D3.1 Overview of eleven member states innovation policies

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1 Industrial innovation in transition

Globalisation, digitalisation and an increasingly networked production process mean fundamental changes in industrial innovation practices. Companies are widely adopting new tools such as open innovation, innovation networks and ecosystems, systemic innovations, public/private partnerships, crowd sourcing, social media, and demand based innovations. These new practices have improved the innovation capabilities of companies and but present new challenges to traditional innovation policy instruments. The Industrial Innovation in Transition (IIT) research project is examining the changes in company innovation practice in 11 European countries and different industrial sectors to understand their causes, features and implications for innovation policy.

1.1 Introduction to the policy overview

Public policy development is strongly interlinked with progress in innovation practice (in companies and elsewhere) and the thinking about innovation processes in research and theory (Kuhlmann et al., 2010). Yet, often policy designs are changed substantially later than important changes in innovation practice. Therefore, an important task within the IIT project has been a systematic matching and analysis of the interplay between emerging trends in innovation practice and innovation policy design and implementation within and across European Member States. To support this task the project has assessed existing innovation policy at national and European levels as a basis for developing recommendations for improving Europe's innovation potential.

This document presents an overview of the policy assessment conducted within the IIT project, which was based on a comparative analysis of the policy portfolios of the 11 member states covered by the study: Austria, Czech Republic, Estonia, Finland, Germany, Italy, Ireland, the Netherlands, Spain, Portugal and the United Kingdom. This group includes countries classed by the EU as Innovation Leaders, Followers and Moderate Innovators, and the review focused on understanding innovation policy variety at national level in terms of its scope, intensity and the depth of policy initiatives.

The document is divided into two parts: following a methodological note, the second part of the document presents the main STI policy trends for each of the eleven countries, starting with a comparison of the national strategies for science, technology and innovation of the eleven countries. The third part contains innovation policy profiles for each of the eleven countries reviewed.

1.2 Methodological Note

Each country profile is based on information gathered from the partners responsible for the country using a policy matrix, which classify the innovation policy instrument based on typology proposed in the working paper by NESTA/MIoIR (Edler, 2013) (see Annex 1), which defines innovation policy as: "*public intervention to support the generation and diffusion of new products, processes or services*". This includes a broad range of policy instruments, programmes, and initiatives, which are classified as either supply-side instruments (influencing innovation generation) or demand-side instruments (influencing those requesting, buying or applying innovations). Within these two classifications innovation policy instruments are grouped according to seven major innovation policy goals:

(1) Increasing research and development investment;
(2) Augmenting skills;

(3) Access to expertise;
(4) Strengthening system-wide capabilities and exploiting complementarities;
(5) Enhancing innovation demand;
(6) Improving frameworks for innovation, including regulation and standards, and
(7) Facilitating exchange and dialogue about innovation.

The policy matrix includes both instruments that are directly targeted at encouraging innovation or which have indirect effects on innovation while addressing other policy purposes.

The policy matrix in Annex 1 was completed by the research partners using a process of "self-assessment", in which the partners were asked to by rank the importance of each policy instrument in each country based on the existence of policy-making activity in that category and data available from public information sources including the annual RIO Reports produced by the European Commission (JRC Science) and the OECD innovation policy platform. The rankings were: no relevance (0), little relevance (1), moderately relevant (2) or highly relevant (3). Where an instrument was relevant (rankings 1-3) the partners were asked to add additional information about the form and content of the policy instrument, including the dates of the policy, sectors covered and any associated performance measures. This information was used to create individual country profiles, which were sent to an innovation policy expert in each country for review and comment. Please note: the country profiles contained in this document are largely based on policy data collected in Autumn/Winter 2015 and should be read with this timeframe in mind. The country profiles were then analysed comparatively to identify any major variations and trends, and this information was used to inform the analysis of the company interview data and policy development activity taking place in other project tasks.

2 Innovation policy frameworks: trends and variation in country profiles

This section contains a brief indicative analysis of some of the primary similarities and variations in the innovation policy portfolios of the study countries.

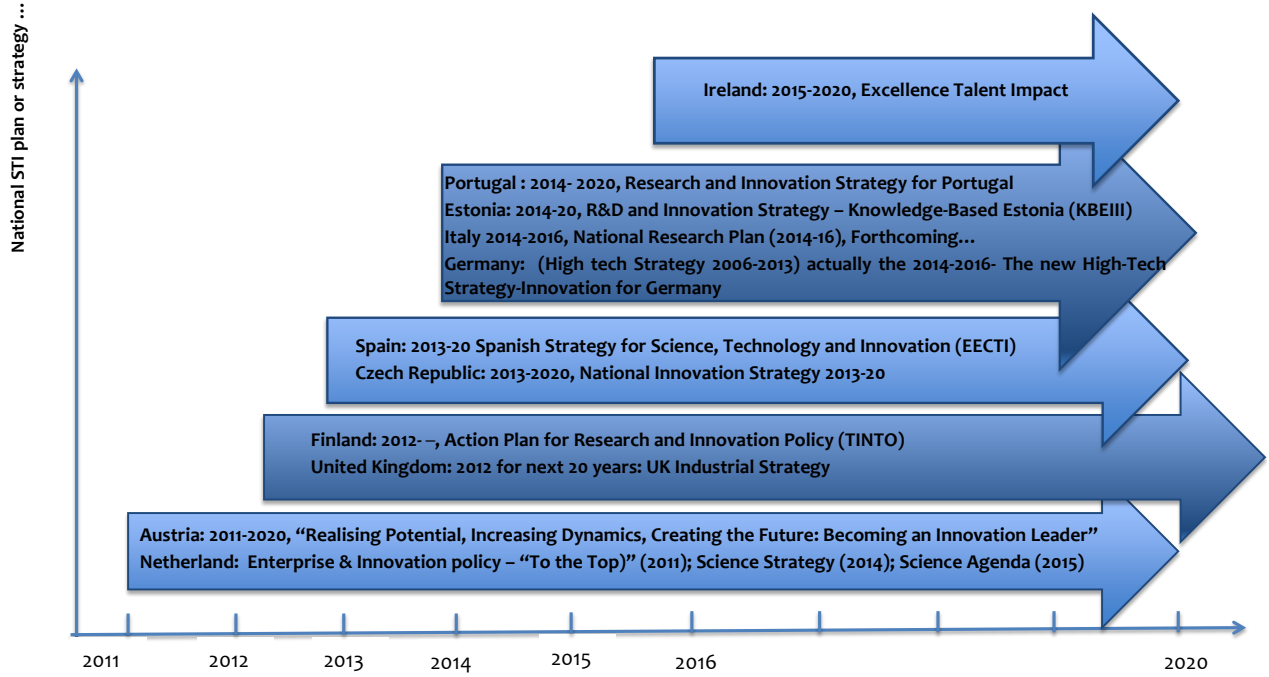
2.1 National strategies for science technology and innovation

In every country studied, a high level national level strategy for science, technology and or innovation was clearly identifiable (see Figure 1). National strategies for science, technology and innovation (STI) serve several functions in government policy making. First, they articulate the vision regarding the contribution of innovation to social and economic development. Second, they set priorities for public investment and government reforms (e.g. funding of university research, evaluation systems). This mobilises actors around specific goals, such as energy, environmental issues or health, and may help steer the investments of private actors, increasingly autonomous universities, and public research institutes. Third, the elaboration of these strategies can engage stakeholders such as the research community, funding agencies, business, civil society, regional and local governments in broad consultations that build a common vision of the future and facilitate coordination within the innovation system[1].

A common aspect of the strategies we reviewed were attempts to reduce the fragmentation of public support for business R&D and innovation and to improve and simplify access to public programmes. By streamlining and consolidating public programmes governments seek to lower the administration and application costs of innovation policy instruments. This is combined with other activity to leverage private funding for innovation. For example, the new strategy for Tekes in Finland is designed to foster a customer approach to deliver public support and to centralise and streamline financing for entrepreneurship. The German government has also bundled R&D and innovation support activities into large Framework Programmes in recent years. The Czech Republic (Technology Agency) has also reduced fragmentation by merging multiple institutions with a remit relating to technology and entrepreneurship policy into a single agency.

[1] OECD 2014

Figure 1: National STI strategies or plans



Source: JOANNEUM RESEARCH; own illustration

Underpinning these broader objectives relating to science, technology and innovation in almost all of the countries, was an emphasis on business innovation and innovative entrepreneurship. Encouraging entrepreneurial culture is seen as critical for stimulating impactful innovation, both in business and society. This is because entrepreneurs, start-ups and small and medium-sized enterprises are associated with driving job creation; greater risk-taking; realising investment in innovation, and building alliances and collaboration. These activities promote economic growth, access to new markets, employment, social change, and sustainability. To support innovative entrepreneurship the strategies promote and design start-up initiatives, fundraising opportunities, the provision of risk capital, and encourage large scale appropriation of innovation and tax initiatives focused on R&D expenditure. A few examples are the new credit guarantees instruments (Qredits and MKB+) in the Netherlands; the non-repayable grants Central Innovation Program for SMEs (ZIM) in Germany, and the research premium in Austria.

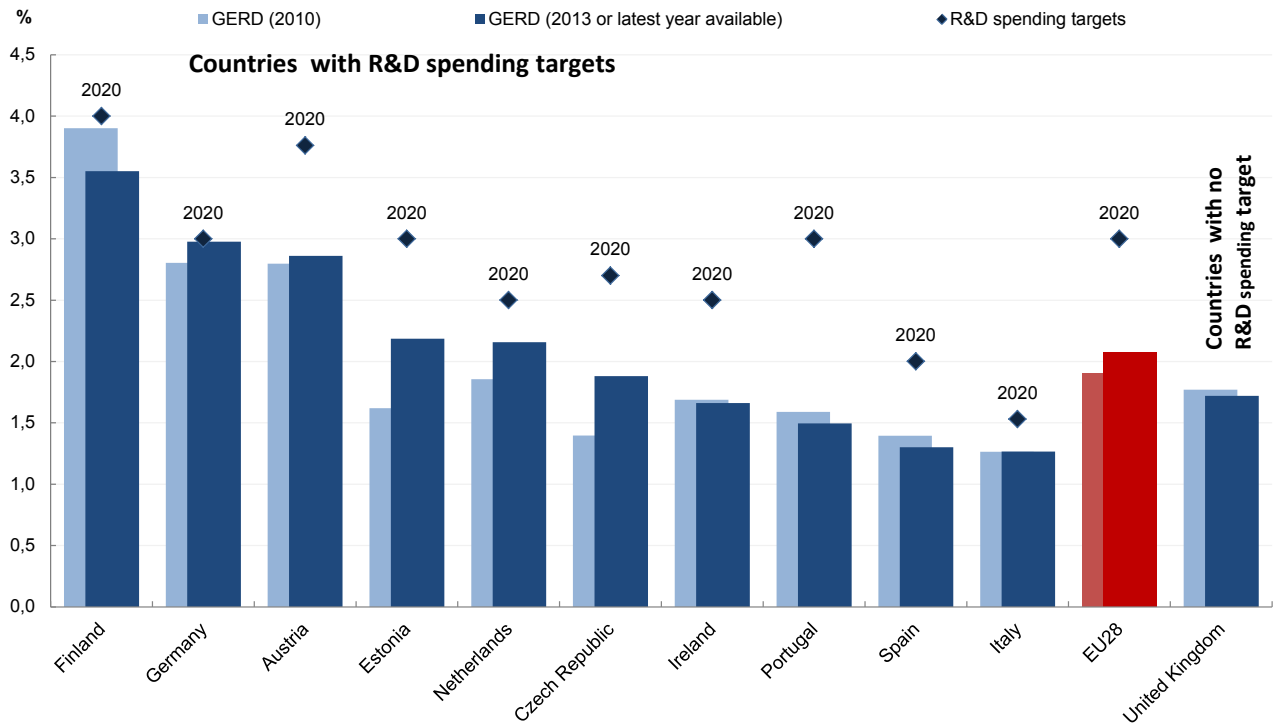
In addition, most countries aim to strengthen their innovation ecosystem[2] by supporting public R&D capacity and infrastructure. The Italian Cohesion Action Plan (CAP), instruments for improving overall human resources, skills and innovation capacity in the Czech Republic; the national science and innovation policy in Spain, and pillars of the Dutch Enterprise Policy that focus on improving condition for public private collaboration. Differences emerge however, when comparing countries at different stages of socio-economic development. Typically, in countries that already rank highly in terms of business R&D and innovation (like Austria, Finland, Germany) there is a focus on investing in the public research and human resources that constitute the general science base that will provide the source of future innovation. This means that in the higher-performing countries research and innovation support is focused on gaining competitive advantage in areas of emerging growth such as nanotechnologies, green technologies,

[2] refers to the flows of skills, knowledge and technologies, knowledge services and finance that facilitates innovation in an increasingly distributed world

information and communication technology (ICT) and health technology, and global challenges. Additionally, the resurgence of industrial policy means that alongside support for multi-application technologies (such as nanotechnology etc.), most of the countries also target innovation support at nationally strategic technologies or sectors, as in the UK, Netherlands, Finland and Germany.

Most countries have adopted quantitative targets to benchmark the performance and progress of their innovation policy, particularly through targets for R&D spending (Figure 2). The volume of GERD to be achieved is often expressed as a percentage of gross domestic product (GDP) and, in some cases, the relative contribution of the business or the public sector is specified as well.

Figure 2: National R&D spending targets and gap with current levels of GERD intensity, 2014



Source: International Monetary Fund (2014), World Economic Outlook, January, www.imf.org/external/pubs/ft/weo/2014/update/01/index.htm; RIO Country reports 2015, https://ec.europa.eu/jrc

2.2 Major similarities and variation in innovation policy instruments and their application

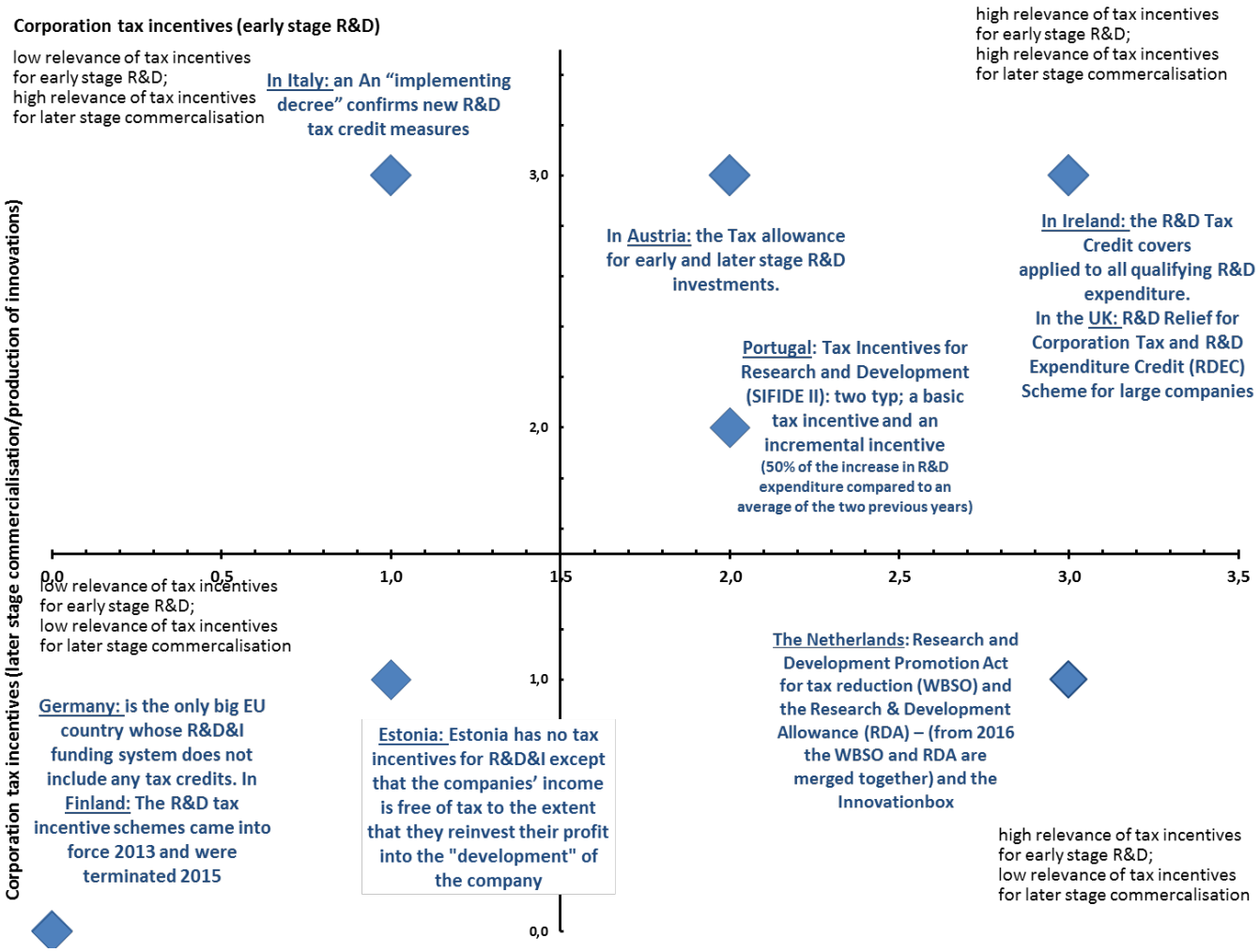
2.2.1 Financial instruments

Financial instruments include both direct (e.g. credit loans and guarantees, repayable advances, competitive grants, innovation vouchers) and indirect funding (e.g. R&D tax incentives). By 2013 about half of total public support to business R&D took the form of tax incentives[3]. Indirect government support through tax incentives is considered the major part of governmental funding for business R&D in many of the EU member states; like in Austria, in the Netherlands, in Portugal in the UK[4]. R&D tax incentives have been simplified and made more generous (e.g. by increasing the tax relief rate) and made more accessible to larger numbers of beneficiaries. Most of the R&D tax incentives address a specific group (e.g. SMEs) or type of R&D (e.g. subcontracted R&D), and R&D tax incentives have become a way of increasing the attractiveness of the national research ecosystem and inter-country competition to attract foreign R&D of multinational enterprises. For example, the Netherlands has made tax relief one of the main instruments of its industrial policy. In 2013 the United Kingdom introduced an expenditure credit scheme to make R&D tax relief more attractive to large firms and to leverage domestic R&D activity.

A variety of tax incentives for R&D and innovation are available for corporate income tax, payroll withholding taxes and social security contributions, personal income tax, value-added tax or other consumption, land and property taxes. Tax relief is granted on the basis of expenditures incurred for R&D activities (expenditure-based) or gains from innovative activities (income-based). Although a few countries – Estonia, Germany, and Finland – do not offer specific tax arrangements for R&D and innovation at central or federal level, R&D tax incentives are universally used. Enhanced deductibility of R&D-related expenditures and accelerated depreciation of R&D investments are imputed on corporate income tax in a broad range of countries, in Austria, in Portugal, in Spain and in the UK. Several governments offer preferential tax treatment for corporate income from royalties, licensing and R&D capital gains in order to encourage the commercialisation of R&D results and to attract or retain intellectual property (IP) like in Italy, in Netherlands, in Spain and in the UK.

