grants) collectively address the full range of the ERA Communication's principles and set out conditions that must be adhered to by grant-holding institutions. Similarly, the QAA Code of practice includes a joint statement of skills that doctoral research students funded by the Research Councils are expected to develop during their research training.

In addition, the Concordat to Support the Career Development of Researchers (see below) states that "Researchers are equipped and supported to be adaptable and flexible in an increasingly diverse, mobile, global research environment" (Principle 3) and recognises the need to support researchers in developing professional skills that they will need to be both effective researchers and highly skilled professionals in whatever field they choose to enter. Signatories to the Concordat have also committed to ensure that "the importance of

[59] http://www.rcuk.ac.uk/researchcareers/postgrad/Pages/home.aspx
[60] http://ec.europa.eu/euraxess/pdf/research_policies/Principles_for_Innovative_Doctoral_Training.pdf

researchers' personal and career development, and lifelong learning, is clearly recognised and promoted at all stages of their career" (Principle 4).

The UK Research Councils use three major mechanisms to support doctoral training comprising Doctoral Training Partnerships (DTP), Centres for Doctoral Training (CDT) and Collaborative Studentships (e.g. CASE awards)[61]. Doctoral Training Partnerships provide training for students across a broad range of subjects determined by a Research Organisation or consortia of Research Organisations. Partnerships involve strategic engagement between the Research Organisation(s) and the Research Council funder(s) in developing the overall programme of training. The DTP model is used by all seven UK Research Councils.

Centres for Doctoral Training were first established by the Engineering and Physical Sciences Research Council (EPSRC) which funds the majority of these centres. More recently, the Arts and Humanities Research Council (AHRC) and the Natural Environment Research Council (NERC) have also adopted the DTC model. Some DTCs are associated with the themes of the RCUK cross-cutting programmes and some are joint between EPSRC and one of the Medical Research Council (MRC) Biotechnology and Biological Sciences Research Council (BBSRC) or the Economic and Social Research Council (ESRC). Each CDT involves a UK university (or a small number of universities) in delivering a four-year doctoral training programme to a significant number of PhD students organised into cohorts. Each Centre targets a specific area of research, and also emphasises transferable skills training.

Collaborative Training provides doctoral students with a first-rate, challenging research training experience, within the context of mutually beneficial research collaboration between academic and partner organisations in the private, public and civil society sectors. The term 'industrial' is sometimes used as a short-hand for these awards, although they are relevant to all non-academic partners including industry, business, public and third/civil society sectors.

3.2.6 HR strategy for researchers incorporating the Charter and Code

The UK has endorsed the principles of the Concordat to Support the Career Development of Researchers, along with the QAA Code of Practice for research degrees.

The UK Quality Assurance Agency (QAA) for Higher Education aims at "safeguarding standards and improving the quality of UK higher education". The UK Quality Code for Higher Education (the Quality Code 2012/13) has replaced the previous Code of Practice introduced in 2004 and is used to assure the standards and quality of UK higher education. Its purpose is to:

- Safeguard the academic standards of UK higher education;
- Assure the quality of the learning opportunities that UK higher education offers to students;
- Promote continuous and systematic improvement in UK higher education; and
- Ensure that information about UK higher education is publicly available, (including selection and admission criteria, skills development, etc.).

[61] http://www.rcuk.ac.uk/RCUK-prod/assets/documents/skills/RCUKCommonTerminologyforPostgraduateTraining2013.pdf

In addition, the Concordat to Support the Career Development of Researchers (2008) constitutes an agreement between the employers (universities) and research funders (Research Councils, funding councils, major charities, etc.) on good management and quality working conditions for research staff.

A UK-wide process enables UK HEIs to gain the European Commission's HR Excellence in Research Award, which acknowledges their alignment with the principles of the Charter and Code. The UK process incorporates both the QAA Code of Practice for Research Degree Programmes and the Concordat to Support the Career Development of Researchers to enable institutions that have published Concordat implementation plans to gain the award. The UK approach will include on-going national evaluation and benchmarking. As of early 2014, 89 UK HEIs have now qualified for HRS4R acknowledgement and the European Commission's "HR Excellence in Research" badge[62].

The UK is content that discussions concerning Commission action on the open labour market priority to address what are seen as social security barriers for researchers should focus on high mobility groups as a whole rather than seeking to treat researchers in isolation. On pension arrangements, researchers in the UK have access to private pension arrangements and may transfer their pensions to another pension arrangement abroad, subject to tax requirements.

Of particular relevance is the organisation 'Vitae': This is a network-based organisation, consisting of a central team based in Cambridge and a series of 8 regional Hubs throughout the UK and international networks. It has the mission to lead world class career and professional development of researchers. Vitae works in partnership with HEIs, research organisations, funders, and national organisations to meet society's need for high-level skills and innovation and produce world-class researchers. Vitae is supported by RCUK and the UK HE funding bodies, namely: Department for Employment and Learning Northern Ireland (DELNI), Higher Education Funding Council for England (HEFCE), Higher Education Funding Council for Wales (HEFCW) and the Scottish Funding Council (SFC). It is managed by CRAC, the Career Development Organisation and is delivered in partnership with regional Hub host universities.

A three-year review of the implementation of the Concordat, in March 2012, noted that, although a a voluntary instrument, the Concordat was having a significant impact within the HE sector. The intention to implement the principles of the Concordat is now widespread in institutions, and the corresponding infrastructure is increasingly in place. The extent and depth of implementation is greatest for the principles on recruitment and selection, recognition and value, and equality and diversity (Deloitte, 2014).

3.2.6 Education and training systems

The UK Government has a well-defined and long term skills agenda for researchers. Some £120m (c. €141.3m) in ring-fenced funding has been allocated by the Research Councils to this objective since 2003 and, as of March 2011, funding has been embedded in normal funding (i.e. PhD fees and indirect costs on research grants).

[62] https://www.vitae.ac.uk/policy/hr-excellence-in-research

A survey, in 2013, points towards significant progress in embedding implementation of the Researcher Development agenda and its funding into HEI processes[63]. However, while RCUK will continue to highlight the importance of Researcher Development, ultimately it is the responsibility of institutions to develop effective and employable researchers. A significant aim will be to embed the monitoring of researcher development into the RCUK Assurance Programme.