[3] Neubig, T. et al. 2016
[4] OECD 2014

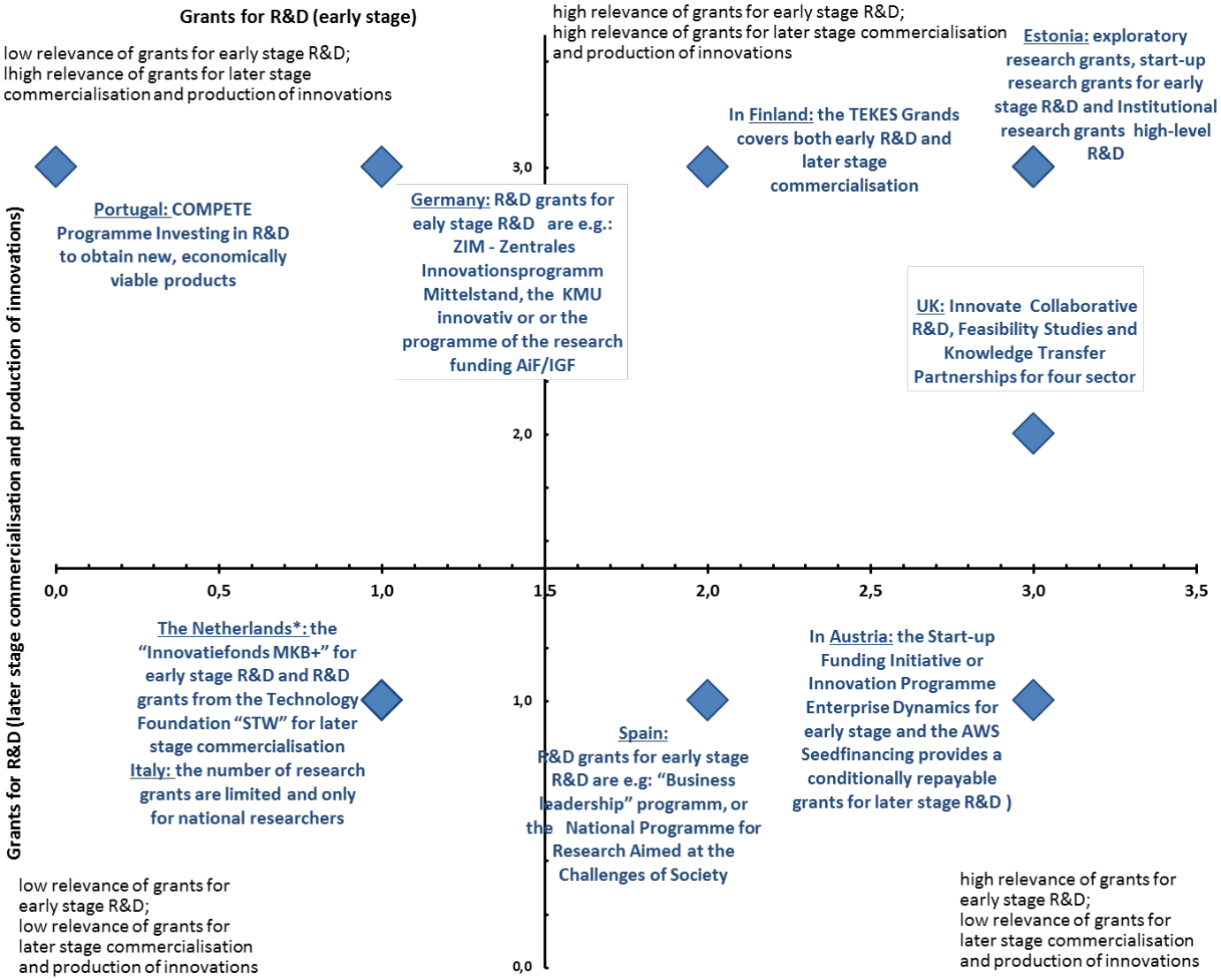
Figure 3: Relevance of tax intensives for early stage R&D versus tax intensives for later stage commercialisation



Source: JOANNEUM RESEARCH, based on policy assessment

Governments offer direct financial support for innovation through public procurement for R&D and a variety of grants, subsidies, loans or equity funding. Direct financial support is offered through competitive grants and debt financing, such as loans for R&D projects. Risk-sharing mechanisms are widely used to provide lenders with insurance against the risk of default and improve firms' access to credit. A loan guarantee implies that in the event of a loan default, the credit guarantee scheme will reimburse a pre-defined share of the outstanding loan to the lender. Some direct support is also linked to public procurement.

Figure 4: Relevance of grants for early stage R&D vs. grants for later stage commercialisation and production of innovations



Source: JOANNEUM RESEARCH, based on policy assessment by country respondents
*In the Netherlands there are hardly any grants or subsidies for supporting R&D in the business sector left, tax incentives are at least 85% of fiscal governmental support for business R&D (OECD 2016)

2.2.2 Indirect support

Other innovation policy instruments outside R&D-related schemes include measures to facilitate the commercialisation of innovation, support the development of networks, promote regional innovation hubs, and ease access to information, expertise and advice. Innovation vouchers or technology consulting services and extension programmes are major policy instruments in this respect.

Policy instruments that facilitate R&D cooperation between business and higher education/RTOs or even public-private partnerships (PPPs) in science, technology and innovation support the interactions required to encourage the development of knowledge and technology in response to changing requirements and the

evolution of different elements of an innovation ecosystem. For business, partnering with public research can help solve problems, develop new markets or generate value through cooperation and co-production. Traditionally used for physical infrastructure, R&D cooperation between business and higher education is increasingly encouraged and facilitated because it is better adapted to some innovation goals or challenges than instruments such as subsidies or tax credits.

Innovation cooperation can take many forms, between individual companies and universities; within research projects with specific short-term goals; to partnerships creating physical research centres with a specific mission (e.g. development of vaccines); in large infrastructure projects with a long-term horizon and broad networks, or innovation clusters[5]. Good examples of policy instruments that support innovation clusters exist in Germany. The network of Catapult Centres being developed in the UK aims to give businesses access to specialist equipment and emerging technologies and connect them to academic expertise. The RETOS-COLABORACION Call in Spain is an instrument for public-private collaboration to increase the participation of private funding in innovative activities, facilitate company access to public research and foster the development of technology-based companies and young innovative companies. The Czech Republic has a Centres of Competence programme to create conditions for the development of long-term cooperation on R&D and innovation. In the Dutch 'Topsectors' approach, each sector has a council governed by a team consisting of firm representatives, an SME, an academic and a high-ranking government official. The government offers financial support for R&D cooperation between business and higher education/RTO's through the 'Topconsortia for Knowledge and Innovation' (TKI's).

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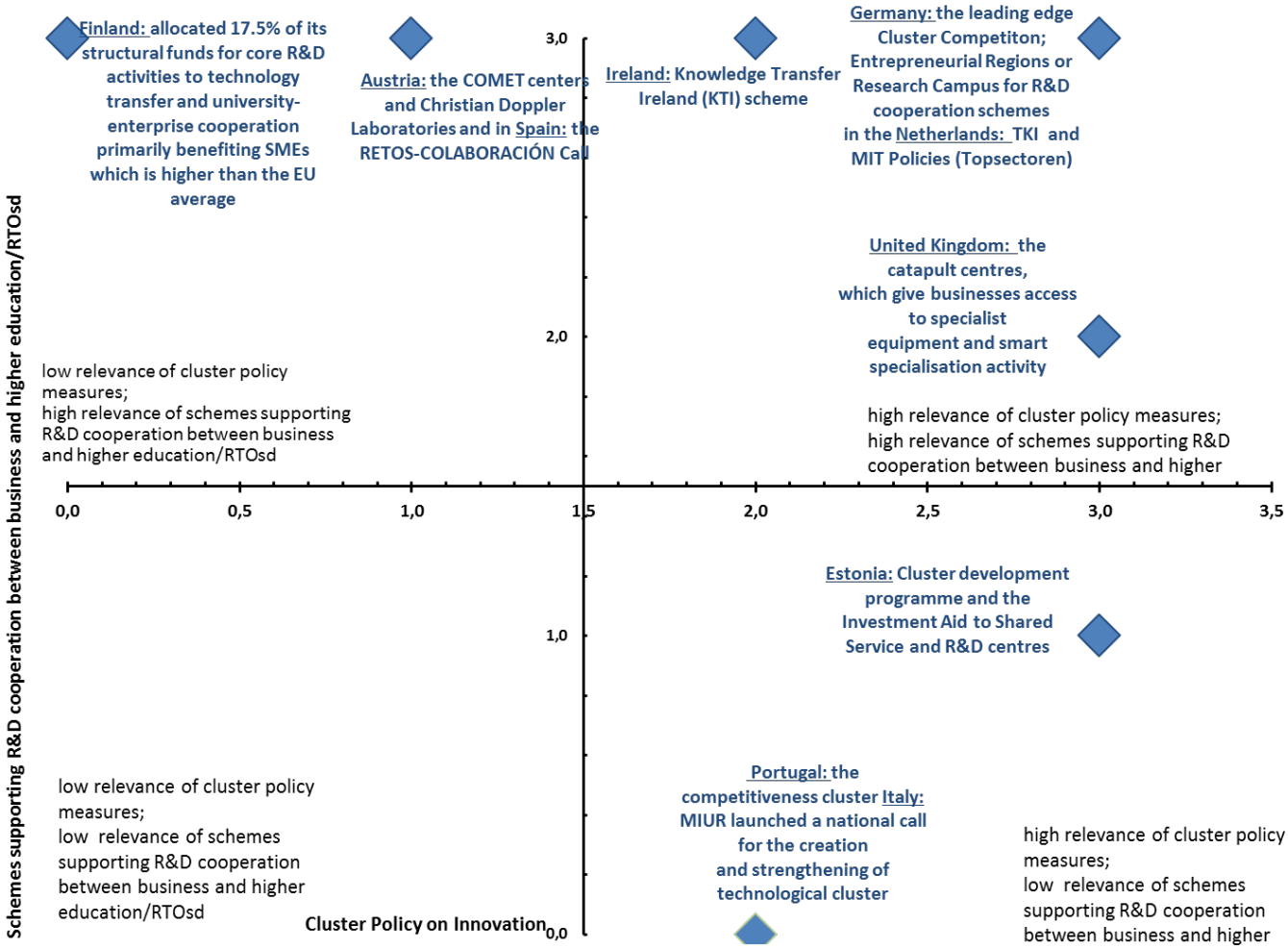
Figure 5: Relevance of policy instruments supporting R&D cooperation between business and higher education/RTOs



Source: JOANNEUM RESEARCH, based on policy assessment by country respondents

2.2.3 Sector /or technology specific development

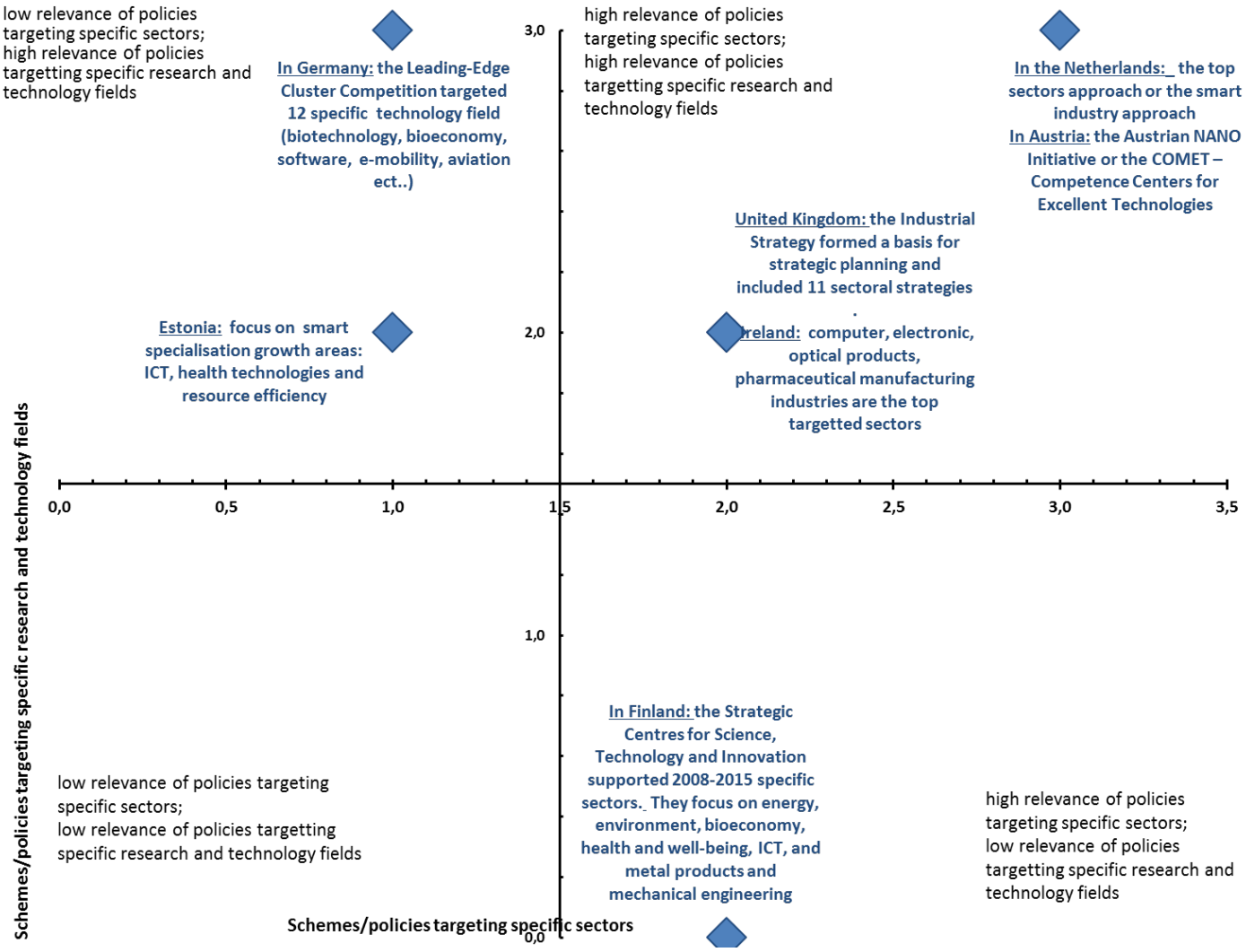
A number of the countries studied are making new large-scale R&D investments in promising technology fields or sectors. For example, under its new Industrial Strategy, the United Kingdom granted £600 million in 2013 to its Eight Great Technologies[6]. Funding should prompt large and smaller players to increase participation in cooperative projects, support "Smart Specialisation" and encourage technology monitoring and foresight analysis in order to identify technological niches and long-term technology developments. In 2013 Germany launched the High-Tech Strategy stands for the aim of moving Germany forward on its way to becoming a worldwide innovation leader. The goal is to increase the speed with which good ideas are translated into innovative products and services. Many countries have adopted a sector-oriented approach in their national strategy or plan for STI and, in some cases, have implemented sector-oriented initiatives combining direct funding (e.g. subsidies, equity funding) and indirect funding (e.g. tax incentives) instruments. For example, the Netherlands presented its Top Sectors initiative following the 2010 general

[6] The eight technologies are: The big data revolution and energy-efficient computing; Satellites and commercial applications of space, Robotics and autonomous systems, Life sciences, genomics and synthetic biology, Regenerative medicine, Agri-science, Advanced materials and Nano-technology, Energy and its storage, http://www.oxfordmartin.ox.ac.uk/opinion/view/236

election. The new enterprise and innovation policy introduces a sector approach across government policy for nine top sectors: water, food, horticulture, high technology, life sciences, chemicals, energy, logistics and creative industries. Italy focuses on FDI to support micro-enterprises and small-sized companies, combining traditional farming, craftsmanship and manufacturing with high-end high-technology sectors.

In Estonia the current R&D&I strategy 'Knowledge-based Estonia' sets out three growth areas: ICT, cybersecurity, software development or the use of ICT for automating industrial processes; health technologies and services (e. g. the use of biotechnology or IT for the development of medical services or products) and more effective use of resources. These areas are Smart Specialisation growth areas in Estonia, where applied research activities are supported by the supporting action NUTIKAS.

Figure 6: Relevance of policies targeting specific sectors or research and technology fields



Source: Joanneum Research based on policy assessment by country respondents

3 Country profiles

The country profiles are designed to provide a concise overview of innovation policy measures in the eleven countries and were constructed according to the methodology described in Section 1.2. The profiles provide an overview of the policy instruments available in each national setting, and highlight some trends and potential gaps in each country's innovation policy profile. The country profiles presented in the following sections also contain information about the structural composition of business expenditure on R&D (BERD[7]) in terms of performance of the main industry sectors, firm size and firms' national affiliation to reflect the industrial structure and business innovation efforts, which form the backdrop to the policy portfolio.

The information is presented according to the NESTA/MIoIR innovation policy goals:

i. Overall national research and innovation (R&I) policy framework (features of national R&I system).
ii. Increasing research and development investment (supported by fiscal measures: tax incentives, grants and loans etc.).
iii. Augmenting skills for better access to expertise (supported by measures for improving supply and demand of skills, services to support enterprises in adopting innovation and deploying new technologies.
iv. Strengthening innovation eco-system capabilities and exploiting complementarities (supported by measures for technology transfer and commercialisation; clusters and Smart Specialisation).
v. Stimulating demand for innovation (supported by public procurement policies).
vi. Improving framework conditions for innovation, including regulations and standards (Supported by policies for the development and use of innovative standard and regulations).
vii. Facilitating exchange and dialogue about innovation.

Please note that comparable data was readily available on policy goals 1-5, which have been completed for nearly all countries. Comparative data relating to policy goals 6 and 7 was less readily available and these sections have only been included when the country correspondent provided significant information relating to that goal.

[7] Business Enterprise Expenditure on R&D (BERD) covers R&D activities carried out in the business-sector by performing firms and institutes, regardless of the origin of funding.

3.1 The Netherlands

3.1.1 Overall national R&I policy framework

The Netherlands is one of the world's most advanced economies, its long-term development underpinned by entrepreneurship and innovation. The economy has recovered from the financial crisis of 2008 and it has the most competitive economy in the EU, being ranked 4th in the World Economic Forum Global Competitiveness Index 2016-2017[8]. Dutch exporters have benefited less than others from an expansion into emerging markets. Strengthening investment in knowledge and innovation is a key to future growth and competitiveness and is also needed to address social challenges. The "top sectors[9]" approach, a new form of industrial policy announced in 2011, focuses public resources on specific sectors and fosters coordination of businesses, knowledge institutions and government activities in these areas. The introduction of the top sector policy created major changes in the overall innovation policy system, as it required integration to deliver the sector-focus and changed innovation policy financing and public-private partnerships, with a greater emphasis on demand-driven aspects[10]. The top sectors comprise nine key economic areas, which are supported through a combination of generic financial instruments and cooperation mechanisms between the "golden triangle" of companies, research institutions and government. Public and private parties are required to participate in the Top Consortia for Knowledge and Innovation (TKIs) for an amount of at least €500 million by 2015[11], recently increased to €800 million by 2016. The Dutch government has also set targets to reduce administrative burdens and compliance costs of the overall nation R/D Policy framework for enterprises, and improve the transparency and provision of public services. This activity is designed to address concerns about sector-specific regulatory obstacles in the top sectors.

Table 1: Gross domestic expenditure on R&D by source of funds in the Netherlands, 2010 and 2014

Indicator	Netherlands		EU
	2010	2014	2014
GERD as % of the GDP	**1.72 %**	**2.16 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**0.83 %**	**1.11 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.70 %**	**0.65 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.20 %**	**0.24 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

In terms of GERD as percentage of GDP, the Netherlands performs at a level similar to the EU28 average (2.16% in 2014), but considerably below Germany, Denmark and Sweden. It is also still below the target of 2.5% set by the Dutch government for 2020. BERD is particularly low in the Netherlands compared to other countries (1.11% in 2014).

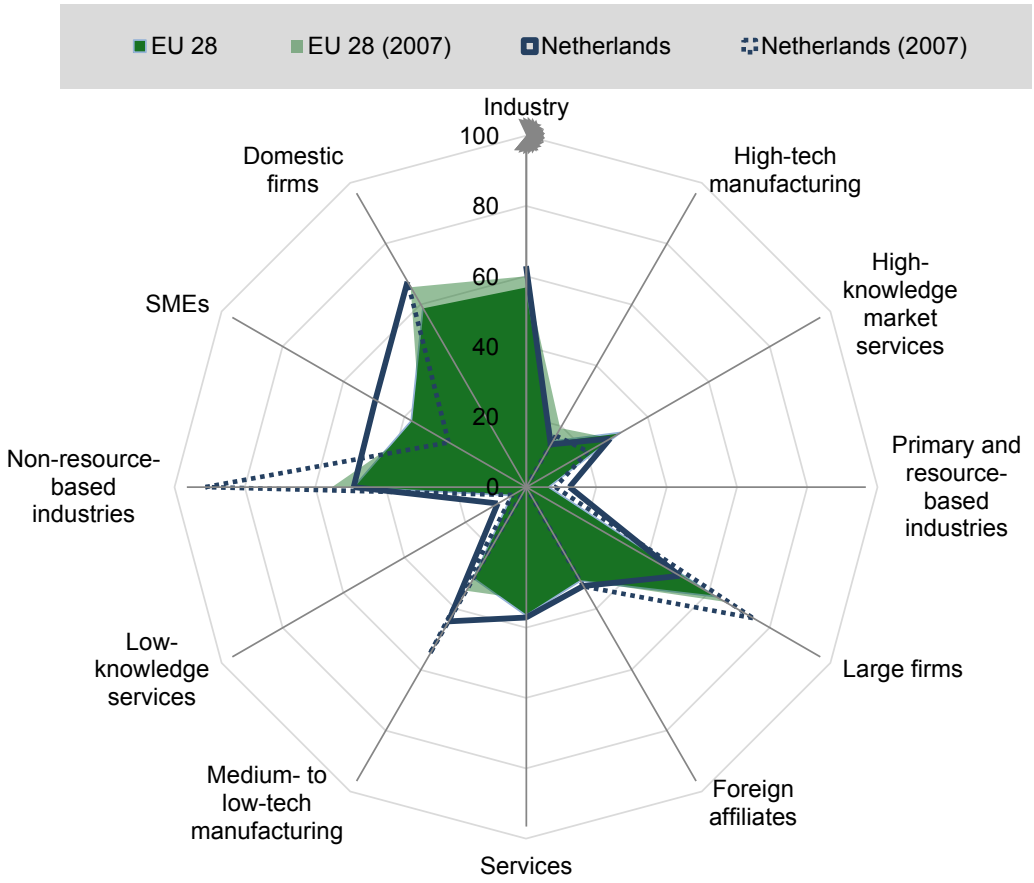
[8] http://www3.weforum.org/docs/GCR2016-2017/05FullReport/TheGlobalCompetitivenessReport2016-2017_FINAL.pdf

[9] Top sectors are: Agriculture & Food, Chemicals, Creative Industry, Energy, High Tech Systems and Materials (HTSM), Life Sciences & Health, Logistics, Peace & Justice and Security Cluster, Water

[10] AWTI 2014 p.2.: The introduction of this sector-based and integrated approach has been accompanied by the loss of financing for knowledge and innovation from the Economic Structure Enhancing Fund (FES). Furthermore, funding for existing institutes and programmes is being phased out.

[11] AWTI 2014 p.3

Figure 7: Structural composition of BERD in the Netherlands, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

According to the Innovation Union Scoreboard 2016[12], the Netherlands is among the 'innovation leaders', private investment in R&D and innovation, however, are closer to the EU median than to leading innovator countries. 62.9% of business R&D expenditure is performed by industry, compared to 37.1% in the services sector.

3.1.2 National policies for increasing research and development investment

The 2015 country specific recommendation of the European Commission for the Netherlands was to: "[shift] public expenditure towards supporting investment in R&D and work on framework conditions for improving private R&D expenditure in order to counter the declining trend in public R&D expenditure and increase the potential for economic growth"[13]. The declining trend in public R&D expenditures has been accompanied by a growth in indirect support. From 2015 onwards the projected direct support is set to decrease alongside indirect support (in 2015 the R&D indirect-fiscal support was 0.15% of GDP and the R&D

[12] http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_nl
[13] http://ec.europa.eu/europe2020/pdf/csr2015/csr2015_netherlands_en.pdf

direct-support 0.74% of GDP, in 2019 indirect-fiscal support was 0.16% and 0.62% the direct support). The total of budgeted direct and indirect support fell from €5.9 billion in 2014 to €5.8 billion in 2019[14].

The Netherlands ranks among the top countries on the EU Ease of Entrepreneurship Index[15]. While early-stage entrepreneurial activity is strong, recent empirical OECD work finds barriers to subsequent growth. In recent years the scarcity of bank lending, combined with the limited role of venture capital in risk financing have been limiting factors. In response, a number of policy instruments include special provisions for start-ups and SMEs, including credit guarantees through the Qredits[16] and MKB+[17]. The government is supporting entrepreneurs (also including start-ups) through its ambitious Entrepreneurship Action Plan. To improve access to capital, knowledge, innovation and the global market the government has set aside €75 million to:

- Provide early-stage finance so entrepreneurs can research whether an idea or product is technically feasible and suitable for the market.
- Provide a Seed Facility supports for private equity firms investing in early stage start-up companies and the R&D credit goes to R&D projects
- Provide a Dutch Venture Initiative (DVI-II-Venture and Growth Capital Fund-of-funds)[18] with focus on Dutch venture capital funds and other funds investing in the Netherlands.
- Strengthen the international position of start-ups and growing businesses and attract foreign start-ups to the Netherlands through the StartupDelta[19] initiative.
- Provide temporary residence permits for non-EU entrepreneurs, creating opportunities for them to start a business in the Netherlands.
- Develop the NLevator initiative – a platform created for and by ambitious entrepreneurs which aims to help businesses grow faster.

Tax incentives are the primary means of financial support for business R&D. The largest innovation policy instrument is the tax credit for R&D salaries, the Research and Development Promotion Act for tax

[14] Van Steen J., 2016
[15] OECD 2014
[16] The government is making investing in SMEs more attractive to financiers by guaranteeing an additional € 100 million in loans accessed through microfinance organisation Qredits. This provides scope for 1,200 SMEs to borrow up to € 250,000 and for 5,300 SMEs to access microcredit of up to € 50,000. Qredits also provides recipients with coaching and online resources, like a guide to drawing up a business plan. (https://www.government.nl/topics/enterprise-and-innovation/contents/support-for-small-and-medium-sized-enterprises-smes)
[17] The Innovation Fund for SMEs helps SMEs transform their ideas into profitable new products, services and processes. The Seed Capital, Fund-of-Funds and Innovation Loans programmes are part of the Innovation Fund for SMEs. https://www.government.nl/topics/enterprise-and-innovation/contents/support-for-small-and-medium-sized-enterprises-smes
[18] Launched in March 2016, it aims at investing in fast growing and/or innovative companies, following the successful implementation of the predecessor initiative, DVI-I, launched in 2013. The Fund-of-funds will target companies in sectors like ICT, clean-tech, med-tech, renewable energy and life sciences, through primary investments in Dutch oriented Venture Capital funds. Similar to the investment strategy of DVI-I, DVI-II will invest in venture and growth capital funds (including hybrid debt/equity funds). (http://www.eif.europa.eu/what_we_do/resources/dvi-II/index.htm)
[19] https://www.startupdelta.org/

reduction (WBSO[20]), which is widely used by SMEs. This was complemented in 2012 by a tax allowance for investment in R&D: the Research & Development Allowance (RDA), which is a tax credit for R&D equipment, and together they amounted to over €1 billion in 2014. From 2016 the WBSO and RDA schemes will be merged. Albeit with some modifications for large firms in particular, the Innovationbox[21], which is approximately 25% smaller than the combined WBSO and RDA, will be continued. This is a consequence of the recent evaluation of the scheme and ongoing policy debates regarding corporate taxation.

3.1.3 National policies for augmenting skills and better access to expertise

One of the key strengths of the Dutch innovation systems lies in the quality of its science base, as reflected in the number and quality of scientific publications. Public R&D expenditure accounts for a large share of GDP. Dutch universities are well placed in global rankings, and science has a strong global impact. Universities and PRIs attract a high share of industry funding for their R&D. While project-based funding has increased in importance, most public R&D funding is disbursed as institutional block funding, of which general university funds (GUF) represent approximately two-thirds. The government's vision for applied research foresees improved efficiency and effectiveness through greater national coherence and a tighter link between funding and quality and impact, particularly in the context of the top sectors.

The Dutch workforce is well educated and has strong innovation skills overall, and education is of high quality, although adult tertiary education attainment and the rate of doctoral graduates in science and engineering could be improved. Current policy efforts focus on maintaining quality in tertiary education and responding to emerging labour market needs. The top sectors' human capital agendas encourage coordination to identify and prepare for emerging skill needs. In 2013, the government launched the 2020 National Technology Pact, involving major stakeholders. Cooperation between HEIs, vocational secondary education and the business sector is a main aspect of the Pact, which aims to increase the number of technically trained people.

3.1.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

Improving circulation and exploitation of scientific knowledge through public private collaboration is one of the main pillars of the Dutch Enterprise Policy. Dutch universities and knowledge institutes have strong links with the business sector, with a high share of industry funding for public research. To foster commercialisation and technology transfer, the Valorisation Programme was introduced in 2011 with a budget of €63 million to support 12 consortia over six years. Valorisation is now part of performance agreements with universities. Collaboration to exploit scientific research is a key objective of the top sectors. Dedicated funding for top-sector instruments (MIT[22], TKI) is only some €106 million a year, but considerable amounts of public research in universities and PRIs are being aligned with the approach: over €500 million in 2015 and a target of €800 million in 2020, of which about 40% will be privately financed.

[20] Companies performing particular R&D activities may benefit from a 32% tax credit (up to 40% for start-ups) of the first €350,000 in R&D wage costs and other R&D expenses and investments, and 16% for those costs and investments exceeding €350,000. http://investinholland.com/incentives-and-taxes/rd-incentives/

[21] Companies may benefit from an effective tax rate of only 5% for income from intangible assets— including technological innovations—created by the Dutch tax payer and for which R&D tax credit was received.

[22] Central and regional authorities are supporting cross-regional innovation by SMEs in the Netherlands' top economic sectors through the €50 million MIT scheme.

Support for business innovation is part of enterprise policy, with instruments for public-private partnerships in the top sectors and generic support for all businesses. Based on experience so far and to better reflect social challenges, efforts were made to simplify and harmonise top-sector instruments: by the Top Consortia for Knowledge and Innovation (TKI) and the SME Innovation Support Top Sectors (MIT) scheme. The TKIs had direct government support of €83 million in 2013, and have fostered many public-private research initiatives. Besides this, the Dutch government also provides a top-up for research-oriented PPP-initiatives by adding 25% to cash contributions from the private sector. To support SME involvement in the TKI research partnerships, policy measures were simplified and a special intervention for SME participation (SME Innovation support for Top Sectors; MIT) was introduced in 2013 with a budget of €20 million (increased to €55 million in 2016). The funding supports exploitation initiatives, collaborative R&D, feasibility studies, innovation vouchers, hiring experts, networking and coaching.

Start-up activity is also being supported through several measures in the Netherlands. To bring university knowledge to the market, consortia of academics and entrepreneurs can apply for the Technology Foundation STW's[23] Valorisation Grant ('Take-off', as of 2014). This grant is designed to take start-ups like university spin-offs through different growth phases. The €19 million of subsidies awarded to projects in the period 2004-2011 led to 47 successful start-ups with a joint annual turnover of €16.8 million. Between 2005 and 2008 start-ups were boosted via a 'Technostarter' programme called 'Subsidy scheme Knowledge Exploitation' (SKE). Many of the 18 locally oriented SKE-initiatives for 'Technostarters' have been continued as Valorisation Programme projects.

3.1.5 National policies for stimulating demand for innovation

The Netherlands is a leader in the use of public procurement to stimulate innovation, and the longstanding PIANoO network supports public organisations to undertake this process. The Netherlands have a goal to spend 2.5% of public spending on innovation and have an innovation procurement action plan - "Innovatiegericht Inkopen" - which includes the use of public procurement, Pre-Commercial Procurement and the Small Business Innovation Research (SBIR) scheme and other instruments to stimulate innovation among contracting authorities prior to the actual procurement and dialogue between contracting authorities and businesses[24]. The budget for the SBIR programme has increased from €1.1 million in 2005 to €26.3 million in 2010[25].

3.1.6 Improving frameworks for innovation, including regulation and standards

When launching the Enterprise Policy in the Netherlands, regulation was predominantly seen as something to be organised in ways that are not costly to business. This is ensured by the Dutch Advisory Board on Regulatory Burden (Actal[26]), and independent board responsible for testing and reducing hindrance caused by regulation that has published several reports on innovation-related topics. The Coalition Agreement agreed to reduce the administrative burden for enterprises, citizens and professionals by a figure of €2.5

[23] Technology Foundation STW focuses on knowledge transfer between the technical sciences and users of research results. The Foundation funds top scientific and technical research through a range of grants. Researchers and users collaborate in each project. http://www.nwo.nl/en/about-nwo/organisation/nwo-divisions/tw

[24] http://www.oecd.org/gov/ethics/procurement-innovation-practices-strategies.pdf

[25] https://www.rvo.nl/sites/default/files/bijlagen/SBIR%20brochure%20The%20power%20of%20public%20procurement.pdf

[26] http://www.actal.nl/english/about-actal/

billion ('Goed Geregeld'[27] written by the ministers of Economic Affairs, the Interior and Kingdom Relations). Selected measures include: prevention of unnecessary rules, reducing duplication in data collection, harmonizing and standardizing administrative procedures, focused use of ICT and digital services, and better communication. The Dutch government has also undertaken effort to make individual policy measures more accessible, for example by simplifying the TKI allowance and MIT-measure to attract more SMEs. With the acknowledgment that all authorities exert influence on R&I dynamics, not just regulators explicitly devoted to this topic, a key mission of the Topsector policy is to identify and address regulatory bottlenecks, which require tailor-made solutions with the involved Ministries. Local government is also committed to reducing administrative burdens through the programme 'Better and more concrete: good rules and focused service'.

[27] Jansen Et al. 2016

3.2 Germany

3.2.1 Overall national R&I policy framework

Germany is a global leader in innovation and science. The Federal Government set the mid-term strategic orientations for Germany's R&D and innovation activity in the High-Tech Strategy (HTS) 2006-2013, which were to: reinforce the S&T base, enhance innovation and job creation, and help address global challenges to improve people's lives. The Federal Government invested up to €27 billion between 2010 and 2013 in five fields of action[28] as part of the HTS[29]. Unlike the R&D policy of the past, the HTS promoted not only individual emerging technologies but aimed to respond to society's need for sustainable solutions for clean energy, good and efficient health care, sustainable mobility, secure communications, and Germany's future competitiveness as an industrial location. The HTS also identified wide-ranging forward-looking projects (Zukunftsprojekte) that are expected to affect society. Implementation of the HTS is supported by a host of initiatives including funding private and public R&D, reforming the education system, and improving industry-science linkages. The follow-up to the HTS -the new high-tech strategy ('Neue Hightech-Strategy'[30]) - enacted by the Federal Government in September 2014 is a comprehensive R&I strategy document covering the period until 2017. The new strategy builds on an R&I strategy process that started in 2006 and covers research, education, innovation and technology transfer and 6 topics deemed particularly relevant for future growth and prosperity in Germany: the digital economy and society, sustainable management and energy, innovation within the world of work, healthy living, smart mobility, and civil security. In parallel, the strategy includes measures for speeding up the process of translating scientific findings into specific applications. These measures include those of fostering cooperation between industry and academia, the scientific organisations and the research institutes of the German government, and supporting SMEs, cutting-edge research clusters, and related networks as they seek to engage in international cooperation. [31]The German government will support projects that see the business and science communities cooperate in electric mobility and digital manufacturing (Industrie 4.0 platform of business associations). SMEs are also prioritised - notably the Central Innovation Programme for SMEs (ZIM) and the programme for Joint Industrial Research, which are both technology-neutral.

Germany spent 2.88%[32] of GDP on R&D in 2014, up from 2.72% in 2010[33]. Public and business expenditure on R&D as a proportion of GDP in 2014 are both well above the EU28 average owing to the government's focus on R&D and to Germany's specialisation in R&D-intensive industries. Business expenditure on R&D (BERD) was 1.95% of GDP[34]; higher education R&D Expenditure was 0.51% of GDP (HERD) and the governmental sector R&D expenditure was 0.42% of GDP (GOVERD). GERD is targeted to reach 3% of GDP by 2020, and public investment in R&D and innovation continues to be a political priority.

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[28] Climate/energy, health/nutrition, communication, mobility and security, promotion of key-technologies
[29] BMBF(2012) Federal Report on Research and Innovation 2012
[30] BMBF (2014b), Die Neue Hightech-Strategie Innovationen Für Deutschland, http://www.bmbf.de/pub_hts/HTS_Broschure_Web.pdf.
[31] The "go-cluster" programme launched by the Federal Ministry for Economic Affairs and Energy will continue to support the internationalisation of regional innovation clusters.
[32] DESTATIS, https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/ForschungEntwicklung/Tabellen/FuEAusgabenUndBIPZeitreihe.html
[33] BMBF (2016) : Bildung und Forschung in Zahlen 2016
[34] DESTATIS, https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/ForschungEntwicklung/Tabellen/BIPBundeslaenderSektoren.html

Innovation in SMEs is a central part of all major R&I strategies and Germany's SME sector is highly developed and a fundamental pillar of the national innovation system. This is evidenced by high shares of SMEs innovating in-house and SMEs introducing product, process, marketing and organisational innovations. The EU Innovation Scoreboard 2016 also registered a downward trend for SME innovation indicators with fewer SMEs creating product or process innovations between 2010 and 2012 (-3.1%) as well as marketing or organisational innovations between 2012 and 2014 (-5.4%) compared to the previous year between 2010 and 2012. This is particularly true for sales of new-to-market and new-to-firm innovations as share of turnover for which a downward trend has been registered over the past ten years.