Vitae (see above) works with the HE sector in providing professional and career development for researchers and building international competitiveness through research, innovation and knowledge exchange. Vitae takes the lead in promoting improvement in "the employability and impact of researchers, to ensure that they are equipped to address research challenges and enhance the UK's economic, social and cultural capital. The Vitae programme provides national leadership and strategic development, and works with HEIs, policy makers, stakeholders, employers and individual researchers. In 2010, Vitae launched the new Researcher Development Framework (RDF). The RDF has been endorsed by thirty major UK organisations (e.g. Funding Councils, Research Councils, Quality Assurance Agency, teaching unions and Universities UK) who are involved in knowledge exchange and the development of a strategic agenda to train and support high level researchers to further improve their skills competencies". The RDF is currently being implemented in UK HEIs and underpins the professional development of researchers. Vitae have produced stakeholder briefings, an online RDF Planner for universities and researchers, and guidance on how to map training exercises, courses and programmes to the Framework (Deloitte, 2014).

The RDF is structured into four domains covering the knowledge, behaviours and attributes of researchers. It sets out the wide-ranging knowledge, intellectual abilities, techniques and professional standards expected to do research, as well as the personal qualities, knowledge and skills to work with others and ensure the wider impact of research. Within each of the domains there are three sub-domains and associated descriptors:

- Domain A: Knowledge and intellectual abilities: The knowledge, intellectual abilities and techniques to do research
- Domain B: Personal effectiveness: The personal qualities and approach to be an effective researcher
- Domain C: Research governance and organisation: Knowledge of the professional standards and requirements to do research
- Domain D: Engagement, influence and impact: The knowledge and skills to work with others to ensure the wider impact of research[64]

[63] http://www.rcuk.ac.uk/RCUK-prod/assets/documents/skills/institutionalresponsesfundingresearcherdevelopmentVitae2013.pdf
[64] https://www.vitae.ac.uk/researchers-professional-development/about-the-vitae-researcher-development-framework/developing-the-vitae-researcher-development-framework/

3.3 ERA priority 5: Optimal circulation and access to scientific knowledge

3.3.1 e-Infrastructures and researchers electronic identity

Both the UK Research Councils and British industry recognise the importance of digital infrastructures and the positive impact they may have on the economy and on employment. In November, 2011, the UK published a Strategic Vision for UK e-Infrastructure[65] and is in the process of investing £165m (c€200m) to strengthen the UK's e-infrastructure in collaboration with industry. The report also notes that "the UK Government is currently spending approximately £200m p.a. (c. €256m) on aspects of e-infrastructure to support the academic community".

Specific measures include the Research Councils' Gateway to Research which aims to provide a mechanism for businesses (particularly innovation intensive SMEs) and other interested parties to identify potential partners in universities to develop and commercialise knowledge, and maximise the impact of publicly funded research (see Section 3.3.2).

The UK Government has set up (in March 2012) an e-infrastructure Leadership Council (ELC) to advise on all aspects of e-infrastructure including networks, data stores, computers, software and skills. RCUK is also currently developing its own complementary integrated set of priorities for e-infrastructure for research, and will work closely with the ELC to ensure linkage. Six areas are being tackled: Computer systems, software, data, skills, authentication and security, and networks. The UK National Research and Education Network, Janet, is a specialised internet service provider dedicated to supporting the needs of the research and education communities within the country. Jisc (formerly the Joint Information Systems Committee but now a private entity with charitable status) has also launched the UK Access Management Federation for Education and Research, which provides a single solution to accessing online resources and services for education and research.

Concerning the preservation of scientific information, the UK is at the forefront of advancing this topic within Europe. The UK Research Councils have already invested in a number of successful repositories. Notable examples include the Economic and Social Research Council's Research Catalogue funded by the Medical Research Council, the Biotechnology and Biological Sciences Research Council, the Chief Scientist's Office, part of the Scottish Government Health and Social Care Directorates and other funding bodies. No new data will be added to the catalogue from May 2014; in future, the RCUK Gateway to Research[66] will provide details of more recent grants and outputs.

The Research Councils operate a Gateway to Research which aims to provide a mechanism for businesses (particularly innovation intensive SMEs) and other interested parties to identify potential partners in universities to develop and commercialise knowledge, and maximise the impact of publicly funded research. The initiative is being developed as part of the BIS Innovation and Research Strategy. The live system was launched at the end of 2013. It may be accessed at: http://gtr.rcuk.ac.uk/

[65] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32499/12-517-strategic-vision-for-uk-e-infrastructure.pdf
[66] http://gtr.rcuk.ac.uk/

The goal of Gateway to Research is to give the public better access to information on research funded by the Research Councils, particularly information such as:

- who, what and where the Research Councils fund and
- the outcomes and outputs from Research Councils' funding, linking to already available open access repositories and/or data catalogues.

It also contains information on the outcomes, outputs and impact held on RCUK's Research Outcomes System (ROS)[67] and the Medical Research Council's ResearchFish[68], and links to other available open access repositories and data catalogues. Moves are currently underway, as part of RCUK's Research Outcomes Harmonisation Project, to bring together the Research Council facilities into a single source – all seven Research Councils now use ResearchFish, and it is currently used by over 90 research funders to gather information from researchers about the outcomes of their work.

3.3.2. Open Access to publications and data

The UK Government announced in July 2012 that it will make publicly funded scientific research available for anyone to read for free, by accepting all of the recommendations in the independent report on open access – the Finch Report[69], published in June 2012. The report concluded that the most effective way to deliver OA was through the 'gold' open access model in which Article processing Charges (APCs) are paid upfront to cover the costs of publication. Arrangements are being put in place to make publicly funded scientific research available for anyone to read for free: around 45% of such research will be available in 2013-14, increasing to over 50% in the following year. The Finch working group undertook a review of progress in implementing the report's recommendations in November 2013[70]. According to data from the European Commission[71], the UK is one of the EU countries that least uses Gold Access journals (7.2%), although its overall access percentage is 55.9%, which places it eight overall in the EU27.

Recent major policy developments include the announcement in September by the leading UK medical charities (Arthritis Research UK, Breast Cancer Campaign, the British Heart Foundation, Cancer Research UK, Leukaemia & Lymphoma Research and the Wellcome Trust) of the Charity Open Access Fund (COAF)[72]. This has been established for an initial two-year period, and will operate in a similar way to the Wellcome Trust's established scheme of block grants to institutions to meet the costs of APCs for articles arising from projects funded by one of the consortium partners.