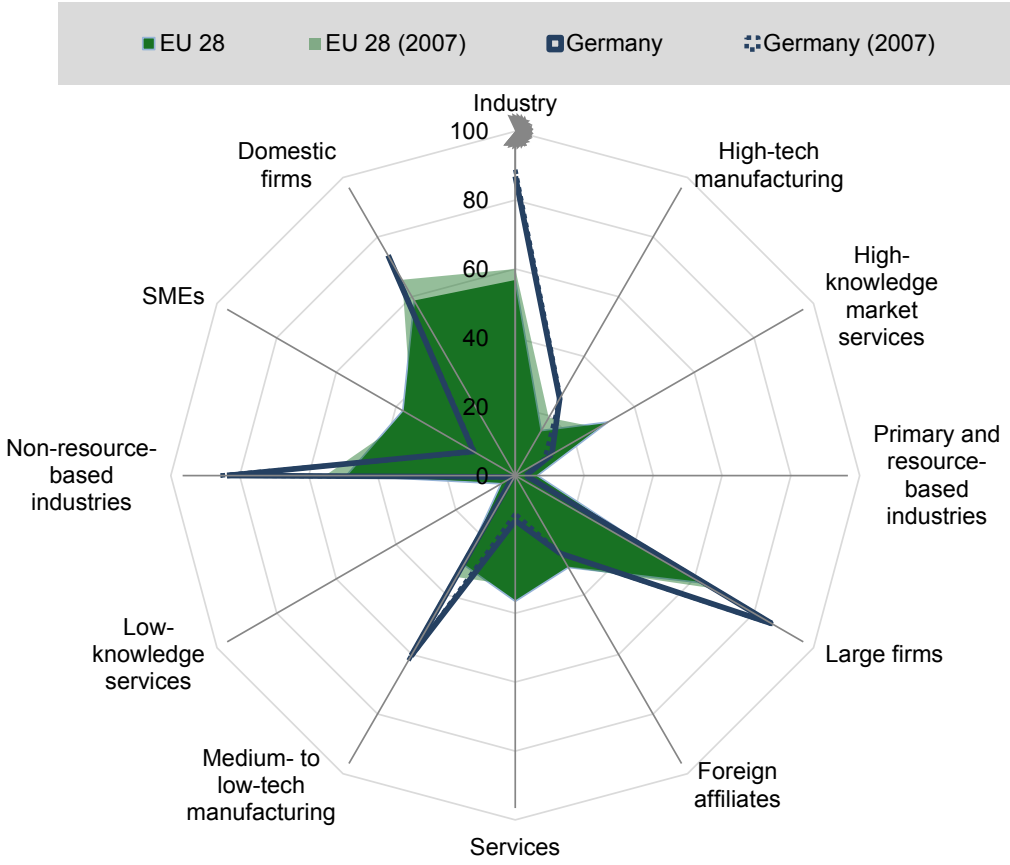
Table 2: Gross domestic expenditure on R&D by source of funds, 2010 and 2014

Indicator	Germany		EU
	2010	2014	2014
GERD as % of the GDP	**2.71 %**	**2.88 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**1.82 %**	**1.93 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.49 %**	**0.51 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.40 %**	**0.42 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

The private sector plays a leading role in financing GERD in Germany, amounting to more than twice the contribution from the government. Germany has the largest Research and Innovation (R&I) system in Europe and the EU Innovation Union Scoreboard 2015 classifies Germany as an innovation leader member state together with Sweden, Denmark and Finland. Firms in high and particularly medium-high technology manufacturing sectors, such as automotive, machinery and equipment, electric equipment, chemicals as well as pharmaceuticals, are the largest R&D investors. Eight of the 50 largest R&D investors in 2015 worldwide are headquartered in Germany, although the participation and investment of important SMEs (the 'Mittelstand') in innovation in Germany has been eroding over time. Germany continues to improve the conditions for entrepreneurship by supporting entrepreneurship and improving the conditions for venture capital investors. German firms actively participate in open innovation activities and knowledge markets, and specialised providers of R&D services such as research institutes are also gaining importance.

Figure 8: Structural composition of BERD, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

3.2.2 National policies for increasing research and development investment

Germany is the only large EU country that does not include tax credits in its R&I funding system. Instead, R&D funding in Germany takes the form of direct funding schemes at federal and state levels (non-repayable cash grants and loans). Approximately €5 billion annually is reserved for R&D projects in the form of non-repayable project grants, which can provide up to 50% of eligible project costs, with larger amounts available to SMEs. Other programmes support SME innovation: the Central Innovation Program for SMEs (ZIM[35]) is one of the most well-known, and the "KMU-innovativ" programme develops SMEs that fall within the technology objectives of the High-Tech Strategy. The ZIM, with €550 million a year, offers grants for SMEs' applied R&D and innovation projects, and Innovation Vouchers (2011-16) are available to fund 50% of the cost of professional advice on innovation management for SMEs. This complements other direct funding schemes such as the High-Tech Gründerfonds for start-up firms (since 2005).

Compared to other EU countries the later stage venture capital market in Germany is underdeveloped and has been identified as a limiting factor for growth in high tech manufacturing and knowledge intensive

[35] The Central Innovation Program for SMEs is a national programs without a specific technological focus

services, which are fields that Germany seeks to develop[36] [37] [38]. Seed, start-up and early stage financing are well pronounced but later stage venture capital financing is less readily available, accounting for only 5% of total funds raised in 2015. Comparatively more firms in Germany received seed financing in 2015 compared to the average received by companies in other European countries (21% of venture capital financed firms and 7% of venture capital provided compared to 13% and 3% respectively).[39] Examples include the "INVEST – grant for venture capital" scheme introduced in 2013 to reduce risk for early stage investors and business angels by reimbursing 20% of equity-capital investments in young innovative enterprises under certain conditions. The High-tech Start-Up Fund launched in 2005 is an investment fund for government technology start-ups operated by the government-owned development bank KfW and industrial partners. Another tool is ERP-Startfonds, which provides up to €5 million early stage equity financing for R&D intensive firms, leveraging matching investments from private lead investors. The Federal Government also announced that it intends to launch a €500 million fund via the European Investment Fund (EIF) to finance the growth of German start-ups.

3.2.3 National policies for augmenting skills and access to expertise

Germany has a strong science base, and high public spending on R&D. Germany ranks fourth globally in terms of publication output and numbers of citations[40]. German researchers are well connected internationally; 49%[41] of scientific articles are published with international co-authorship. Major initiatives are under way to further strengthen the performance of universities and PRIs.

Nevertheless a lack of skilled personnel was identified as an emerging constraint facing the German R&I system in 2014. Two trends influence the human capital underlying the German R&I system: an ageing society which means a large share of scientists and engineers are close to retirement, and a shift in the career choices of secondary school students. The German R&I system has traditionally benefitted from a labour force in which innovation is not exclusively the task of university trained scientists and engineers, but also emerges from the vocational education system. Recent policy initiatives are focused on increasing the attractiveness of vocational training and positioning it as a stepping stone to further, academic qualifications. This is reflected in the "Promotion of Advancement through Training Act" passed by the Federal Government in 2015 which improves the permeability between vocational and academic education and encourages dual university careers combining work with university education.

Opportunities for recognizing foreign professional qualifications in Germany have been improved significantly by the 2012 "Recognition Act". The extension of the Higher Education Pact was designed to address drop-out rates by including new dedicated funds for quality improvements. Moreover the Federal Government will make approximately €2 billion available by 2020 as part of the "Quality Pact for Teaching"

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[36] Sofka, W. (2016), RIO Country Report Germany 2015

[37] Ernst & Young (2015): http://www.ey.com/Publication/vwLUAssets/ey-venture-capital-and-start-ups-in-germany-2015/$FILE/ey-venture-capital-and-start-ups-in-germany-2015.pdf, Berlin: Ernst & Young, http://www.ey.com/Publication/vwLUAssets/ey-venture-capital-and-start-ups-in-germany-2015/$FILE/ey-venture-capital-and-start-ups-in-germany-2015.pdf

[38] EFI (2016), Gutachten Zu Forschung, Innovation Und Technologischer Leistungsfähigkeit Deutschlands 2016, <link: https://www.bmbf.de/files/EFI_Gutachten_2016.pdf

[39] EVCA (2016), European Private Equity Activity Data 2007-2015, http://www.investeurope.eu/research/activity-data/annual-activity-statistics/

[40] OECD (2015), OECD Science Technology and Industry Outlook 2015, OECD Publishing, Paris.; http://www.scimagojr.com/countryrank.php

[41] http://www.scimagojr.com/countrysearch.php?country=de

to enhance the quality of teaching at higher education institutions. The Initiative for Excellence ('Exzellenzinitiative') package (2007-17) is designed to foster elite research in universities by enhancing international visibility and competitiveness in three areas: graduate schools, excellence clusters and institutional strategies.

The Pact for Research and Innovation (updated in 2009) is a joint effort of the federal government and the states (Länder) to increase R&D funding of major PRIs, including the German Research Foundation (DFG), by 5% a year over 2011-15. In all this will mean €4.9 billion in additional funding for R&D. These have recently been complemented by funding schemes such as the Research Campus competition launched by BMBF in 2011.

3.2.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

German industry and science generally have strong links and a very high proportion of public research funded by industry. The goal of forward-looking projects, such as Industry 4.0, Sustainable Mobility and Better Health, is to achieve specific science and technology objectives over the next 10 to 15 years. The Framework Programme Research for Sustainable Development (FONA) (2010-14) supports research on climate change mitigation and adaptation, sustainable resource management, and innovative environmental and energy technologies with a budget of €2 billion to maintain and enhance Germany's position as a leader in these technology areas. The National Research Strategy Bioeconomy 2030, with a budget of €2 billion for 2011-16, aims to strengthen the future competitiveness of the German biotechnology industry and thus to help address global challenges in nutrition, climate change, etc. Other sectoral programmes include the Nano Initiative Action Plan 2015; the Photonics Research Germany programme with €410 million over 2012-15, and the German Space Activities programme which has an annual budget of €1.2 billion. The CLIENT project, a funding line under FONA, helps to establish international partnerships on R&D and application of environmental and climate protection technologies and to trigger the development of lead markets. The Digital Agenda 2014-2017[42] encourages digital development – a long-term priority for economic and innovation policy - concentrates on: Digital Infrastructure; Digital Economy and Digital Workplaces; Innovative public administration; Digital environments in society, education, research, science, culture and media; Security protection and confidence for society and business, and European and international dimensions of the Digital Agenda. The Digital Agenda requires coordinated implementation through the business community, the social partners, civil society and academia.

Industrie 4.0 is a platform of business associations with the overarching objective of utilise the enormous potential of digitisation of commerce and "Industrie 4.0" to strengthen Germany's manufacturing base. In the two funding programmes "Autonomics for Industrie 4.0" and "Smart Service World", the Economic Affairs Ministry is already providing close to €100 million to foster research and innovation in the field of "Industrie 4.0". The substantive work of the platform is initially being undertaken in five working groups (reference architecture, standardisation / research and innovation / security of networked systems / legal framework/ labour, training).

[42] BMWi 2014, Digitale Agenda 2014 – 2017Digitale, http://www.bmwi.de/BMWi/Redaktion/PDF/Publikationen/digitale-agenda-2014-2017,property=pdf,bereich=bmwi,sprache=de,rwb=true.pdf

On-going initiatives to strengthen and improve collaboration between business and science include the Leading Edge Cluster competition (three competition rounds since 2007), with a total funding of €1.2 billion (50% private funds and 50% from BMBF), and Research Campus, a competitive funding scheme under the HTS which enables co-location of private and public research competences under a medium to long-term perspective that build a reliable public-private partnership. The Science and Industry Research Union are tasked among other things with advising on faster and more effective transformation of innovative ideas into innovative products. The Leading Edge Cluster Competition also supports high-performing clusters in their respective areas.

3.2.5 National policies for stimulating demand for innovation

Innovative public procurement is key element in the new Hightech-Strategy, and activities so far have included developing a competence center for the procurement of innovation (with a budget of about €1 million p.a.), the launch of a prize competition (€10k for a purchase of an innovative product or service or an innovative procurement procedure), and a pilot project of pre-commercial procurement.

3.2.6 Improving frameworks for innovation, including regulation and standards

Recent efforts for assessing or reducing inadvertent effects of regulation in Germany on businesses have been centered on a newly enacted law for the reduction of bureaucratic burden in 2016 ('Bürokratieentlastungsgesetz'- (BEG II, PDF: 307 KB),)[43]. The law is particularly aimed at SMEs and reducing requirements for reporting and tax accounting. Parliament has approved the law in July 2015[44] and the Federal Government provided an accompanying commitment to offset new bureaucratic burdens on firms with the reduction of existing ones ('Bürokratiebremse')[45]. Ex-ante assessment of the impact of new law on firms includes an explicit innovation criterion[46]. However, the impact assessment so far finds no effect on innovation as reported by firms. There is no dedicated government department which is predominantly charged with overseeing the effects of regulation. Responses by German firms to the most recent Community Innovation Survey (CIS2012) to the question concerning what degree costs from government regulation are obstacles to innovation activities, 33% indicate that it is not a relevant factor[47] whilst 20.5% indicated this was a highly important obstacle to innovation. Therefore regulation is an important obstacle for innovation but not a dominant one, e.g. 62% of firms in Germany indicate strong price competition as a highly important obstacle to their innovation activities.

[43] https://www.bmwi.de/Redaktion/DE/Dossier/buerokratieabbau.html
[44] Deutsche Bundesrat 2015
[45] http://www.bmwi.de/DE/Presse/pressemitteilungen,did=719462.html
[46] Kienbaum, 2015
[47] ZEW (2014)

3.3 Austria

3.3.1 Overall national R&I policy framework

Austria is a small and open advanced European economy with a strong and well-developed research, technology and innovation (RTI) system which went through rapid progression in recent decades. After nearly two decades of sustained growth, the expansion of R&D expenditure has slowed in the aftermath of the financial crisis, and constraints on public R&D expenditure are tight in current budgets. The main challenge is to increase the efficiency of current R&D expenditure and to continue structural and institutional reforms in research organisations and public administration while launching new initiatives to address bottlenecks.

In March 2011, the Austrian Council of Ministers announced a new national Research, Technology and Innovation (RTI) Strategy for 2011-20, 'Becoming an Innovation Leader'[48], which addresses research and innovation in an integrated manner. It emerged from an ex ante consultation process that included all relevant stakeholders. The strategy includes a target to invest 3.76% of GDP for R&D by 2020, a minimum of 2/3 of which should come from the corporate sector by 2020. The strategy's target of a 10% increase in the number of R&D active companies by 2013 was achieved, and extended to a 25% increase by 2020. A new national target also aims to increase the annual number of start-ups by three percent by 2020.

Austria is characterized by relatively centralised national RTI policy and R&D financing, with only 9.4% of public R&D investments being financed by the regions (i.e. "Bundesländer" or federal states) and 0.2% by municipalities. The regions' R&I policies primarily focus on direct funding of applied R&D to foster science-industry relations, technology transfer and innovation support measures for the regional economy. In 2013, the economy and science portfolios were merged into the new Ministry for Science, Research and Economy.

Table 3: Gross domestic expenditure on R&D by source of funds in Austria, 2010 and 2014

Indicator		Austria	EU
	2010	2014	2014
GERD as % of the GDP	**2.74 %**	**2.79 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**1.84 %**	**2.16 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.71 %**	**0.63 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.14 %**	**0.14 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

GERD increased from 2.74% in 2010 to approximately 2.75% in 2015 and only three EU Member States (the innovation leaders Sweden, Finland and Denmark) show higher current GERD per GDP. BERD as a share of Austrian GDP stood at 2.16% in 2014, significantly higher than the EU-28 average (1.3%). Government intramural expenditure (GOVERD) and expenditure on higher education R&D (HERD) accounted for 0.14% and 0.63% of GDP in 2014 (EU-28: 0.25% and 0.47% respectively).

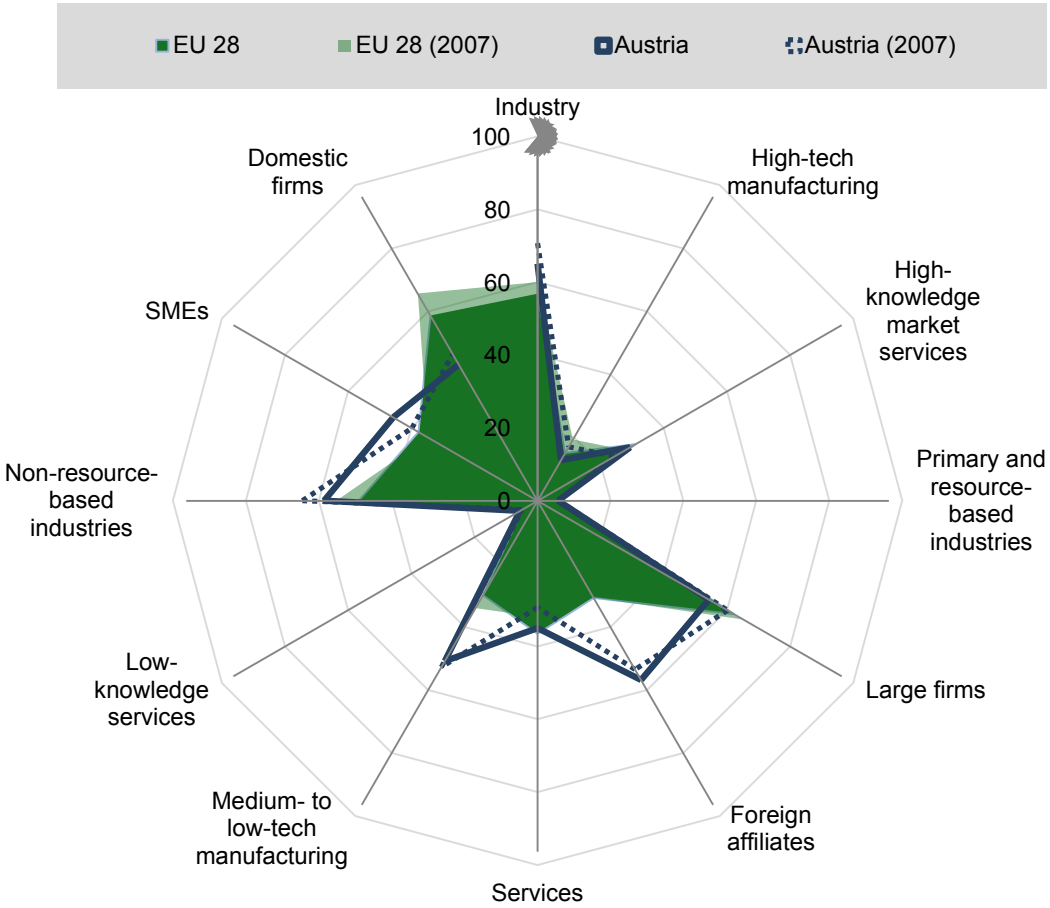
The Austrian private sector is strong in R&D, with BERD having grown continuously in absolute terms from €5,520 million in 2010 to €6,963 million in 2014. The country is ranked 4th in business R&D expenditures in

[48] https://www.bmvit.gv.at/bmvit/en/innovation/policy/index.html

the EU[49]. Employment in medium- and high-tech manufacturing is comparatively high at 5.8% (Netherlands: 2.7%, Belgium: 4.7%, Ireland: 5.2%). Given these indicator values, the innovation performance of the private sector has been somewhat disappointing. Austria ranks only 23rd in non-R&D innovation expenditures[50]. In the Innovation Union Scoreboard, Austria has slid down continuously from 8th to 11th rank between 2011 and 2015. The negative trend of Austria's innovation performance is despite an array of public support instruments for private R&I which has been built up over the past two decades. There has been an increase in measures, supporting in particular SME innovation and cooperation between public research institutions and SMEs. New initiatives to stimulate innovation activity include a package of measures (Jungunternehmer-Offensive[51]) introduced in 2012 to support young entrepreneurs and the Frontrunner Initiative for leading innovative firms. A new voucher scheme for innovation in creative industries was introduced in 2013, and the Loan Initiatives for innovative start-ups as well as the AWS PreSeed and AWS Seed Financing schemes for high-technology companies were broadened and expanded. The number of global corporate investors in R&D is at the EU median and foreign MNEs is the main driver of R&D performed by large companies. However, many innovative, R&D performing SMEs are competitive in niche export markets and a noteworthy strength (see Figure 9).

[49] http://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure
[50] BMVIT 2015
[51] http://www.bmwfw.gv.at/Wirtschaftspolitik/Standortpolitik/Seiten/Information_Alternative_Fruehphasenfinanzierungsinstrumente.aspx

Figure 9: Structural composition of BERD in Austria, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

3.3.2 National policies for increasing research and development investment

In the last 5 years public support has shifted towards indirect support measures[52] and moved slightly towards strengthening business R&D. About 30% of government support was spent in form of indirect support on business R&D[53]. The support the targets in the new RTI Strategy, which seeks to increase the number of research-intensive firms by 3% a year and firms conducting R&D by 25% by 2020, administrative procedures associated with providing fiscal incentives were simplified in 2011[54] and the remaining instrument, the R&D premium, was raised from 10% to 12% to reach €547 million in 2016. The share of tax incentives for R&D expenditures in the policy mix has increased by 42% from 2006-2011 (latest available year). In 2011 tax incentives were consolidated into a single unified tax refund instrument, the research premium ("Forschungsprämie"[55]). Up to 10% of a company's R&D expenditure (including up to €1 million

[52] Mainly supporting tax incentives, public procurement activities and other demand-side policies
[53] https://www.oecd.org/sti/outlook/e-outlook/stipolicyprofiles/competencestoinnovate/innovationpolicymixforbusinessrdandinnovation.htm
[54] Budgetary reform Austria: https://www.bmf.gv.at/services/publikationen/BMF-WP_3_2008_Budgetary_Reform_in_Austria-Towards_tighter_co.pdf?5hhh7q
[55] https://www.ffg.at/forschungspraemie

for extramural research) can be deducted from taxable income, and carry-over and refunds are allowed. The application procedure, which includes certification of the applicant firm by the Austrian Research Promotion Agency (FFG), has been further simplified in 2013 and 2014 to induce more SMEs with low administrative capacity to apply foregone tax revenue was €572 million in 2012, €377 million in 2013 and €495 million in 2014.[56] Furthermore, 74% of indirect funding went to large enterprises in 2014 (77% in 2012), prompting a debate about the effectiveness of the instrument[57]. An evaluation of the instrument's effectiveness had been postponed during 2015, but is likely in 2016.

In comparison with other Member States of similar innovation capacity, Austria's equity financing system is underdeveloped (European Commission 2015). The venture capital (VC) market is small with a total investment volume of €65 million in 2013, total private equity investments in 2013 stood at 0.09% of GDP, which is far below the EU average (0.28%), Business Angel investments in 2013 were also low (€2.9 million) compared to the Netherlands (€9.8 million), Ireland (€13.2 million) or Belgium (€10 million) (OECD 2015).

The low supply of private equity is not particularly linked to the scale-up phase, which is often perceived to be the most problematic one in Europe, but affects all development stages of young companies. In 2015 the Ministry for Science, Research and the Economy issued the "Land of Founders" ("Gründerland") strategy, which includes an ambitious goal to turn Austria into the most attractive location for start-ups in Europe. Stakeholders from the entrepreneurial and venture capital communities contributed to formulating the strategy. A new law on crowdfunding passed in 2015 significantly liberalised and clarified regulation of retail investment. In 2014, the Austrian federal promotional bank AWS established AWS Equity Finder[58], a capital brokerage platform, to facilitate contact between business angels, venture capitalists and crowdfunding and crowd-investment platforms. Aside from improving framework conditions, the Austrian government also provides direct support to boost venture capital supply[59]. Two public venture capital funds have been launched by Austria Wirtschaftsservice Gesellschaft (AWS) in 2013 to facilitate market creation and leverage private VC investment. They focus on early-stage ("Gründerfonds", €65 million) and later-stage investments (€45 million). For the early stages in the start-up process of technology-oriented (potential) companies, AWS administers the instruments "Seedfinancing" and "PreSeed"[60].

3.3.3 National policies for augmenting skills and better access to expertise

Against the backdrop of increased international competition, Austria is preparing for a potential lack of human resources in STI. To rectify this education was included in the RTI Strategy and policy instruments focused on raising participation in MINT subjects (mathematics, informatics, natural and engineering sciences) have been produced. The New Secondary School initiative is a major educational reform and the “Forschungskompetenzen für die Wirtschaft” is an initiative to build R&D skills, while the Lifelong Learning Strategy and the Lifelong Guidance Strategy aim to increase human capital at all levels. Joint ministerial

[56] https://www.parlament.gv.at/PAKT/VHG/XXV/AB/AB_04890/imfname_442347.pdf
[57] http://derstandard.at/2000021530709/Drei-Viertel-der-Forschungspraemie-geht-an-Grossbetriebe
[58] https://equityfinder.at/
[59] http://www.bmwfw.gv.at/Wirtschaftspolitik/Standortpolitik/Seiten/Information_Alternative_Fruehphasenfinanzierungsinstrumente.aspx
http://www.bmwfw.gv.at/Wirtschaftspolitik/Standortpolitik/Seiten/Information_Alternative_Fruehphasenfinanzierungsinstrumente.aspx
[60] http://www.awsg.at/Content.Node/foerderungen_alle/hochtechnologie/48257.php

initiatives such as “Jugend innovative”, Sparkling Science and Innovation Generation aim to stimulate interest in and skills for STI in young people.

3.3.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

Recent initiatives have focused on improving knowledge transfer and science-industry cooperation[61] in order to boost private sector innovation performance, particularly that of SMEs. The share of public-private co-publications in Austria is 3.1% (EU-28 average: 1.8%). Several schemes support facilities where academic and industry researcher's work together, and a publicly funded industrial PhD programme placed its first call in 2014. Longstanding initiatives to promote strategic science-industry collaboration include the competence centres for excellent technologies (COMET), cooperation and innovation networks (COIN-Net), as well as the Christian Doppler (CD) Laboratories. The Josef Ressel Centres programme (started in 2012) applies the principles of the CD Labs in local contexts. The Laura Bassi centres of expertise support a forum for skilled female and male researchers from academia and the private sector to work together. Recent initiatives include the regional and thematic Knowledge Transfer Centres and IPR Commercialisation Programme (2014-18)[62] and new rules and guidelines for the ownership and licensing of publicly funded research results and IPR licensing support for public research institutions.

The Competence Centres for Excellent Technologies (COMET) have received favourable evaluation results. Their role is to facilitate knowledge transfer and cutting-edge private R&D through collaboration between science and industry in jointly defined long-term research programmes. In 2011 the FFG launched a specific programme for high-tech start-ups in Austria, the ‘AplusB’ Academia plus Business programme to ensure a sustainable increase in the number of academic spin-offs; enhancing the exploitation of research results by business and supporting other technology transfer measures. Projects are typically technology-oriented, relatively complex or demanding in terms of the level of supervision and support needed, and of considerable significance in view of the expected impact of structural change and economic growth on the economy. AplusB centres were supported between 2012 and 2014 with €50m. There are presently eight AplusB (Academia plus Business) centres, and in 2002-2014 the founder centres helped 486 businesses get started.[63]

Austria was an “early mover” in cluster policy, founding the Automotive Cluster Styria in 1995. Almost every federal state (Land) runs cluster initiatives or incubators to link companies and research institutions around thematic priorities. Nationwide, there are more than 100 innovation infrastructure sites (Impulszentren). A national platform for clusters was established in 2008 to create a structured and cooperative forum for regional and national clusters. Around 55 cluster initiatives with around 10,000 partners and 20 technology parks participate in the platform. In 2014 the focus will be on enabling technologies and societal challenges.

[61] Cuntz, A. (2015): RIO Country Report Austria 2014. JRC Science and Policy Report. Luxembourg: Publications Office of the European Union, 2015.
[62] New BMWFW Funding Programme Knowledge Transfer Centres and Exploitation of IPR, http://wissenschaft.bmwfw.gv.at/home/research/national/knowledge-transfer-centres-and-exploitation-of-ipr/
[63] Ploder M., Streicher J., Linshalm E., Grasenick K.,.Handler R. (2015) Evaluierung des AplusB-Programms, https://www.bmvit.gv.at/innovation/publikationen/evaluierungen/downloads/aplusb_evaluierung_end.pdf

3.3.5 National policies for stimulating demand for innovation

The Austrian Federal Government adopted the Austrian Action Plan on Public Procurement Promoting Innovation (PPPI) in September 2012. Its aim is to exploit the large procurement volumes distributed by national and municipal authorities (about € 40 billion per anum) is twofold: to encourage industry to deliver innovative goods and services on the one hand, and to supply public bodies and citizens with advanced and (eco)efficient goods and services on the other. The responsibility for the ongoing implementation of the Austrian PPPI Action Plan lies with the Austrian Federal Ministry of Science, Research and Economy (BMWFW) and the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT). In 2013 a PPI Service Centre was established within the federal procurement agency, initiated and financed by the BMW FW and the BMVIT. It is a single point of contact for PPPI issues in Austria, initiates and conducts PPPI pilot projects and offers services in further education and training and has a PPPI online platform. Its goals are to strengthen the Austrian innovation system, the competitiveness of its creative industries and enhance the country's international image as a creative, innovative and cultural nation, among others. Surveys by the ERAC (European Research Area and Innovation Committee) and the OECD confirm that Austria has made "considerable progress" in public procurement promoting innovation (PPPI).

3.3.6 Improving frameworks for innovation, including regulation and standards

Austria is a newcomer who is trying to establish a research, technology, and innovation (RTI) evaluation culture in a reasonable time frame. Unlike the Anglo-Saxon or Scandinavian countries, whose tradition in evaluation goes back several decades, Austria succeeded in leapfrogging and has become one of the leading European countries in RTI evaluation in only a few years. The most specific formalised approach concerning RTI evaluations can be found in the 'Guidelines to support economic-technical research and technology development', which were issued by the Federal Ministry of Transport, Innovation and Technology (BMVIT) in 2007. There it states that "*a written evaluation concept must be established, containing the purpose, aims and procedures, as well as the dates for controlling the achievement of the funding objectives and suitable indicators*"[64] for all funding programmes based on the RTI directive. These guidelines also call for the implementation of monitoring procedures. The guidelines refer to the Research and Technology Funding Act, which explicitly mandates the application and use of evaluations.

[64] Research and Technology Funding Act, Section II, § 12, last accessed on 16 October 2015.

3.4 Czech Republic

3.4.1 Overall national R&I policy framework

The Czech Republic is an open European economy. Industry accounts for more than a third of GDP, considerably above the OECD average. An export-led recovery spurred by the automotive sector started in early 2013, after six quarters of contraction and economic growth is expected to continue gathering pace. While its STI system is catching up with EU15 standards in some respects, the system as a whole is still lagging behind. Improving the framework conditions for innovation (including competitiveness) is one of the main challenges for the Czech Republic. The Country business environment is in need of improvement as whilst the Ease of Entrepreneurship Index has improved over time, it is still below the EU median and venture capital for innovation is scarce.

The National RDI Policy of the Czech Republic 2009–2015 [65] is the central policy document, developed to facilitate the implementation of the Reform of the Research Development and Innovation system in the Czech Republic launched in 2008. In 2013, the Update of the National Research, Development and Innovation Policy (NRDIP) 2009-2015 with an outlook to 2020 assessed the progress. An aim of the Update was to create better framework conditions for innovation, knowledge transfer, diffusion of frontier technologies and development of human resources as well as to re-align the reform agenda with the revised government medium-term budgetary plans in public R&D spending. Three other important strategies influence the Czech research and innovation policy:

(1) The updated National Priorities of Oriented Research, Experimental Development and Innovation[66] that have been summarized under six long-term thematic focus areas: i) Competitive knowledge-based economy; ii) Sustainable energy and material resources; iii) Environment for quality life; iv) Social and cultural challenges, v) Healthy population and vi) Safe society. The priorities are designed to reflect major societal challenges, including those outlined at the EU level, and needs of the society as concrete goals resolvable through RDI in its available capacity by 2030.
(2) The National RIS Strategy, which identifies eight key enabling technologies: i) Advanced materials; ii) Nanotechnology; iii) Micro- and Nano-electronics; iv) Advanced production technologies; v) Photonics; vi) Industrial biotechnology; vii) Knowledge for digital economy, cultural and creative industries; viii) Social science knowledge[67].
(3) The Strategy of International Competitiveness adopted by the Government in 2011[68] and addressed framework conditions affecting innovation performance in a broad sense. The core of the competitiveness strategy called “3i” deals with institutions, infrastructure and innovation; the three pillars that are indicated as the main weaknesses of the current system.

The Technology Agency of the Czech Republic was established to make the governance of the public support system for applied research and development more efficient by removing overlaps. There is no

[65] CRDI (2009) National Research, Development and Innovation Policy of the Czech Republic 2009–2015, http://www.vyzkum.cz/FrontClanek.aspx?idsekce=1020, accessed on 16/04/2015
[66] CRDI (2012) National Priorities of Oriented Research, Experimental Development and Innovation, ttp://www.vyzkum.cz/storage/att/BDEBEF2534A2EA16F06E7B23B378747D/National%20priorities.pdf
[67] MEYS (2014) Národní výzkumná a inovační strategie pro inteligentní specializaci České republiky (Národní RIS3 strategie), http://www.msmt.cz/strukturalni-fondy/ris3-strategie-cr?lang=1,
[68] MIT (2011a) Strategie mezinárodní konkurenceschopnosti České republiky pro období 2012 až 2020, http://www.mpo.cz/dokument87682.html,

comprehensive strategy for the internationalisation of STI. The Interdepartmental Policy of International Cooperation in R&D was being developed as part of the update of the NRDIP by the end of 2014.

The NRDIP (2009-15) set targets of GERD at 2.7% of GDP and public R&D expenditures at 1% of GDP by 2020. GERD increased from 1.34% of GDP in 2010 to 1.98% of GDP in 2014, averaging a 6% increase a year over 2010-14, well above the EU average. The share of industry-R&D expenditure dropped from 0.77% to 1.1% between 2010 and 2014. In spite of efforts to move to a knowledge-intensive economy, innovation performance is lagging. While BERD as a share of GDP is slightly below the EU28 median, innovation output is far below the median. Both the NRDIP and the International Competitiveness Strategy seek to strengthen business innovation. In spite of the impact of the economic downturn on public finance, public support for business R&D and innovation has increased in both relative and absolute terms since 2009, accounting for 58 % of all public R&D and innovation expenditures in 2012[69].

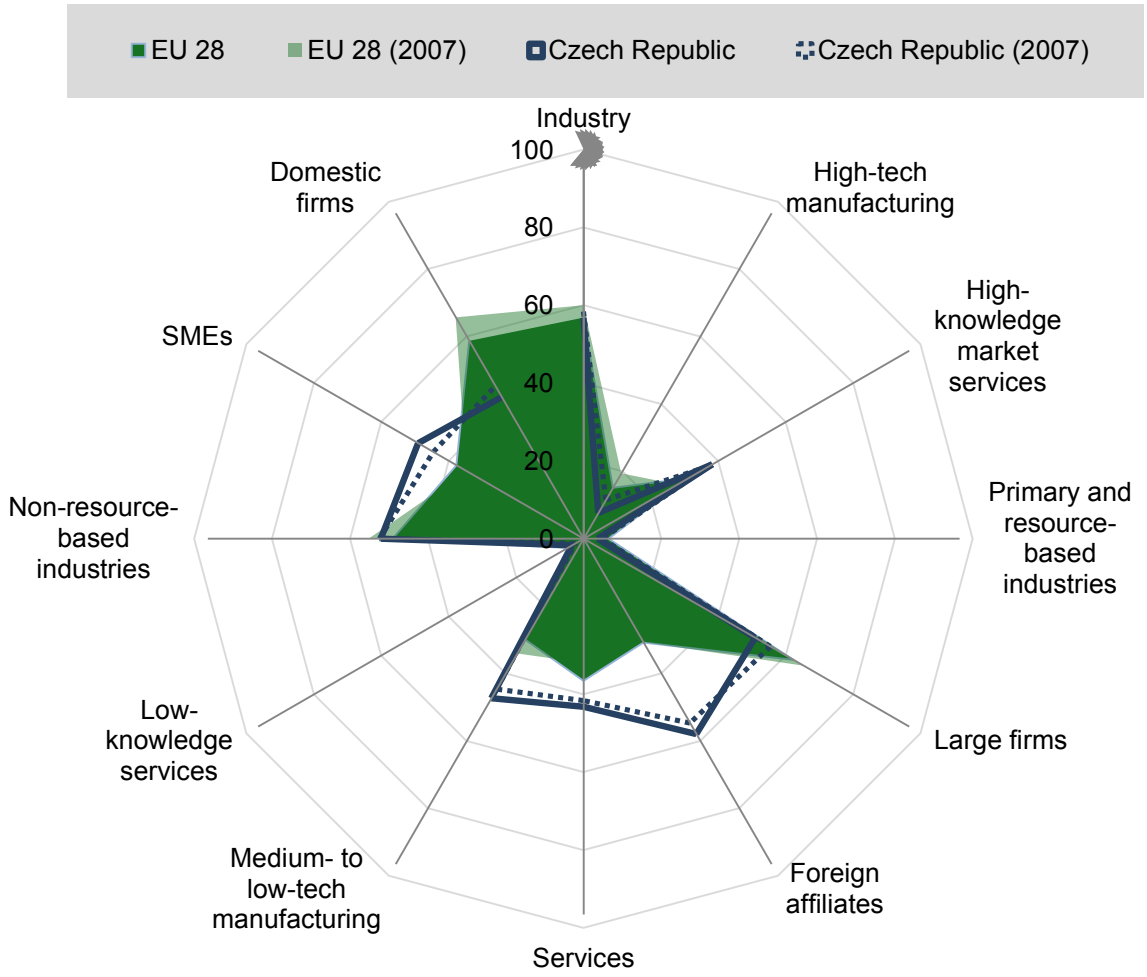
Table 4: Gross domestic expenditure on R&D by source of funds in the Czech Republic, 2010 and 2014

Indicator	Czech Republic		EU
	2010	2014	2014
GERD as % of the GDP	**1.34 %**	**1.98 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**0.77 %**	**1.1 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.27 %**	**0.53 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.29 %**	**0.36 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

[69] Srholec M., Szkuta K. (2016), Rio Country Report 2015 Czech Republic

Figure 10: Structural composition of BERD in the Czech Republic, 2007 and 2012, as a % of total BERD or sub-parts



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

3.4.2 National policies for increasing research and development investment

There are three main sources of R&D funding in the Czech Republic, the largest being the business sector (38%), followed by the government (34%), and foreign funding (27%). EU structural funds also have an increasingly important role, and EC contribution increased from 3.5 % of the publically funded GERD in 2007 to almost 46% in 2013. In general, external funding (category abroad) has become very important as it represented 13.9% of the total GERD in 2010 and over 30% in 2014. It is important to note that this is not only due to the increase in the structural funds but also due to the less dramatic but significant increase in the funding from foreign businesses, with foreign affiliates accounting for 55% of all business expenditure on R&D in 2013.

The Czech Republic is characterized by the high employment in medium-high manufacturing. About one quarter of Czech value added comes from manufacturing industry and this sector accounts for two-thirds of Business Expenditure on R&D (BERD). Still, the majority of BERD concentrates downstream with a predominance of experimental development rather than research and is dominated by a few large foreign

affiliates. This results in a dual economy with R&D intensive multinational companies utilizing imported intermediate outputs and non-innovative and not integrated into the global value chains domestic companies.

Technology Agency of the Czech Republic [70] was established in 2009 as the dominant supporter of applied research and innovation and launched a portfolio of new programmes (most prominently ALFA, the Competence Centres and the forthcoming EPSILON) but none of its programmes are specifically devoted to supporting innovation in SMEs. In 2014, the Czech government has extended the existing tax credits to external R&D services, i.e. contractual research purchased from research organizations[71]. This change was also aimed at stimulating industry-academia collaboration.