For universities, publishers, and other agencies, the major development concerns preparations for implementing the policies for OA in the next Research Excellence Framework, which take precedence over other policies. In parallel, these stakeholders have provided evidence to the independent review of the implementation of RCUK's OA policies[73]. RCUK's policy statement declares that "Free and open access to publicly-funded

[67] http://www.rcuk.ac.uk/research/researchoutcomes/
[68] http://www.mrc.ac.uk/funding/guidance-for-mrc-award-holders/researchfish/
[69] http://www.researchinfonet.org/wp-content/uploads/2012/06/Finch-Group-report-FINAL-VERSION.pdf
[70] http://www.researchinfonet.org/wp-content/uploads/2013/02/Final-version.pdf
[71] http://science-metrix.com/files/science-metrix/publications/d_1.8_sm_ec_dg-rtd_proportion_oa_1996-2013_v11p.pdf
[72] http://www.wellcome.ac.uk/About-us/Policy/Spotlight-issues/Open-access/Charity-open-access-fund/index.htm
[73] http://www.rcuk.ac.uk/research/openaccess/2014-independent-review-of-implementation/

research offers significant social and economic benefits. The Government, in line with its overarching commitment to transparency and open data, is committed to ensuring that such research should be freely accessible. As major bodies charged with investing public money in research, the Research Councils take very seriously their responsibilities in making the outputs from this research publicly available – not just to other researchers, but also to potential users in business, charitable and public sectors, and to the general public"[74].

The UK Government agrees that support for OA publication should be accompanied by policies to minimise restrictions on the rights of use and re-use, especially for non-commercial purposes, and on the ability to use the latest tools and services to organise and manipulate text and other content. Where APCs are paid to publishers, the Government expects to see unrestricted access to, and use of, the content.

According to the UK Open Access Implementation Group, a consortium which includes the Research Councils, Universities UK, Research Libraries UK, the Wellcome Trust and a small number of universities, "a range of public and private sector organisations are committed to Open Access, and have (as appropriate) OA policies, statements of principle or relevant business models that are wholly supportive of OA. This, on its own, has not yet been sufficient to see a major shift toward OA in the UK higher education sector, despite the clear benefits that such a shift would bring. It is proposed that more effective and regular coordination between these organisations will lead to a significantly increased rate of movement toward OA in UK higher education".

The coverage of OA costs varies according to the body concerned. For example, the Wellcome Trust "will provide grant-holders with additional funding, through their institutions, to cover open access charges, where appropriate, in order to meet the Trust's requirements" , while "Funding for Open Access arising from Research Council-supported research will be available through a block grant awarded directly to research organisations". Furthermore, "RCUK will undertake a comprehensive, evidence-based review of the effectiveness and impact of its Open Access policy in 2014 and periodically thereafter (probably in 2016 and 2018)". The review was published in March 2015[75]. However, since the impact of OA policy on different disciplinary areas is likely to be varied, RCUK will permit different embargo periods across the disciplines supported by the Research Councils and will consider these differences when monitoring the impact of the policy and when looking at compliance.

[74] http://www.rcuk.ac.uk/research/openaccess/
[75] http://www.rcuk.ac.uk/research/openaccess/2014review/

4. Innovation Union

4.1 Framework conditions

The UK does not articulate strategic actions for research and innovation in the context of legislative frameworks. The Government sets the overall framework conditions for economic growth, which includes business prosperity and investment, through its economic strategy. This was set out in the June Budget 2010 and more recently carried out by the Autumn Statement 2013 and Budget 2014. In parallel, the Devolved Administrations are also taking action to tackle structural reform challenges in areas of devolved competence. These include:

The Northern Ireland Executive's Programme for Government, Economic and Investment Strategies and, most recently, Together: Building a United Community;

- The Scotland's Government Economic Strategy (GES); and
- The Welsh Government's Programme for Government.

Alongside these, government acts to ensure that corporation tax rates remain competitive and that the UK as a whole remains an attractive place to do business. A range of fiscal incentives, supply-side measures and incentives to improve access to finance are in place, involving a mix of public and public-private initiatives. In comparison to supply-side measures, there are a limited number of demand-side measures in place, partly since their role in addressing market and system failures and in stimulating innovation remains to be fully understood and proven.

The overall strategy for research and innovation, including business support is embodied in the 2011 Innovation and Research Strategy for Growth[76], which sets out the government's approach to boosting business investment in innovation and ensuring the UK's success in the global economy. A new strategy for research and innovation was released in late 2014.

4.2 Science-based entrepreneurship

The creation of science and technology parks, incubators and similar activities are largely the responsibility of the founding organisations – typically universities in partnership with local or regional authorities, development organisations and others. These are organised on a local or regional level, although some government support may be available. Government support for young innovative companies can take a range of forms, including finance, advisory and other services: these are generally covered in the available suite of SME support initiatives (see Section 4.5).

The UK Science Parks Association lists over 100 locations in the UK (including Science, Research and Technology Parks, Technology Incubators and Innovation Centres) as its members. These provide the environments for 4,000 companies employing around 75,000 people[77].

At a more general level, in 2012 the Government introduced Start Up Loans to provide finance and mentoring to young entrepreneurs. By 2013, over £45m (€56.25m) of loans had been made to 10,000 entrepreneurs and the Government has pledged a further

[76] https://www.gov.uk/government/publications/government-innovation-and-research-strategy
[77] http://www.ukspa.org.uk/members#sthash.oyKRXYRv.dpuf

£160m (€200m) to the scheme and extended it people of all ages. It is also now quicker and easier to register a business for tax: a new start-up can register as a limited company online in less than a day and the need for capital requirements has been removed.

4.3 Knowledge markets

The UK's Intellectual Property Office (IPO) is responsible for the intellectual property (IP) framework in the United Kingdom for patents, trademarks, designs and copyright. An effective and fair IP framework is essential to support the translation of the results of research into innovative products, processes and services: the UK IPO has "a strong international reputation for the quality of the services [it delivers] and the contribution [it makes] to international thinking on global and European IP policy challenges"[78]. The UK IPO is an executive agency of BIS. Its aim is to "promote innovation by providing a clear, accessible and widely understood IP system, which enables the economy and society to benefit from knowledge and ideas". It offers a range of support services, which together with its overall strategy, are detailed in its corporate strategy[79].