3.4.3 National policies for augmenting skills and better access to expertise

The public research system has gradually improved in recent years, but challenges remain. Public R&D expenditures as a percentage of GDP are well above the EU28 median, and publications in top quartile journals have almost reached the EU28 median, however, there are still relatively few top universities. Following the above-mentioned evaluation and update, the NRDIP has sought to increase the efficiency and responsiveness of public research and cut institutional funding from 56% of GBAORD in 2009 to 5 % in 2013. In addition, a new annual performance-based evaluation is to be used to allocate funding to PRIs and universities.

Improving overall human resources, skills and capacity building is stressed in the national innovation policy. The tertiary education expenditure is at the EU median and only 17% of the adult population is tertiary-qualified[72], compared to 27% for the EU28. The 2009 White Paper on Tertiary Education is the basis for reform. Coordinated and executed by the Ministry of Education, Youth and Sports (MEYS), the reform aims to improve financial support for students, standardise PhD programmes, and increase university research. ERC[73] CZ and NÁVRAT[74] (2012-19), both launched in 2012, support research excellence and researcher mobility with CZK 1 065 million.

3.4.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

The Czech Republic is linked to global science and innovation networks to varying degrees. International co-patenting is above and international co-authorship is below the EU median. The Interdepartmental Policy of International Co-operation in R&D (see below) will set objectives for increasing international collaboration in STI, for improving conditions for the participation of Czech researchers in international research programmes, and for increasing the effectiveness of R&D co-operation. National initiatives to

[70] Technology Agency of the Czech Republic (TA CR) provides competitive funding for applied research, experimental development and innovation.

71 Originally the Czech R&D tax credit scheme was introduced in 2005 with the aim of stimulating private R&D expenditure. It was introduced as a deduction from the income tax in the amount of 100 % of expenditure on R&D in the taxable period, http://www.czechlegislation.com/en/586-1992-sb ,

[72] OECD 2014

[73] The ERC operates according to a "curiosity-driven", or "bottom-up", approach, allowing researchers to identify new opportunities in any field of research. Accordingly the portfolio ERC funded projects spans a wide range of topics and research questions.

[74] A programme called NÁVRAT, i.e. “return" in English, administered by the MEYS is aimed to improve conditions for re-integration of top researchers coming back from abroad. Only a small number, not more than several dozens, of researchers have been supported by these programmes so far.

foster internationalisation include COST CZ (2011-17), EUREKA CZ (2011-17), EUPRO II (2011-17), KONTAKT II (2011-17), MOBILITY (2011-18), GESHER (2010-16) and INGO II (2011-17)[75].

Science and technology parks, regional innovation centres and agencies play a significant role in the regional innovation infrastructure and in the formulation, implementation and evaluation of regional strategies. The European Union and the Czech government have invested €102 million in the establishment of these parks, e.g. Technology and Innovation Centre of the Czech Technical University in Prague, the South Moravian Innovation Centre in Brno, the Science and Technology Park of Palacky University and the University of West Bohemia in Plze, and the Innovation Centre of the Technical University in Ostrava.

A set of Competence Centres supports RDI centres in progressive fields that involve long-term public-private collaboration. The centres have a budget of about €240 million over 2012-2019, and complemented by other programmes such as:

- Programme ALFA, which supports applied research and experimental development and stimulates public-private R&D cooperation with a budget of about €290 million over 2011-2016.
- OMEGA supports applied social science research and experimental development with a budget of €12 million over 2012-2017.
- GAMA funds the verification of R&D results in terms of their practical application and their commercial use with a budget of €69 million over 2014-2019; DELTA provides grants for joint international projects with third countries with a budget of €30 million over 2014-2019.
- EPSILON, a follow-up of ALFA, will support applied research and experimental development with a high potential for rapid application in innovations in competitive knowledge-based economy, sustainability of energy and material resources and environment for quality of life. It has a budget allocation of €373 million over 2015-2025.

3.4.5 National policies for stimulating demand for innovation

One of the Competence Centres - BETA - specifically includes a programme of public procurement in research, experimental development and innovation for the needs of public administration bodies with a budget of €25 million over 2012-2016.

The Czech Republic is adopting the legal and other measures required to facilitate public procurement of innovation initiatives, and public authorities are participating in Pre-Commercial Procurement programmes with other member states.

3.4.6 Improving frameworks for innovation, including regulation and standards

Evaluation framework is underdeveloped in the Czech Republic, there have been no policy actions assessing the impact of regulation on innovation. (RIO Country Report on Czech Republic, 2016)

[75] Srholec M., Szkuta K. (2016), Rio Country Report 2015 Czech Republic

3.5 Finland

3.5.1 Overall national R&I policy framework

Finland is a northern European economy with an industrial structure dominated by high technology and medium-high technology. It has a strong and sustained technological specialization in ICT, metal products and machinery, environment, materials, energy, wellbeing, and food and agriculture sectors. Overall, the Finnish STI system performs well by EU28 standards[76]. Over the last decade, the Finnish economy has been going through major structural reforms and the earlier strong export sectors (e.g. forestry and paper, metal industry, ICT) have radically diminished. Finnish strategic objectives for research and innovation policies have undergone gradual changes during the last years - largely initiated by the 2009 international evaluation of the R&I system. The key weaknesses identified in the evaluation related to the lack of growth entrepreneurship and difficulties in internationalisation. In response, the economic policy has focused increasingly on facilitating swift industrial reforms and in supporting start-ups and high growth companies. The current policy approach does include demand-side measures (such as public procurement for innovation), while the majority are still supply-side instruments. Much emphasis has been put on increasing the performance of public policies for R&I and internationalisation through joint activities and strategic programmes; the new Team Finland and the Council of Strategic Research in the Academy of Finland are prime examples in that regard.

An Action Plan for Research and Innovation Policy (TINTO) has been implemented since December 2012 with a renewed focus on education and an emphasis on research and innovation at all levels. In September 2013, the Finnish government also adopted a "Resolution on Comprehensive Reform of State Research Institutes and Research Funding"[77], which focuses on building up multidisciplinary, high-level research of significant societal relevance and research in support of government decision making. The resolution covers re-organisation of PRIs, reallocation of some public research funding to competitive research funding, and creation of a new, strategic research funding instrument within the Academy of Finland to support long-term research on challenges facing Finnish society.

Regarding the Finnish governance system, it is centralised in terms of national guidelines, strategies and funding but a mix of national and local administration allows regions to have a relatively high degree of autonomy in the design and implementation of regional policies. Regions' role is especially focused on allocating structural funds. The major R&I programmes in Finland are thematic and funded by the Academy of Finland, Tekes and by the industry led SHOK consortia. However, as stipulated in the new Government Programme, the SHOK[78] and INKA[79] programmes will be terminated, leaving the Academy and Tekes as the main programme funders.

The combined impact of the economic recession and Nokia's restructuring caused a remarkable decline both in public and private R&D investments. R&D investments have declined in Finland since 2010 from €7,164 million to €6,512 million in 2014 (Eurostat), and GERD (as % of GDP) has declined since 2010 when it

[76] Finland still ranks among the World's best in R&D intensity (Eurostat) and competitiveness (WEF; The Global Competitiveness Report 2015 – 2016), in terms of scientific and technological excellence and Innovation (Innovation Union Scoreboard or IUS 2015) and (GII - Global Innovation Index 2015; Cornell University, INSEAD, and the World Intellectual Property Organization WIPO).
[77] http://vnk.fi/en/comprehensive-reform-of-state-research-institutes-and-research-funding
[78] Strategic Centres for Science, Technology and Innovation (SHOK)
[79] Regional innovation programme called Innovative Cities (INKA)

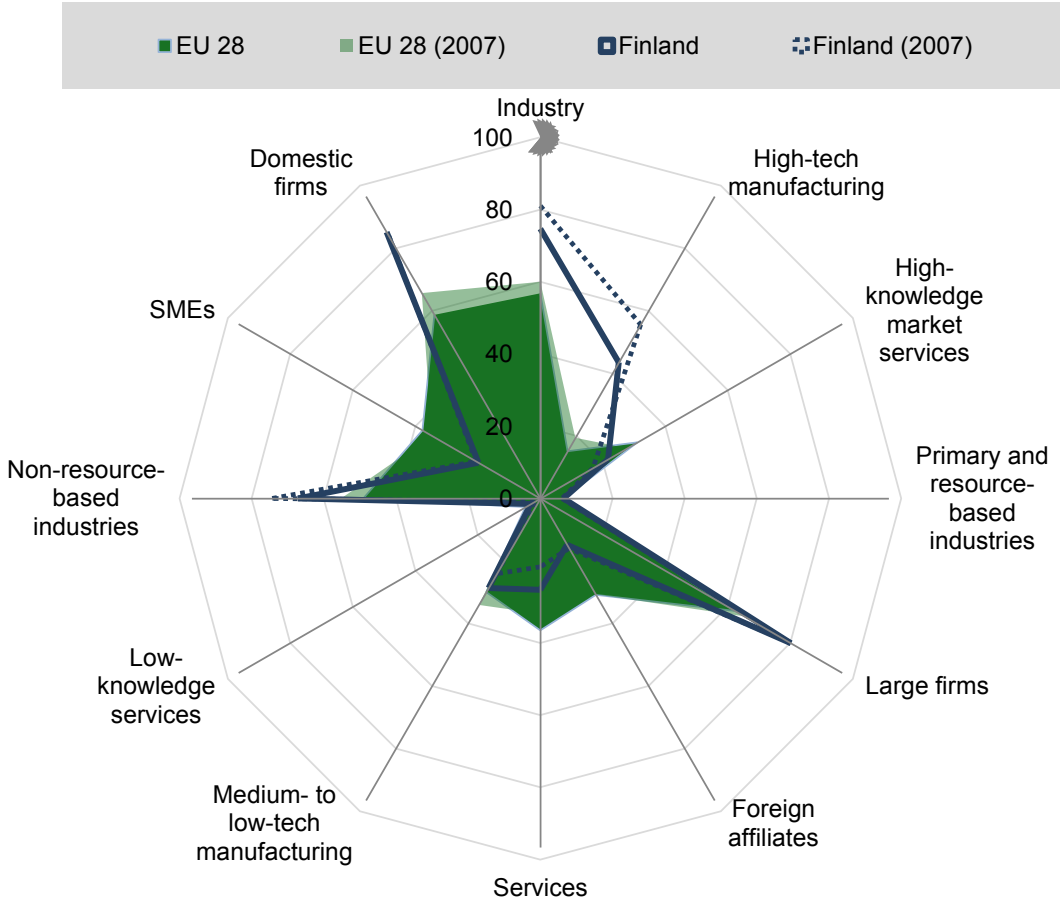
was 3.9% to 3.55% in 2014 and has continued to decline after that. Finland's BERD intensity is well above the EU28 median. In 2014 business R&D expenditure (BERD) was €4.4 billion (2.15% of GDP). BERD is primarily performed by the high-technology manufacturing sector and large firms such as Nokia (see Figure 11). Although still the EU's top R&D investor, private sector R&D spending declined and so has public funding more recently so Finland does not meet its 4% R&D intensity target. Finland's BERD intensity is well above the EU median.

Table 5: Gross domestic expenditure on R&D by source of funds in Finland, 2010 and 2014

Indicator	Finland		EU
	2010	2014	2014
GERD as % of the GDP	**3.75 %**	**3.17 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**2.59 %**	**2.15 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.76 %**	**0.73 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.34 %**	**0.27 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

Figure 11: Structural composition of BERD in Finland, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

In Finland 74.7% of business R&D expenditure is performed by industry, compared to 25.3% in the services sector.

3.5.2 National policies for increasing research and development investment

The Government's objective is to use business aid to restructure the economy and industry and to boost the internationalisation of companies; at the same time the Government significantly cuts R&D grants for enterprises. The future focus of R&D Investments is state aid from direct grants to refundable forms of funding, such as loans, guarantees and equity investments.

The conditional or subsidised loans and grants from TEKES are the most important measures for increasing research and development investment. In 2013 the government adopted an extensive growth funding programme (2014-17) for start-up and new innovative companies. Connected with the growth companies, a temporary tax incentive for private investment in start-ups was introduced, and Vigo accelerators[80] were set up and expanded to increase the volume of the domestic venture capital market. The newly founded Tekes Venture Capital Ltd[81] adopts asymmetric profit distribution mechanisms functioning as the fund of funds. During its first year, over 600 companies used this benefit and received an average €125,000 tax deduction (RIO Country report Finland). The government also decided on a fixed-term tax credit in 2013–2015 for private individuals to invest in start-up companies.

3.5.3 National policies for augmenting skills and better access to expertise

Finland has a strong science base, high public expenditure on R&D, highly ranked universities and a high rate of scientific publications relative to GDP. A number of measures in recent years aim to increase the quality of the science base through structural changes, improving financial incentives and reforming the financing models. These include the new University funding model (2013), the structural development scheme for polytechnics (implemented in 2014), the reform of research institutes and research funding (starting 2014) including the establishment of Council of Strategic Research in the Academy of Finland (SRA) in 2014, and the R&I recommendations for 2015-2020 by the Research and Innovation Council. A new funding model for universities was introduced in 2013, with greater emphasis on quality, effectiveness and internationalisation, and strategic funding to support universities' profiles and their diversity has been increased. The new funding model has been reviewed in 2015. A new Polytechnics Act will take force from the beginning of 2014 to help polytechnics to meet changes and challenges in Finnish workplaces and society by shifting responsibility for their basic funding to the state and by granting them the status of independent legal entities. In 2015 a new program called Post Docs in Companies (PoDoCo) was introduced in Finland. The purpose of PoDoCo is to support the placement of Doctoral students in companies, aiming eventually to the strategic renewal of the Finnish industry and helping PhD students find opportunities to pursue industrial careers.

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[80] The Vigo Accelerators are private companies that are run by experienced entrepreneurs. The Accelerators offer their proven business expertise, funding and extensive contact networks to the target companies. The Accelerators invest both money and time into the target companies and take on both a strategic and an operative role in the companies. The Accelerators have been selected from the best applicants in their respective fields in a public procurement process.

[81] Tekes Venture Capital Ltd invests in venture capital funds which invest in companies in their early stages of development. The purpose of the company is to develop Finland's venture capital market. The market is developed in cooperation with private investors. At least half of the capital in the target funds is raised by private investors. Through the provision of venture capital, early stage companies can achieve their development and growth targets.

3.5.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

According to a study conducted in 2014, currently there is significant uncertainty among the business enterprises in Finland regarding the long-term development of the Finnish innovation system. The Strategic Centres for Science, Technology and Innovation (SHOK) were public-private partnerships for innovation to meet the needs of Finnish industry and society in the next five to ten years. They focus on energy, environment, bioeconomy, health and well-being, ICT, and metal products and mechanical engineering. SHOK activities are being developed on the basis of the international evaluation of SHOKs in 2013. From 2014 the Centre of Expertise Programme (OSKE 1994-2013) will be replaced by INKA, the Innovative Cities Programme (2014-20). The programme has selected 12 urban regions in which to create and strengthen internationally attractive innovation clusters. The Smart City Programme (2013-17) supports collaborative projects between business, municipalities and research organisations to provide companies with opportunities to bring new products and services to the market. The new INKA programme has incorporated the EU Smart Specialisation concept. A synchronised national and regional innovation strategy was updated in 2013 when city regions organised large-scale planning in order to participate in INKA. As both the SHOKs and the INKA programme were terminated at the end of 2015, the effects of which remain to be seen.

Success in science, research and innovation is becoming more global in terms of collaboration, and access to human as well as financial resources. However, the degree of STI internationalisation in Finland is quite weak, affecting both public and private sectors. Finland shows moderate levels of international funding for R&D (17% of GERD in 2014). Finland's volume of stocks of foreign direct investment (FDI/ GDP) is at 38% in 2014, being also lower than in other leading countries. To exceed the EU average in the stock of FDI as a share of GDP (46.6% in 2012) by 2020 from its current level, the government adopted in December 2012 a decision- in-principle, Team Finland – Strategy for Promoting Foreign Investment, this strategy seeks to improve the efficiency of existing FDI promotion efforts by bringing them under a single umbrella. In addition, international companies conducting R&D activities in Finland can apply for Tekes' funding even without being registered in Finland or having a Finnish partner.[82]

Finland is committed to addressing the weak internationalisation of its science base. To support several EU programme participation and broader internationalisation, the University funding model reforms in 2013 sought to increase incentives for internationalisation. The Finland Distinguished Professor Programme (FiDiPro) scheme was established to attract high level foreign talent to Finland. Finally, venture capital funding through the Vigo Accelerator and by YIC funding scheme aims to attract foreign investment for start-ups in Finland. Finland slightly increased its applications to H2020 compared with FP7, although there was a slight decline in signed grants.

3.5.5 National policies for stimulating demand for innovation

Prior to 2009 the role of innovation oriented public procurement was modest in Finland but the development of public procurement in research and innovation policies is high on the political agenda[83].

[82] http://www.finland.org/public/default.aspx?nodeid=44642

[83] Both the Public Procurement Act (348/2007) and the Government Decree on public procurement (614/2007) implement Directive 2004/18/EC. Procurement in the water, energy, transportation and postal sectors: The Act on public contracts in the utility sectors (349/2007) implements Directive 2004/17/EC. Defence and security procurement: The Act on Public Procurement in Defence and Security (29.12.2011/1531) implements Directive 2009/81/EC92.

The target to increase the share of innovative public procurement up to 5% is a strong incentive for innovation, although the means to reach the target have not been defined. The total value of public procurement in Finland was €33.09 billion Euro in 2012, equal to approx. 17.2% of GDP.(2014, European Commission, DG Internal Market study) The public sector has a significant role in the development and renewal of markets (e.g. health, social services, environment, construction, and transport) and municipalities represent 2/3 of procurement volume. (RIO Country Report 2015: Finland). Tekes have several programmes (like Smart Procurement Programme[84] (2013-16)) for piloting public procurement of innovation – the projects were funded with the main focus areas of construction and real estate, social and health care, energy and environment, and water supply. This funding is targeted at all Contracting Authorities, and it typically covers 50% (depending on type of cost, funding can vary between 25% and 75%) of total project costs. The procurement must be extensive enough to have an impact on the development of the sector, at least regionally.

3.5.6 Improving frameworks for innovation, including regulation and standards

Improvement of the regulatory framework for business is among the top priorities in the new government Programme[85]. The programme acknowledges that "due to excessive regulation and administration, Finland has lost its agility and competitiveness". The government Programme further states that "The government will assess all EU regulation from the perspective of economic growth, competitiveness and jobs, and will also require a corresponding approach by EU institutions." The implementation plan of the Government Programme identifies several actions that will reduce the regulatory burden of companies.

Much of this deregulation focuses on labour market issues or promoting open markets and competition environment. However, by the time of writing, these actions have not yet been identified in detail. It is likely that in terms of new innovations the most relevant actions are related to the priority sectors (cleantech, digitalisation, bioeconomy and health services).

[84] The Smart Procurement Programme aims to create new market opportunities for SMEs and produce ground-breaking innovative solutions to serve the needs of the Finnish public sector. The main focus areas for the programme are those areas in which the public (or private) procurement has a major impact on the market: energy and environment, ICT, health care, built environment, security and safety and private strategic procurement. The programme budget is about € 60m of which TEKES covers half.