In addition, the Lambert toolkit for IP offers guidelines for universities and companies that wish to undertake collaborative research projects.

4.4 Knowledge transfer and open innovation

The challenge of translating the results of publicly supported R&D into commercial products, process and services has led to the development of an extensive range of long-standing measures to promote science-industry collaboration. To this has been added new cluster-type measures (such as 'Catapults', Knowledge and Innovation Centres and Research and Innovation Campuses) and other incentives, which address a range of actors, through a broad variety of modalities to promote and sustain collaboration for innovation. As might be expected, the complexity of the innovation process which engages a diverse set of actors along its timeline and the periodic assessment of the impact of government interventions has led to the development of a comprehensive set of measures. Evidence suggests that these measures have been successful – indeed the longevity of several of them (albeit subject to some modification) points towards them having received positive appraisals during their lifetime. Examples of long-standing measures include Knowledge Transfer Partnerships, Collaborative R&D, Knowledge Transfer Networks and Research Council CASE awards. New measures would include the funding for the Catalysts. Moreover, the Research Councils support substantial translational activity including following on funding, IKCs and research and innovation campuses, together with support for university-business collaboration to help ensure the future uptake of research outputs: for example, the launch of the Gateway to Research in 2013 aims to encourage university-business connections.

In 2012, the Government commissioned a review of business-university links by Sir Tim Wilson[80]. The report made a number of broad ranging observations and recommendations

[78] http://www.ipo.gov.uk/about-plan2014.pdf
[79] http://www.ipo.gov.uk/ipostrategy.pdf
[80] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32383/12-610-wilson-review-business-university-collaboration.pdf

for government, business and universities. In response to the report, the Government produced a report on how these recommendations could be taken further and developed and on the actions it was already taking[81]. Essentially, the Government concluded that many of its actions were already fulfilling or working towards the Wilson recommendations, including developments in HE policy, training and knowledge transfer and acknowledges that further action was necessary to maintain UK performance in this area.

In October 2013, under the banner 'Innovation Scotland', Scotland launched the Single Knowledge Exchange Organisation (SKEO) and in November 2013, it launched a new framework for entrepreneurship and innovation in November 2013 called Scotland Can Do. It also runs Interface, a free, national service which match-makes businesses with research resources in Scotland's universities and research centres with the aim of supporting the establishment of a number of Innovation Centres where businesses and universities can work together. In addition, the Northern Ireland Executive has been working on the development of Competence Centres.

In terms of the requested measures, few statistics are available in the public domain, or are captured at an aggregate level (it is debateable if any are captured at the institutional level). However, the Higher Education Funding Council for England (HEFCE) commissions an annual survey of related KE/KT indicators in its Higher Education-Business and Community Interaction (HE-BCI) Survey[82]. This examines "the exchange of knowledge between universities and the wider world, and informs the strategic direction of 'knowledge exchange' activity that funding bodies and higher education institutions (HEIs) in the UK undertake".

[81] Following up the Wilson review of business-university collaboration: Next steps for universities, business and Government. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/32399/12-903-following-up-wilson-business-university-collaboration-next-steps.pdf

[82] http://www.hefce.ac.uk/whatwedo/kes/measureke/hebci/

% researchers in public organisations with experience in private sector	not collected
share of doctorate holders employed in BE sector	not collected
share of professors whose primary occupation is in industry, not in HEIs/RPOs	not collected
number of researchers benefiting from academia-industry research placement/exchange contracts	not systematically collected – institutional level
academia held patents licensed/sold to industry	955 (HE-BCI 2012/13)
- number of invention disclosures;	4,300 (HE-BCI 2012/13)
- number of patent applications by RPOs	1,942 (HE-BCI 2012/13)
no. of start-ups (incl. turnover and survival rate) stemming from public-private cooperation	
- staff startups (created, active after 3 yrs, active, turnover)	62, 298, 432, £91.5m
- graduate startups (created, active after 3 yrs, active, turnover)	3,502, 3,270, 8,127, £376.4m
no./volume of "partnership" and joint collaborative research agendas signed between the public and private sector (inc. public funds)	£951m
other public research commercialisation indicators (e.g.: licensing fees, etc.) - contract research - courses for business/community - consultancy income - Facilities and equipment related services - IP income	 £1,166.8m £653.3m £400.0m £141.4m £86.6m
Science, Research and Technology Parks, Technology Incubators and Innovation Centres	100+ (UKSPA) 4,000 companies 75,000 employees

Source: all data HE-BCI 2012/13.

The 2014 BIS Annual Innovation Report[83] notes that "'Open innovation' where firms and other stakeholders collaborate to develop new ideas is an area of increasing policy interest. This is because innovation entails problem-solving, and this frequently involves problems that are outside the existing capabilities of businesses". However, this forms the only mention of the term, possibly since there is extensive academic debate concerning the distinction between 'open innovation' and long standing modes of collaboration. Typically, policy documents tend to assume that the terms collaboration and knowledge exchange are sufficient.

[83] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293635/bis-14-p188-innovation-report-2014-revised.pdf

4.5 Innovation framework for SMEs

Support for SME growth is a major priority in UK innovation policy. The specific tax credits scheme for SMEs provides a major focus of policy support and this is reinforced by a range of more tailored schemes of R&D support which address the specific needs of SMEs. There has also been an increase in policy attention on a range of schemes aimed at mobilising financial support and investment – more recently, these schemes have received even greater attention in response to the need to protect newly created and developing small companies from the effects of the financial downturn. Measures aimed at the creation of start-ups and spin-offs also exist under the broad challenge of increasing the transfer of research results into economic outputs. Examples of SME-focused measures include both direct support and measures to stimulate cooperation and knowledge sharing. Some of the main instruments are:

- R&D Tax Credits for SMEs (indirect support)
- Smart (direct support for R&D)
- Business Coaching For Growth; Manufacturing Advisory Service; Business Link; GrowthAccelerator; OpentoExport (Advisory support and capacity building)
- Enterprise Capital Funds; UK Innovation Investment Fund; Enterprise Finance Guarantee; Venture Capital Trusts; Business Angel Co-Investment Fund; Enterprise Investment Scheme; Seed Enterprise Investment Scheme; Business Growth Fund (Improvement of access to finance – particularly to mitigate effects of economic downturn).
- Leveraging of ERDF funding for innovation (targeted at firms in economically challenged areas)
- Innovation Vouchers (Access to range of services from science base providers)
- Launchpad (Targets SMEs in clusters)
- Small Business Research Initiative (Encourages SMEs to access government departmental procurement funding – demand-side measure)

Overall, SME support is delivered through a multimodal and flexible range of support measures addressing the spectrum of SME needs at both national and targeted regional/local levels. Measures tend to be tailored to the specific needs of SMEs and access is facilitated by a range of on-line approaches. Attempts are made to reduce bureaucracy (e.g. the cabinet Office 'Red Tape Challenge'[84]) and to ensure that regulations do not create disadvantages to any businesses (e.g. the 'One-In, One-Out' rule[85] for new regulation). In common with all innovation support schemes, those for SMEs are regularly evaluated in order to assess their performance – international comparisons may be used where similar contexts exist.

With regards to insolvency, the UK helps businesses start again after non-fraudulent bankruptcy through measures such as a 1-year discharge or the removal of restrictions. Two separate registers, the individual insolvency register[86] and the BRO (Business

[84] http://www.redtapechallenge.cabinetoffice.gov.uk/home/index/
[85] https://www.gov.uk/government/collections/one-in-two-out-statement-of-new-regulation
[86] https://www.insolvencydirect.bis.gov.uk/eiir/

Restriction Order) register[87], enable people to differentiate between "culpable" bankruptcies and people who went bankrupt due to circumstances beyond their control[88].

It is recognised that UK businesses have historically underperformed in obtaining EU funding. For example, of the private commercial organisations participating in FP7, 11.2% were from the UK compared to 11.4% from France and 15.8% from Germany. Participation by UK SMEs compares even less favourably. The government recognises that action must be taken to ensure that, in the interests of economic growth, more UK businesses are able to take advantage of the benefits and opportunities offered by Horizon 2020[89].

4.6 Venture capital markets

Most of the measures aimed at the support of a strong venture capital market are those already discussed under the section dealing with the support for SMEs. These are: Enterprise Capital Funds; UK Innovation Investment Fund; Enterprise Finance Guarantee; Venture Capital Trusts; Business Angel Co-Investment Fund; Enterprise Investment Scheme; and the Seed Enterprise Investment Scheme.

There are no specific incentives for investors to invest in limited partnership fund structures, although the tax treatment of carried interest in a typical private equity or venture capital fund is agreed in a memorandum of understanding between the British Venture Capital Association and Her Majesty's Revenue and Custom (the UK Government taxation authority). However, investment in private equity and venture capital more generally does attract fiscal incentives. Schemes, such as venture capital trusts (VCTs), Enterprise Investment Scheme and Seed Enterprise Investment Scheme aim to encourage investment in small and start-up companies by UK resident individuals and are eligible for tax incentive support. For example, investment of up to €237,265 in a VCT will attract tax relief of 30% provided it is held for at least 5 years. Moreover, any capital gains made on the sale of shares in a VCY will be exempt from Capital Gains Tax.

The British Business Bank, using its £300m (€375m) Investment Programme, is intended to promote greater diversity in the sources of lending to businesses, including mezzanine finance funds, supply-chain finance schemes, invoice finance platforms and peer-to-peer lenders. The Government, in conjunction with the Financial Conduct Authority has developed a regulatory framework to instil confidence amongst businesses and investors in new peer-to-peer and peer-to-business platforms. This came into effect in April 2014[90]. In addition, the British Business Bank assists fast-growing businesses in accessing investment through initiatives such as the Business Angel Co-Investment Fund. Here, businesses can obtain equity investments of between £100,000 and £1m (€125,000 and €1.25m) in partnership with syndicates of business angels. The Bank also runs a number of Enterprise Capital Funds which combine £487m (€608m) of public and private venture capital investment in high growth businesses.

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[87] http://www.start.biz/business_names/how_to_register.php?gclid=CLT89qebi8ECFdTLtAod2BgAuw

[88] http://ec.europa.eu/enterprise/policies/sme/business-environment/failure-new-beginning/policy_structure/support_for_policy_development/some_good_practices_en.htm

[89] https://www.innovateuk.org/documents/1524978/2138994/Delivery%20Plan%202014-15

[90] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/266212/bis-13-1313-small-business-great-ambition-FINAL.pdf

4.7 Innovative public procurement

The UK makes relatively limited use of demand-led schemes to help stimulate innovation, possibly since the effectiveness of its use is as yet poorly understood or demonstrated.

The sole instrument in this area is the Small Business Research Initiative (SBRI), which supports SMEs in providing innovative public sector solutions. "SBRI provides innovative solutions to challenges faced by the public sector, leading to better public services and improved efficiency and effectiveness. It generates new business opportunities for companies, provides SMEs a route to market for their ideas and bridges the seed funding gap experienced by many early stage companies. It supports economic growth and enables the development of innovative products and services through the public procurement of R&D"[91]. In 2012 an expansion to the scheme was announced which saw its budget rise to £100m (€125m) in 2013-14. Following this, in its March 2013 Budget, the Government signalled its intention to dramatically increase the value of SBRI contracts to £200m in 2014/15 (€250m). Figures from Innovate UK indicate that over 1,300 SBRI contracts valued at more than £130m (c. €162m) have been awarded since April 2009. These have generated new business opportunities for many companies and brought benefits to more than 40 public sector bodies[92].

All Government departments are now expected to expand their use of the scheme. Specific targets for key departments for 2013-14 have been set out, including £50m (c. €62.5m) from the Ministry of Defence and £30m (c. €37.5m) from the National Health Service. There is, however, no national target for the procurement of innovative goods and services by the public sector.

The specifications for SBRI tenders reflect a mix of generic and client-specific requirements, for example:

- Quality of the science and technological innovation
- Relevance to the Challenge
- Potential impact on the [departmental/client-focused topic]
- Expertise and track record of the team
- Value for money
- How the proposals will meet Phase 1 deliverables
- Outline plans for solving the Challenge [specific client demands] as a whole

[91] https://sbri.innovateuk.org/
[92] https://sbri.innovateuk.org/sbri-for-business

5. Performance of the National Research and Innovation System

This chapter provides an assessment of the performance of the national research and innovation system and identifies the main structural challenges faced by the national innovation system.