[85] http://valtioneuvosto.fi/en/sipila/government-programme

3.6 Estonia

3.6.1 Overall national R&I policy framework

Estonia is a small European economy, where 90% of enterprises are micro enterprises with less than 10 employees[86]. Following the Knowledge-Based Estonia II Research and Development and Innovation Strategy (2007-13), the government has created two medium-term strategies: the Estonian Research and Development and Innovation Strategy (2014-20) the "Knowledge-based Estonia" (launched in January 2014) and the Estonian Entrepreneurship Growth Strategy (2014-20). These two new medium-term strategies were prepared together in a coordinated process.

The structure and basis of Estonia's research and development (R&D) system is the Organisation of Research and Development Organisation Act (RDOA)[87]. Based on the 2011 amendments of ORDA, several changes in governance have been made since 2012. The Estonian Research Council was established in March 2012 and combines the functions of several previous bodies (the Estonian Science Foundation, the Research Competence Council, and the Department of International Co-operation of the Archimedes Foundation). The Research and Development Council advises the Government of the Republic on matters related to R&D.

A strategic aim of the Estonian R&D and Innovation Strategy (2014-20) is to strengthen the role of branch ministries[88] in supporting R&D in socio-economically important areas. Representatives of these ministries are being invited to the advisory bodies of the Ministry of Research and the Ministry of Economic Affairs and Communication (MEAC) and are involved in preparations to join international research networks (such as joint programming initiatives). The instruments of financing Estonian research and development activities are base financing, research grants, national science programmes, financing of centres of excellence and doctoral schools, covering the expense of research and development infrastructure.

Table 6: Gross domestic expenditure on R&D by source of funds in Estonia, 2010 and 2014

Indicator		Estonia	EU
	2010	2014	2014
GERD as % of the GDP	**1.58 %**	**1.44 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**0.79 %**	**0.63 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.60 %**	**0.64 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.16 %**	**0.17 %**	**0.25 %**

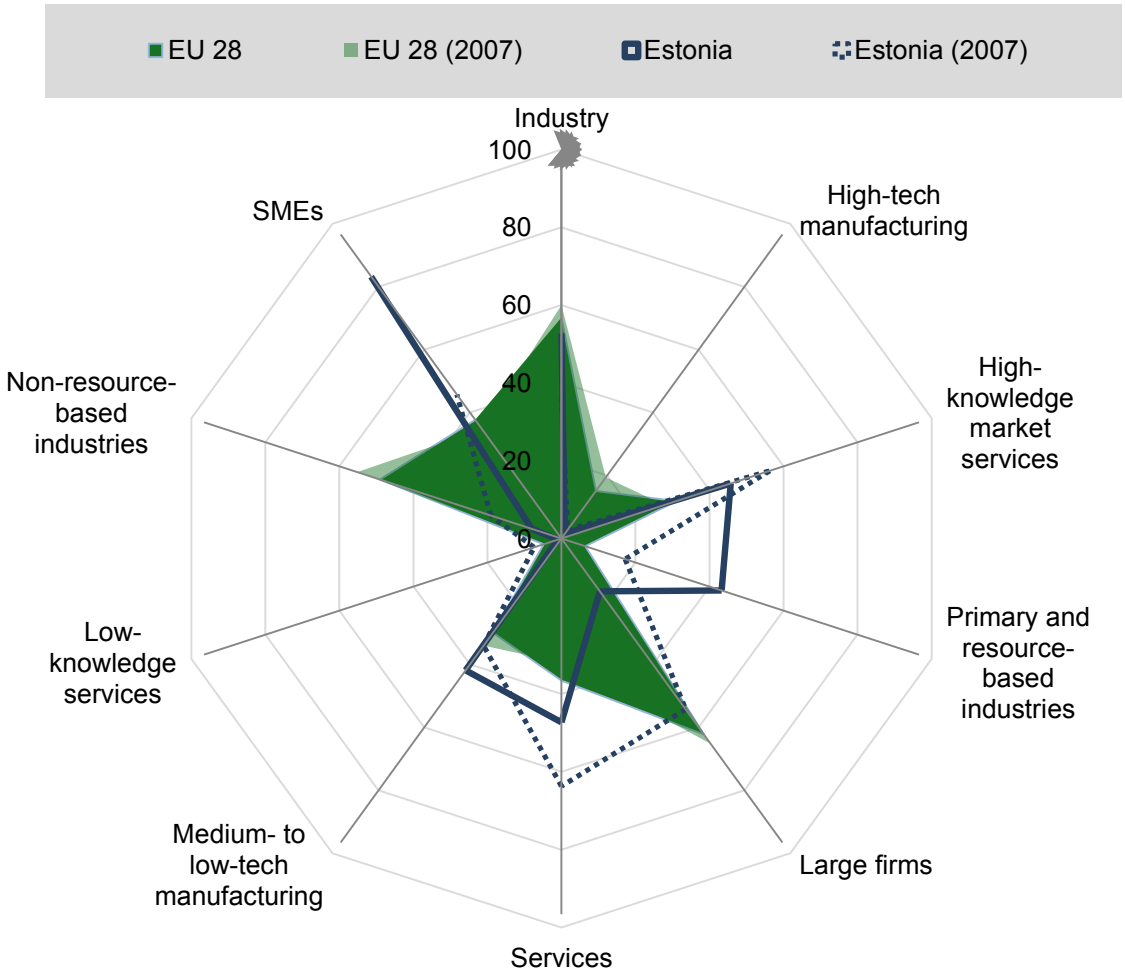
Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

[86] Statistics Estonia 2015, News http://www.stat.ee/78415/?highlight=teenindus

[87] The Government of the Republic prepares national R&D development plans, submits them to the Riigikogu (parliament), approves national R&D programmes and ensures the cooperation between the ministries and enacts legislation

[88] The Ministry of Education and Research implements national research policy organizes the financing and evaluation of the activities of R&D institutions and coordinates international research cooperation at the national level. The Ministry is also responsible for the planning, coordination, execution and monitoring of research policy related to the activities of universities and research institutes. The Minister of Education and Research is advised by the Research Policy Committee. The Ministry of Economic Affairs and Communications is responsible for planning, coordinating and executing research and development activities and innovation policy related to business.

Figure 12: Structural composition of BERD in Estonia, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

Estonia has one of the fastest increases in R&D expenditure in the EU. In Estonia 52.7% of business R&D expenditure is performed by industry, compared to 47.3% in the services sector. BERD is concentrated in medium-high to low-technology manufacturing and services and in a small number of firms. Productivity growth and higher employment through capital deepening and structural change to higher added value activities are central objectives of the government's economic policy. Innovation is considered essential to achieving these goals and the government is committed to stimulating business R&D and innovation through direct funding and non-financial measures with a combined budget of €140 million over 2014-20. The target towards total R&D investments (GERD) in 2020 is set at 3% of GDP and business sector R&D investments (BERD) at 2% of GDP by 2020. Considering the relatively weak economic growth, the decline of BERD and also of GBAORD, reaching the target in 2020 is not very likely.

3.6.1 National policies for increasing research and development investment

Estonia has a conductive business environment, and an improved supply of venture capital. Through the Estonian Entrepreneurship Growth Strategy, the government aims to shift to a market- based approach to public support, with fewer direct grants and more financial instruments, including venture capital. In addition to project financing, it will put services (e.g. strategic business analysis, project planning, and capacity building for enterprises) at the heart of its support for business innovation[89]. Over 2014-20, the government has allocated €85 million for the Entrepreneurs' Development Programme and Innovation Voucher scheme, €48 million for various entrepreneurship schemes, and €7 million for innovative start-ups (Start-up Estonia). Energy, sustainable development and environmental issues are increasingly important government priorities. In 2008-15 the Estonian government has six national programmes in support of R&D in energy technology, ICT, biotechnology, health, environment technology and material technology.

The Estonian Energy Technology Programme is a cooperative programme involving research, business and the state to develop oil shale technologies and new, mainly renewable, energies. The centres of excellence and competence centres also target ICTs, the environment, new materials, health care and medicine. Launched in 2012, the Baltic Innovation Fund (BIF), €100 million for 2013-16, will invest in private equity and VC funds in Estonia, Latvia and Lithuania.

3.6.2 National policies for augmenting skills and better access to expertise

In 2010, the government adopted a Research Infrastructures Roadmap for upgrading existing research infrastructures and creating new ones. It lists 20 research infrastructures of national importance to guide public investments in R&D infrastructures over the next 10-20 years. Over 2007-13, investments in R&D infrastructures – €177 million) were largely funded by EU Structural Funds. In continuing to modernise R&D infrastructures, the government's priorities are to achieve sustainable funding and maintenance of R&D infrastructures and to support the effective use and sharing of these infrastructures, including with the business sector. The Research Infrastructures Roadmap was updated in 2014[90].

Estonia already has a good skills base, with in-school students performing very well in science. With regard to skills development, the government's priorities are to continue to develop human resources with a focus on engineers, to turn brain drain into balanced brain circulation, and to increase the attractiveness of careers in research. The R&D and Innovation Strategy aims for 300 PhD graduates a year by 2020. The Estonian Euraxess Services[91] Network provides information services and customized assistance for increasing the inward and outward mobility of foreign and Estonian highly skilled people. Several public initiatives aim to raise young people's interest in S&T careers to address the relatively low rate of doctoral graduates in science and engineering. For 2014-20 specific measures are being planned to support the development of human resources and to raise the quality of teaching.

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[89] Estonia received country specific recommendations in the 2012, 2013, 2014 and 2015 European semester cycles. The Council recommendations have been almost identical during the years 2013-2015 and they focus on intensifying prioritisation and specialisation in the research and innovation system. The 2015 CSR is worded as follows: "Focus public support for research and innovation on a coordinated implementation of the limited number of Smart Specialisation areas." Through the implementation the Estonian Entrepreneurship Growth Strategy Estonia aims stimulating and focusing RD&I investment.

[90] https://hm.ee/en/activities/research-and-development/financing-infrastructure

[91] http://euraxess.ee/

Public research has improved significantly over more the last decade. Today, Estonia has a relatively strong public research system, with a high level of public R&D expenditures and strong performance in terms of international scientific publications. The system is quite well connected to global knowledge and innovation networks. However, industry-science linkages are not very strong. Efforts are being made to strengthen interactions between the scientific and business communities. For example, the University of Tartu has adopted a new governance structure that involves external partners in the university's management. The government has a programme for training doctoral students in cooperation with firms as well (OECD 2014).

3.6.3 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

The need to address the weak cooperation between science and business is identified as a major challenge of the Estonian R&I system in the RIO country specific recommendations for 2012, 2013 and 2014 by as well as the Country Reports issued by the European Commission in the frame of the European Semester exercise[92]. There seems to be an inherent mismatch between the needs of the business sector and the provision of knowledge from the public sector. Estonia's National Reform Programme 2014 acknowledges the need to further strengthen cooperation between research institutes and companies but is vague on specific actions. As regards specific knowledge transfer promotion programs, clusters and technological development centres are being set up. The 2014-2020 Technological Development centres (competence centres) programme (opened its new round in November 2014, continuing from the previous programming period) provide Estonia's entrepreneurs with opportunities for cooperation in the development of new technologies, products and services and aims to increase qualified staff in business-oriented R&D, and their movement between businesses and research institutions. Estonia has also introduced innovation voucher grants for SMEs. The 2014-2020 Cluster Development Programme (new round opened in June 2015) aims to increase the value added of companies and the sales of their products/services (including exports) as well as to promote cooperation between companies and research institutions.

Estonia does not have a separate national or regional R&I strategy on Smart Specialisation – a form of lead market development policy. Instead, the country's Smart Specialisation framework comprises the Entrepreneurship Growth Strategy (adopted by the government in October 2013) and the Research, Development and Innovation Strategy (adopted in January 2014). Investing in Smart Specialisation high-growth areas to increase the return on public investment in R&D is the guiding principle for targeting priority areas. The new R&D and Innovation Strategy prioritises RDI investments selected and managed using the Smart Specialisation approach to foster faster growth in the selected fields. These are: ICT, including the use of ICT in industry and other sectors, cyber-security and software development; health technologies and services, including biotechnology, e-health (IT use in the development of medical services and products); and more effective use of resources, including materials science and industry, innovative construction, i.e. "smart houses", health-promoting foods, chemical industry (more effective use of oil shale).

The Estonian Entrepreneurship Growth Strategy targets the ICT, health and resource-based sectors of the economy and The Entrepreneurs' Development Programme was launched in 2013 to increase the international competitiveness of Estonian firms through better strategic planning, R&D and skills development.

[92] DG ECFIN, Country report for Estonia http://ec.europa.eu/europe2020/pdf/csr2015/cr2015_estonia_en.pdf,

3.6.4 National policies for stimulating demand for innovation

Estonia has not (yet) developed and agreed upon a strategic framework for innovation procurement. Elements of demand-side innovation policy are included in some initiatives and programmes, but this is not the outcome of systemic policy implementation[93].

3.6.5 Improving frameworks for innovation, including regulation and standards

Rules for Good Legislative Practice and Legislative Drafting[94] (passed by the Government in 2011) stipulate that any legislative intent, concept and draft Act is prepared, an impact assessment is carried out, a report on the impact assessment is prepared and an ex-post impact assessment is carried out in compliance with the Methodology of impact assessment (approved by the Government in 2012). The same principles and methodology also applies to strategies and other policy measures of all fields, including innovation policies.

MEAC regularly carries out feasibility studies and ex-ante and ex-post evaluations of policy measures and programmes[95] since the early 2000s and uses the results to improve policies and measures. There is no special government department responsible for overseeing the impacts of regulation on innovation. Evaluations are commissioned by MEAC to different institutions, depending on the issue and based on the expertise of evaluators.

[96]

[93] http://www.oecd.org/gov/ethics/procurement-innovation-practices-strategies.pdf
[94] https://www.riigiteataja.ee/en/eli/508012015003/consolide
[95] Policy evaluations, including innovation, commissioned by MEAC in English and in Estonian
[96] Ruttas-Küttim R., 2016

3.7 Spain

3.7.1 Overall national R&I policy framework

In Spain the government is currently deploying policies corresponding to two strategic documents, the Spanish Strategy for Science, Technology and Innovation[97] (SSSTI) (2013-20) and the National/State Plan for Scientific and Technical Research and Innovation[98] (2013-16), both approved by the Ministerial Council in February 2013. The main national public programmes to stimulate research and innovation in the private sector are included in the "Business leadership in R&I programme" and in the "Promotion of R&I towards societal challenges programme". Both programs are part of the State Plan of Scientific and Technical Research Innovation (2013-2016).

Research and innovation policy in Spain faces several challenges. First of all the weak coordination of R&I policies in Spain and a fragmented regional landscape of bodies and programmes to promote innovation activities and foster science-business cooperation create significant challenges for businesses, especially for smaller firms. Second, the interaction between public and private research is weak. Third Spain's R&D intensity (spending on R&D relative to GDP) and innovation performance keeps declining, against the backdrop of a relatively low number of innovative firms and limited incentives for collaboration between public research and business. Due to this facts Spain underperforms in respect of most business innovation indicators.

Spain is one of the EU Member States that has been hardest hit by the financial and economic crisis that started in 2008. Before the crisis, during the 2002–2008 periods, gross expenditure on research and development (GERD) had doubled in absolute terms and the increase in relative terms was also remarkable: GERD, as a percentage of gross domestic products (GDP), reached an intensity of 1.35% in 2010. Since 2010, overall R&D intensity has decreased: in 2014, it had decreased to 1.24%. Today, research and development (R&D) funding indicators suggest a decreasing trend. Government budget appropriations or outlays on R&D (GBAORD) were €5,776 million in 2014, 0.23% of GDP, lower than in 2010 (0.27%).

Table 7: Gross domestic expenditure on R&D by source of funds in Spain, 2010 and 2014

Indicator		Spain	EU
	2010	2014	2014
GERD as % of the GDP	**1.35 %**	**1.24 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**0.69 %**	**0.65 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.38 %**	**0.35 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.27 %**	**0.23 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

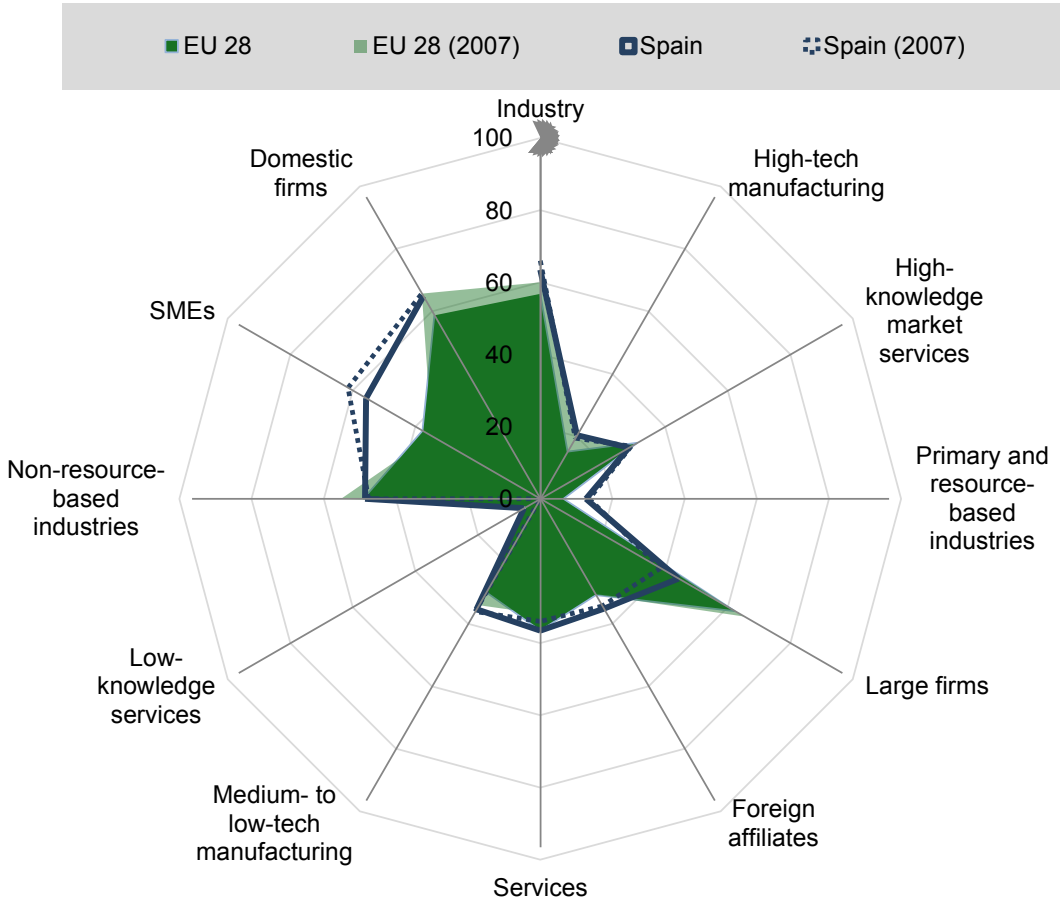
BERD is below the EU median, 63.5% of business R&D expenditure is performed by industry, compared to 36.5% in the services sector. International comparisons of business innovation performance reveal weaknesses and SMEs outweigh large firms in terms of performing R&D. A goal of the SSSTI is to increase

[97] Ministry of Economy and Competitiveness (2012); SPANISH STRATEGY ON SCIENCE, TECHNOLOGY AND INNOVATION 2013-2020, http://www.idi.mineco.gob.es/stfls/MICINN/Investigacion/FICHEROS/Spanish_Strategy_Science_Technology.pdf

[98] SPANISH NATIONAL PLAN FOR SCIENTIFIC AND TECHNICAL RESEARCH AND INNOVATION 2013-2016 http://www.idi.mineco.gob.es/stfls/MICINN/Investigacion/FICHEROS/Spanish_RDTI_Plan_2013-2016.pdf

BERD from 0.69% of GDP in 2012 to 1.2% in 2020. As the country's economic structure is characterised by a predominance of SMEs and low R&D-intensive business sectors, innovation policy focuses on the growth and internationalisation of innovative companies, increased business R&D spending in large companies, strengthening demand for HRST in companies and encouraging the generation and dissemination of emerging technologies.