5.1 Performance of the National Research and Innovation system

A brief review of Table 2 (below) indicates that the UK performs well in terms of Human Resources and scientific output: it is well above the EU average both in terms of new doctorate graduates per thousand population and the percentage of the population (aged 25-64) having completed tertiary education. Its output of international scientific co-publications per million population is almost three times the EU average. This tends to reflect its long-established, strong and internationally well-regarded higher education sector which has continued to perform well despite some strong spending cuts over recent years.

According to the International Comparative Performance of the UK Research Base (BIS 2013), "while the UK represents 0.9% of global population, 3.2% of R&D expenditure, and 4.1% of researchers, it accounts for 9.5% of downloads, 11.6% of citations and 15.9% of the world's most highly-cited articles". The UK has now overtaken the US to rank 1st by field-weighted citation impact.

In addition, "with just 2.4% of global patent applications, the UK's share of citations from patents (both applications and granted) to journal articles is 10.9%. The UK is a highly productive research nation in terms of articles and citation outputs per researcher or per unit of R&D expenditure, resulting from a trend towards increasing outputs from broadly stable or decreasing inputs. It is likely that recent increases in UK research productivity have, at least to some extent, been driven by the increase in UK international research collaboration, which is also associated with greater citation impact. Taken together, the observation that the UK punches above its weight reflects the underlying well-roundedness and high impact of UK research across most fields of research" (BIS, 2013). Similarly, the UK performs well in terms of public-private co-publications indicating a reasonably high level of scientific dialogue between the public and private sector.

To give more specific details, on average in 2012, the UK produced 22.7 publications per 10,000 inhabitants, well above the EU-28 average (13.8). The UK is also internationally orientated with 47.13% of publications internationally co-published. In 2012, the UK had about 1070 international scientific co-publications per million population (placing it in 11th position among the EU28 and above France and Germany). In the period 2002-2012, almost 14.6% of the UK's scientific publications were in the top 10% most cited publications worldwide in comparison with 11% of top scientific publications produced in

the EU28 (Science Metrix, 2014)[93]. The share of public-private co-publications in the UK was 2.6% in the period 2008-2013, slightly below the figure for the EU28 (2.8%)[94].

Although the UK is below the EU average in terms of R&D expenditure in the public sector (as a percentage of GDP), this may reflect the fact that much of the government research sector has undergone a process of privatisation (to varying degrees) over a number of years. Thus, in comparison with the HE sector the PRO sector is relatively small compared to many EU member states.

The UK performs well in its support for start-ups and small companies, with an above EU average score for venture capital and seed capital as a percentage of GDP.

UK investment in BERD as a percentage of GDP lies below the EU average, although it does relatively well in terms of medium and high-tech product exports (just above the EU average) and in knowledge-intensive services exports (well above the EU average). Its performance in license and patent revenues from abroad falls slightly below the EU average although this might reflect a stronger domestic revenue performance.

While statistics on applications to national patent offices (NPOs) are not always comparable across countries, they can provide some indication of technological development activities that are not captured by EPO/PCT data. In the UK, approximately 55,000 patent applications were made at the EPO in the period 2000-2010, while around 64,000 patents took the PCT route. Over the same period, the UK Intellectual Property Office received almost 132,000 applications in this period – well over double either of the other two routes. (These figures are based on fractional counting).

[93] These publication data are based on Elsevier's Scopus database. ScienceMetrix, Analysis and Regular Update of Bibliometric Indicators, study conducted for DG RTD. They represent an update of the data displayed in the table below. See also http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=other-studies.

[94] Scival 2014, Scopus based publication indicators derived from Elsevier's SciVal platform, www.scival.com last accessed December 2014.

Table 5 Assessment of the Performance of the National Research and Innovation System.

1. ENABLERS	Year	UK	EU
Human resources			
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	2011	2.40	1.70
Percentage population aged 30-34 having completed tertiary education	2012	47.10	35.80
Open, excellent and attractive research systems			
International scientific co-publications per million population	2012	1,021.30	343.15
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	2009	13.39	10.95
Finance and support			
R&D expenditure in the public sector as % of GDP	2012	0.60	0.75
Venture capital (early stage, expansion and replacement) as % of GDP	2012	0.18	0.08
2. FIRM ACTIVITIES			
R&D expenditure in the business sector as % of GDP	2012	1.14	1.31
Linkages and entrepreneurship			
Public-private co-publications per million population	2011	79.46	52.84
Intellectual assets			
PCT patent applications per billion GDP (in PPS€)	2010	3.27	3.92
PCT patent applications in societal challenges per billion GDP (in PPS€) (climate change mitigation; health)	2010	0.81	0.85
3. OUTPUTS			
Economic effects			
Contribution of medium and high-tech product exports to trade balance	2012	4.25	1.27
Knowledge-intensive services exports as % total service exports	2011	61.16	45.26
License and patent revenues from abroad as % of GDP	2012	0.46	0.59

Source: European Commission, IUS Database (2014).

5.2 Structural challenges of the national R&I system

As noted in previous Country Reports, despite its overall good performance, the UK's national R&I system still faces a number of challenges, some of which have been in existence for some time. These are:

- Continuing low levels of private sector investment in R&D&I
- Concerns over the translation of the results of publicly supported R&D into commercial products, processes and services
- Continuing to maintain the capacity of the national system of the science and research infrastructure
- Addressing the future skills needs of industry, particularly in regard to high-end and complementary skills sets

- Continuing to support the specific needs of SMEs, particularly high-growth innovative companies
- Mobilising government resources for procurement in supporting demand-led innovation.
-

5.3 Meeting structural challenges

Table 6 Assessment of the Performance of the National Research and Innovation System: Challenges and responses

Challenge	**Policy measures/actions addressing the challenge**	**Assessment in terms of appropriateness, efficiency and effectiveness**
low level of private sector investment in R&D&I	- R&D Tax credits: modification to SME R&D Tax credit	- apparently popular measure (total number of companies supported has risen from 1,780 in 2000/01 to 11,920 in 2011/12. Estimates are that claims are made for around two-thirds of all spending by businesses on R&D.
translation of the results of publicly supported R&D into commercial products, process and services	- national network of Catapults (£240m between 2011-15)	- measure based on thorough review (Hauser, 2010) and positive review in 2014
	- investment of €58m in graphene research hub, €24m in satellite-based sensing services and €209m in to life sciences commercialisation	- investments based on thorough reviews
	- NIHR Translational Research Partnerships	
	- increased investment in NIHR Biomedical Research Centres/Units	- based on strategic reviews and designed to capitalise on UK research strengths. Too early to assess.
	- Collaborative R&D (c€184m in 2012-13)	- existing measure. Evidence suggests well used and effective: cost benefit ratio of £7:1.
	- Knowledge Transfer Networks (KTNs): (c€18m in 2012-13) (new Special Interest Groups in priority areas)	- supports 15 KTNs with over 38,000 members through the Connect web platform. Apparently well-used and successful measure.
	- Knowledge Transfer Partnerships (KTPs) (€30m in 2012-13)	- over 1,000 live projects per year – apparently popular and successful longstanding measure. Positively evaluated several times
	- Innovation and Knowledge Centres	- focus on business exploitation of emerging research and technology fields
	- Higher Education Innovation Fund (€174m per year from 2011-15) – extra €7m input 2012	- good uptake, recently revised allocation process.

Challenge	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
maintenance of research infrastructure	- UK Research Partnership Investment Fund: budget raised to €336m in 2012 - protection of the science budget 2010-2015 (€23b)	- number of partnerships already in place - appropriate measure given financial climate; efficient use of resources given need to maintain system stability; indicators (publications, researchers, etc.) seem to indicate effectiveness.
	- additional €575m of capital investment since 2010: Large Facilities Capital Fund; Research Capital Investment Fund; HEFCE Research Capital allocation - tax breaks worth €174m over 4 years for research & innovation campuses in local Enterprise Zones	- measures are appropriate; efficiency and effectiveness are ensured through strategic Large Facilities Roadmap which prioritises needs - regional measure aimed at improving performance of centres of excellence for business-research innovation activities
ensure future supply of HRST	- existing range of research training through Research Councils (incl. CASE awards), move towards delivery through teaching/research clusters and centres of excellence - continuing review of training and teaching needs addressed by HE funding bodies and research councils - support for early career post-doctoral research and career development fellowships through Royal Societies, Research Councils and British Academy	- addresses both generic and more specific employee skills needs. There is still demand from employers for additional skills sets. - ensures delivery of appropriately trained researchers into the research base and business - support for excellent researchers, addresses need to maintain quality as lynch pin of research support
	- increased support for Apprenticeships schemes in 2011 – further expansion announced in 2014 Plan for Growth. - Richard Review of Apprenticeships published Nov 2012 – Government adopted number of recommendations in Spring, 2013 and further Higher Apprenticeships planned.	- addresses absence of adequate pathway for lower level technical skills provision – skills addressed at several levels Appears to be addressing needs as perceived by Richards Review

Challenge	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
support for SME growth	- R&D Tax credits: increased rate to 225% for SMEs + small changes in 2014: cost to government in 2010/11 = c. £1,460[95]	- based on recent assessment of tax credit; effective and efficient measure
	- Grant for R&D relaunched as /Smart (budget doubled to €48m in 2012)	- long-standing measure – addresses finance market failure, positively evaluated[96].
	- Business Coaching For Growth - Manufacturing Advisory Service - Business Link - GrowthAccelerator - OpentoExport	- advisory services: add further dimension to increase absorptive capacity.
	- Enterprise Capital Funds programme increased by €500m over 3 years (Autumn 2014)	- addresses decrease in availability of VC due to credit crunch. Too early to assess.
	-UK Innovation Investment Fund	- positive review in 2012
	- Enterprise Finance Guarantee: extended Autumn 2014 to provide c. 625m of new funding by 2015/16.	- lending hit record low in late 2012 – requires increased uptake/effectiveness
	- Venture Capital Trusts	- in October 2012, amount of money invested in VCTs fell for first time since start of credit crisis as investors switched to Enterprise Investment Schemes.
	- Business Angel Co-Investment Fund (€58m)	- supports UK business angels market against economic downturn. Figures suggest co-investment has declined possibly due to downturn
	Enterprise Investment Scheme and Seed Enterprise Investment Scheme	- stimulates investment support in financial downturn. Too early to assess effects.
	- encouraged five main banks to set up a Business Growth Fund of €2.9b to fund high growth companies	- addresses lack of supply of bank capital support for small companies engendered by credit crunch. 2012/13 review[97] suggests modest increase of uptake since previous year
	- Leveraging of ERDF funding for innovation	- channels ERDF support to regional needs through existing measures
	- awareness raising on Smart Specialisation	
	- innovation voucher scheme (agri-food and built environment)	- based on regional pilots, will focus on sector with low levels of private sector innovation and growth
	- extension of Launchpad: designed to strengthen clusters through facilitating cooperation and networking	- tailored to specific local needs. Early examples appear to be successful.

[95] BIS (2014d)

[96] E.g. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/344917/report107.pdf

[97] Branching out. How Growth Capital can seed success. Review 2012/13. Available at: http://www.businessgrowthfund.co.uk/wp-content/uploads/2013/07/Review-2013.pdf

Challenge	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
support for public procurement and demand led innovation	Small Business Research Initiative Budget 2013 announced Government's intention to increase value of contracts c. €50m in 2012-13 to over c. €250m in 2014-15.	Appropriate to policy goals of investigating potential of demand led innovation from Government. Some examples of success. Evaluation under way.
	Innovation Platforms (c.€250m)	Address sectoral demand issues (linked to societal challenge areas) through collaborative activities; strong connection to KTNs
	BIS exploring options for a new Centre of Expertise to provide expert advice on the development of innovation to the public sector	Too early to assess
	Package of measures to standardise procurement, etc. with NHS	Too early to assess

The ongoing low level of private sector investment in R&D&I has been an issue identified by a succession of governments through a series of policy documents. The main instruments addressing it, in terms of size, are the R&D Tax credits for large companies and SMEs. These are accompanied by a range of indirect measures such as awareness promotion, prizes, advisory services, etc. In terms of their appropriateness and impact, the focus on tax credits offers business a demand-led flexible support, which can be used according to the specific needs of each company, rather than a cumbersome and confusing range of targeted measures. In addition, tax credits offer a relatively administratively simple instrument for government and avoid issues such as deadweight, market distortion and the need to balance multi-modal interventions. Against this, they do however remove from government the flexibility to prioritise funding on certain sectors or technologies. These main instruments are supported by range of lower cost flexible services and awareness raiding initiatives which appear to satisfy a number of business support niches (Cunningham, 2014).

An extensive range of long-standing measures have been developed and evolved to address the challenge of translating the results of publicly supported R&D into commercial products, process and services. Recent additions to this range include new cluster-type measures (such as 'Catapults', Knowledge and Innovation Centres and Research and Innovation Campuses), alongside incentives that address a range of actors, through a broad variety of modalities to promote and sustain collaboration for innovation. Over time, the Government has put in place a comprehensive, and complementary, set of measures, which evidence (gathered from an extensive process of review and evaluation) suggests have been successful. The longevity of several of them (albeit subject to some modification) attests to their success over time. Examples of relevant new measures would include the funding for the Biomedical Catalyst (and recent announcements of agri-tech and industrial bio-tech catalysts). Moreover, the Research Councils support substantial translational activity including following on funding, IKCs and research and innovation campuses, together with support for university-business collaboration to help ensure the future uptake of research outputs: for example, the launch of the Gateway to Research in

2013 is aimed at the encouragement of university-business connections (Cunningham, 2014).

Efforts towards the maintenance of the science and research infrastructure have largely been achieved through the provision of long-term stable funding streams. Support for the research base has been a priority of a succession of administrations since 1993. Additional support streams for capital equipment and facilities have also been added to the policy mix, initially to offset the erosion of research infrastructures caused by the structure of HE research and more latterly as a more strategic effort to maintain and support infrastructure for research in key priority areas. The ring fenced protection of the research base funding appears to offer a continuing stable platform of support although increases in inflation (albeit being very low) have tended to erode the real value of research funds over the longer term. Thus, despite cutbacks in other government areas, support for research and innovation seems to be holding despite the continuing series of economic uncertainties.

In terms of ensuring the future supply of HRST, there has been continuing support for research training (through the Research Councils) although universities have seen significant cutbacks in their funding for teaching activities. The shortfall, to be addressed by the increase (and removal in 2014) of the cap on student fees that HEIs could charge, appears to have been less than initially feared and student enrolments appear to be increasing after a slight decline. In terms of skills provision for industry, it could be argued that further structural change is required and that the emphasis placed on the HE sector as the leading supplier of skilled manpower is inappropriate, since the lack of a strong vocational/technical training sector remains an issue.

The specific tax credits scheme for SMEs provides a major focus of policy support and is reinforced by a range of more tailored schemes of R&D support which address the specific needs of SMEs: since their introduction in 2000-01 up until 2012-13, over 100,000 claims had been made and more than £9.5b (c. €11.6b) in tax relief claimed[98]. There has also been an increase of policy attention on a range of schemes aimed at mobilising financial support and investment – these schemes received greater attention in response to the need to protect newly created and developing small companies from the lingering effects of the credit crunch. Measures aimed at the creation of start-ups and spin-offs also exist under the broad challenge of increasing the transfer of research results into economic outputs. Overall, SME support is delivered through a multimodal and flexible range of support measures addressing the spectrum of SME needs at both national and targeted regional/local levels.

Finally, the challenge of mobilising the significant resources invested by government in the procurement of (high tech) goods and services continues to focus policy attention on the issue of public procurement in support of innovation and demand led innovation. There are a limited number of schemes, the most significant being the Government-wide SBRI, although some also exist at departmental level – notably in the National Health Service (NHS). The topic continues to attract significant policy debate (an evaluation of the SBRI is ongoing) and there are policy efforts in place to raise activity in this area. Some evidence of success exists at the level of specific projects, e.g. in those run by the NHS.

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Annex 2 – Abbreviations

AHRC	Arts and Humanities Research Council
BBSRC	Biotechnology and Biological Sciences Research Council
BERD	Business Enterprise Expenditure on R&D
BIS	Department for Business, Innovation and Skills
CBI	Confederation of British Industry
CSA	Chief Scientific Adviser
CSR	Comprehensive Spending Review
CST	Council for Science and Technology
DAs	Devolved Administrations
DCLG	Department for Communities and Local Government
DCMS	Department for Culture, Media and Sport
DEFRA	Department for Environment, Food and Rural Affairs
DFID	Department for International Development
DH	Department of Health
EPSRC	Engineering and Physical Sciences Research Council
ERA	European Research Area
ESFRI	European Strategy Forum on Research Infrastructure
ESRC	Economic and Social Research Council
FE	Further Education
fEC	Full Economic Costing
FP	European Framework Programme for Research and Technology Development
G7	Group of seven industrialised nations
GBAORD	Government Budget Appropriations or Outlays for R&D
GDP	Gross Domestic Product
GERD	Gross Expenditure on R&D
GSIF	Global Science and Innovation Forum
HE	Higher Education
HE-BCI	Higher Education-Business and Community Interaction
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institutions
HEIF	Higher Education Innovation Fund
HERD	Higher Education Expenditure on R&D
HMRC	Her majesty's Revenue and Customs (Tax Agency)
HM Treasury	Her Majesty's Treasury (Finance Ministry)
KTN	Knowledge Transfer Network
KTP	Knowledge Transfer Partnership
LCFC	Large Facilities Capital Fund
LEP	Local Economic Partnership
MoD	Ministry of Defence
MRC	Medical Research Council
NAO	National Audit Office
NERC	Natural Environment Research Council
NESTA	National Endowment of Science Technology and the Arts
NHS	National Health Service
NRP	National Reform Programme
OECD	Organisation for Economic Co-operation & Development
OLS	Office for Life Sciences
ONS	Office for National Statistics
PRO	Public Research Organisation
PSA	Public Service Agreement
PSRE	Public Sector Research Establishment

RAE	Research Assessment Exercise
RCIF	Research Capital Investment Fund
RCUK	Research Councils UK
RDA	Regional Development Agency
REF	Research Excellence Framework
RTO	Research & Technology Organisations
S&T	Science and Technology
SBRI	Small Business Research Initiative
SET	Science, Engineering and Technology
SME	Small and Medium-sized Enterprise
STEM	Science, Technology, Engineering & Mathematics
STFC	Science and Technology Facilities Council
TSB	Technology Strategy Board – now Innovate UK
UKTI	UK Trade and Investment
UTC	University Technical College

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