Figure 13: Structural composition of BERD in Spain, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

It is remarkable that all the policies and specific measures supporting R&I that have been established in the period 2012-2016 will be continued by the new Spanish Government constituted on 4th November 2016.

3.7.2 National policies for increasing research and development investment

The government's structural reforms seek to improve the environment for business R&D and innovation by removing the limit on the amount of gross tax against which the tax credit for R&D can be taken and by substantially modifying the patent box tax relief.

To address the lack of venture capital, the Centre for Development of Industrial Technology (CDTI) created in 2012 the INNVIERTE programme, to promote venture capital in Spanish technological firms and support

the creation and growth of new innovative firms. The Centre for Development of Industrial Technology (CDTI) offers information services to companies interested in developing R&D projects. The CDTI remains responsible for funding industrial and innovative activities nearer to the market. It also supports the creation of business consortia in regions (e.g. Andalusia, Extremadura, Galicia) to develop strategic projects (INNTERCONECTA programme). The 2015 budget for these initiatives was €125 million.

3.7.3 National policies for augmenting skills and better access to expertise:

Human resource constraints are considered the most pressing challenge of the Spanish research and innovation (R&I) system (ERAC, 2014). The first one is directly linked to the economic crisis. Since 2008, the main consequence of research and development (R&D) budget reductions has been the non-renewal of temporary researchers' contracts. This has resulted in a drastic reduction in the possibilities for young researchers to obtain a stable position of employment. The second factor that explains the increasing unemployment rate among recently graduated PhD researchers is the limited access to research project funds for researchers with temporary contracts.

Improving overall human resources, skills and capacity building and raise STI skills training capacities to international standards is highly stressed by the government R&I strategy. It also seeks to encourage job placement and opportunities for researchers in the public and private sectors. Both strategic documents establish several instruments to strengthen human resources for STI, including additional resources for doctoral and postdoctoral training grants and the introduction of mobility schemes. The "National Programme for the Promotion of Talent and Its Employability" provides schemes to promote researcher careers. Among them Ramón y Cajal programme facilitates the recruitment of national and foreign professors in Spain's science system, including an initial grant to begin their research projects in Spain and an additional €100,000 for institutions that award them permanent contracts after five years. In addition, Law 14/2011 on Science, Technology and Innovation confirmed the 'Profesor Doctor Contratado' contract, created in 2001, and included the 'Investigador distinguido' contract, in order to offer stable contracts to non-civil servant researchers. The programmme "Torres Quevedo" promotes permanent employment of PhDs in the private sector, technological centres and other business entities and especially in newly established high-technology enterprises. "Emplea" offers loans for hiring experts in the management of innovation, including the transfer and exploitation of knowledge, on the basis of three-year contracts, to perform these activities in enterprises, technological centres and technological platforms.

The government aims to reinforce public research capabilities and to foster research excellence and infrastructures in order to increase the international impact of universities and research centres. To this end it sponsors individual R&D projects on basic research and interdisciplinary applications of frontier knowledge. It also funds projects carried out in research centres, including investments to acquire equipment and develop scientific infrastructures. The "Severo Ochoa" programme identifies, promotes and supports high-quality research centres; in the last three years and on the basis of international peer reviews, it has funded 18 centres, spending a total of €72 million.

3.7.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

The Spanish industrial structure is characterised by a significant proportion of small and medium-sized firms in low-tech traditional sectors (RIO Country Report, 2014). It lacks large private investors with a leading role in creating R&D-related networks. Furthermore, since the beginning of the crisis in 2008, Spain has faced a

dramatic reduction in the number of companies active in R&D, which has decreased from 12,997 in 2008 to 7,628 in 2014 (ERAC, 2014) Over the decade 2000–2009, the considerable increase in public and private R&D expenditure did not significantly boost innovation in Spain. During this period, the country made little progress in accumulating intellectual assets (e.g. patent applications, community trademarks and designs), improving public–private and private–private partnerships or introducing new innovative products, processes and services (EC, 2012: 25). These characteristics suggest that the low engagement of business with R&I can partly be ascribed to a lack of innovation-friendly framework conditions and to a limited innovation culture (ERAC, 2014; COTEC, 2015). Spain has designed a large number of support schemes to foster R&D activities, to increase knowledge transfer between public and private sectors and, more generally, to increase innovation culture. In 2011, the Law on Science, Technology and Innovation introduced several changes in order to improve knowledge transfer mechanisms. It encourages, for example, the creation of technological spin-off companies by allowing researchers to work part-time in private companies that were created by the organisations for which they originally worked. The Spanish Strategy for Science, Technology and Innovation (2013–2020), established in 2013, explicitly mentions, as one of its four goals, the promotion of business leadership in research and development. The National/State Plan for Scientific, Technical Research and Innovation (2013–2016) also encourages the creation of university spin-offs and public–private research cooperation (RIO Country Report, 2014). To complement this, several programmes have been launched to promote innovation clusters and knowledge transfer mechanisms. Some relevant sub-programmes that aim to promote knowledge transfer are the RETOS Colaboración, Torres Quevedo; EMPLEA; EQUIPA (technology parks); INNCIDE (Knowledge Transfer Offices); NEOTEC (New Technology Based firms); Innovative Companies Associations and Clusters (AEI); Technology Platforms; and 'CIEN' Strategic private consortia for innovation.

By EU standards Spain's science and innovation systems are not well integrated in international networks. The government therefore seeks to expand Spain's participation in the European Commission's Joint Programming projects (e.g. ERA-NETs, JUs and JPIs). It will also foster international collaborative networks between research groups and centres. Spain participates in two future and emerging technologies (FET) initiatives: Graphene and the Human Brain Project. These EU-wide initiatives address science-driven, large-scale multidisciplinary research that offers substantial benefits for European competitiveness and society.

Spain invests in enabling technologies, notably ICT and biotechnology, which are important for health sciences and energy, but also space-related technologies. Spain has in recent years deepened its specialisation in biotechnology and nanotechnologies, in environment-related technologies and in ICT. Programmes and public- private partnerships (e.g. Strategic Action in Digital Society and Economy) target ICTs and research excellence projects and networks in biomedicine and health, and the role of public users in Smart Specialisation is supported by regional strategies.

The SSSTI (2013-20) has integrated technology and innovation activities with scientific research and aims to promote technology transfer through knowledge circulation and co-creation based on long-term public-private partnerships and commitments and reinforced researcher mobility between public and private research centres.

3.7.5 National policies for stimulating demand for innovation

The Royal Decree 345/2012 tasked the Directorate General of Innovation and Competitiveness (DGIC) with the promotion and dissemination on the use of innovation procurement. Whilst Spain does not have a stand-alone innovation procurement action plan, PPI is integrated within the national innovation strategy

(2010), which directs PPI towards lead markets (i.e. Health, Energy, e-Administration, Defence, etc.). A regulation on innovation procurement passed in 2011 obliges annual reporting by ministries regarding the amount allocated to innovation procurement in their budgets and action programmes, and in 2013 a target of 3% in new investment for innovation procurement was pursued. PPI is also supported in the Spanish Strategy for Science, Technology and Innovation 2013-20 and the Plan for Scientific, Technical and Innovation Research 2013-16. Funding for innovation procurement comes from structural funds, as well as specific allocations in budgets. The current Programme 2014-20 allots €300 million within the pluri-regional programme to innovation procurement[99].

3.7.6 Improving frameworks for innovation, including regulation and standards

Despite an intention to establish a culture of policy monitoring and evaluation across the whole R&I system, effective instruments to achieve this goal are still limited (ERAC, 2014; RIO country report, 2014). To achieve efficiency and accountability in all public administration actions linked to the promotion of research, development and innovation (RDI), the Spanish Strategy for Science, Technology and Innovation (2013–2020) foresees 'the setting up of an integrated information system and the improvement of the quality of indicators for monitoring the actions funded by the Public Administrations and their impact'. While the integrated information system has been developed through a Platform for research and innovation (PAID), further steps are expected to improve the monitoring system. In addition to the creation of a national research agency, the elaboration of two policy intelligence tools is recommended (ERAC, 2014: 73).

Recent law to support entrepreneurs and their internationalisation, approved in 2013, does provide fiscal incentives and measures to boost entrepreneurial initiatives (particularly those that are export-oriented). Disbursements in public calls to support STI activities in firms reached €929 million.

[99] http://www.oecd.org/gov/ethics/procurement-innovation-practices-strategies.pdf

3.8 Portugal

3.8.1 Overall national R&I policy framework

The Portuguese economy contracted in 2011-13 in the wake of the global financial crisis. However, GDP is forecast to grow in real terms in 2014. The government has taken significant action to restore the sustainability of public finances and restart growth. On-going reforms aim to improve product and labour market regulation, upgrade education and skills, and enhance innovation.

Innovation policy coordination in Portugal was only institutionalized in 2011 with the creation of two high-level advisory councils for research and innovation, the National Council for Science and Technology (CNCT) and the National Council on Entrepreneurship and Innovation (CNEI), both chaired by the prime minister. The government is currently preparing a National Strategy for Research and Innovation (NSPRI) for 2014-20. It will introduce multi-level governance mechanisms at national and regional levels and coordinate research and innovation efforts around strategic areas/sectors and different innovation actors with a view to better translating research results into innovative goods, services and processes. A working group created in 2013 is coordinating the preparation of the new plan by the Ministry of Economy and the Ministry of Education and Science in collaboration with sectoral ministries and regional agencies. The first result is the definition of a Portuguese Strategy for Smart Specialisation to foster activities that will contribute to the development of a coordinated, regionally based, strategy, with the following axis:

- Axis 1: Cross-cutting Technologies and its applications
- Axis 2: Industry and Production Technologies
- Axis 3: Mobility, Space and Logistics
- Axis 4: Natural Resources & Environment
- Axis 5: Health, Well Being and Territory

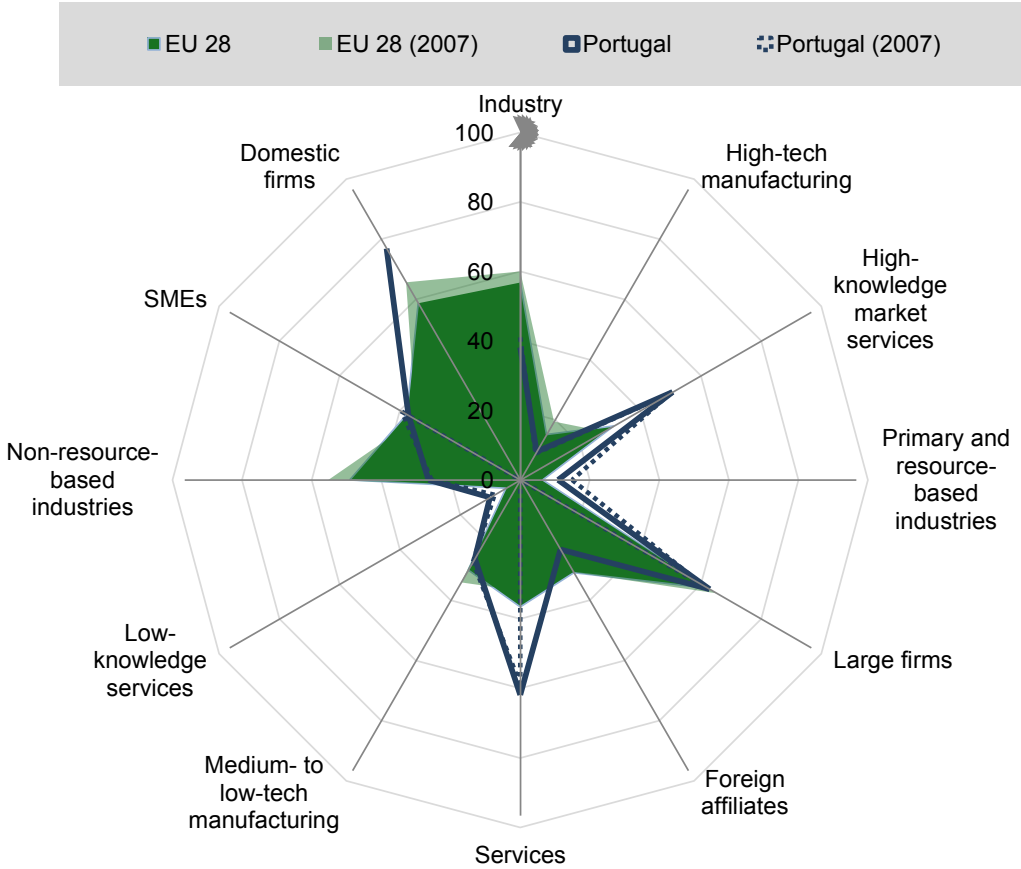
The National Strategy for Research and Innovation (2014-20) addresses social challenges such as ageing and climate change. The Foundation for Science and Technology (FCT) has established calls for Exploratory Projects (2013-15) supporting blue-sky research in emerging fields with a budget of €8.5 million. They favour multi-disciplinarity, industry involvement, co-funding and the participation of early career researchers (researchers who obtained their PhD between 2003 and 2009).

Table 8: Gross domestic expenditure on R&D by source of funds in Portugal, 2010 and 2014

Indicator		Portugal	EU
	2010	2014	2014
GERD as % of the GDP	**1.53 %**	**1.21 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**0.79 %**	**0.62 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.67 %**	**0.53 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.07 %**	**0.06 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

Figure 14: Structural composition of BERD in Portugal, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

The difficult national business environment and the contraction of domestic demand places enterprises in the position of having to find external markets while facing challenges in terms of efficiency (productivity and competitiveness) and financing. Recent efforts relating to investing in innovation and research, increasing productivity and competitiveness point in the right direction and public funding of R&D has been sustained, despite the pressures created by public expenditure reduction.

3.8.2 National policies for increasing research and development investment

Portugal's business R&D expenditure and innovation output performance are below the EU median owing to its specialisation in low- and medium-low-technology industries and to the small share of investment in R&D by large companies compared with other European countries.

The government established, in 2007, in the context of the COMPETE 2007-2013 programme, under the 2007-2013 National Strategic Reference Framework, three key initiatives to stimulate business R&D and support business innovation.

- SI I&DT, an R&D incentive, seeks to intensify BERD, increase firm competitiveness and foster cooperation among STI actors.

- SI Inovação targets the development of new goods, services and processes in export-oriented firms in strategic sectors.
- SI Qualificação PME aims to increase the competitiveness of SMEs through financing to enhance their productivity, flexibility and responsiveness to the global market.

In 2013, the first two initiatives sponsored 847 projects with a budget of €755 million. However, BERD increased only from 0.6% to 0.7% of GDP between 2007 and 2012. In the period 2014-2016, Financial Incentives have been established for innovative investments (new products or services / new production methods or processes) and also for R&I projects (base rate: 25%; up to €1 million, non-refundable; 75% of the incentive's amount that exceeds €1 million, non-refundable; the remaining 25% of the incentive's amount that exceeds €1 million, refundable - interest free loan).

Tax incentives are in Portugal also an important instrument for promoting business R&D activities. In Portugal they include the system of Tax Incentives for Research and Development (SIFIDE II)[100] and the regime of scientific patronage. SIFIDE II provides generous incentives for companies and its application has been revised and extended in 2014 with the Tax Investment Code (Decree-Law 162/2014) until 2020. SIFIDE II comprises two types of incentives for companies performing R&D: a basic tax incentive, corresponding to 32.5% of eligible R&D expenditure undertaken in the relevant fiscal year, and an incremental incentive, corresponding to 50% of the increase in R&D expenditure compared to an average of the two previous years. The amount of tax credits approved under SIFIDE has been close to €100 million/year.

Incentives for Agro Industries are also remarkable. Companies investing in agricultural activities and agro food processing and marketing are granted with variable cash grants (Agricultural activities, 30% to 70% of investment amount up to a maximum of €2million, non-refundable; Agro food processing, 25% to 65% of investment amount up to a maximum of €3million non-refundable).

Portugal's business environment is very conducive to entrepreneurship, although provision of venture capital is at the median of EU countries. The National Innovation Agency (ANI) has an overarching role in enhancing enterprise creation and growth through innovation. Various initiatives support business innovation, entrepreneurship and SMEs. The Financial Support to Company Growth (FINCRESCE) programme aims to improve financing conditions for SMEs with good innovative capabilities and risk profiles.

3.8.3 National policies for augmenting skills and better access to expertise

Portugal's public R&D expenditure as a share of GDP is at the EU median, but its shares of top 500 universities and scientific publications over GDP exceed it. Reform of the public research system has been an STI policy priority for a long time. The 2007-13 National Strategic Plan for Research and Innovation (NSPRI) emphasised cooperative innovation projects, fellowships and research contracts. Except in 2011, the public R&D budget increased steadily during the decade to 2013. Policy emphasis has recently shifted from expansion to excellence and effectiveness, and initiatives to support career development (e.g. the Investigator Programme and the PhD programmes) and build research infrastructures have been introduced. Academic PRIs will be evaluated to identify their research capabilities of strategic interest.

[100] https://www2.deloitte.com/content/dam/Deloitte/us/Documents/Tax/us-tax-countrypage-portugal.pdf

In the last years the government has taken steps to reorganise vocational and education training (VET) and is considering the creation of professional schools to match the skills supply better to industry needs. The Foundation for Science and Technology (FCT) also plays a strong role in policy for augmenting skills and better access to expertise. To improve the supply of high-level STI workforce, the FCT allocated an average of €151 million a year during 2011-13 to fund PhD studies and postdoctoral training for an average of approximately 11,000 fellowships a year. The FCT is redesigning its support for human resources by reducing the emphasis on individual PhD fellowships and moving towards supporting PhD programmes as a whole and integrating training support into research and institutional grants. The FCT's Investigator Programme of 2012 supports the recruitment of talented scientific researchers to work in Portuguese research centres under five-year contracts. In 2012, 159 national and non-resident researchers were selected for funding and a further 209 were selected in 2013 through an international peer-review process. From 2013 to 2015, three annual calls for PhD Studentships, PhD Studentships in Industry and Post-Doctoral Fellowships have been made, with around 1,000 studentships / fellowships granted in each call. FCT aims to support the best graduates who wish to pursue research leading to a PhD degree, and the most creative post-doctoral researchers in pursuing cutting-edge projects, in Portuguese or foreign research centres, in all fields of research. It has a goal of 1,000 researchers by 2016.

The Strategic Initiative for Entrepreneurship and Innovation, approved in 2011, focuses on strengthening knowledge and capacities, reinforcing innovation and entrepreneurship, and promoting innovation financing. SIFIDE provides fixed and incremental tax credits for R&D and supports the hiring of doctoral-level graduates in companies. In 2013, the government launched INOVA, Creative Youngsters: Entrepreneurs for the 21st century programme to develop an environment that favours innovation and creativity in primary and secondary schools. The programme seeks to foster youngsters' analytical capabilities and the mind-sets needed to identify business opportunities, take risks and face competition. Various public and semi-public initiatives support capacity development for business innovation, and entrepreneurship amongst SMEs. For example '+Innovation +Industry' is a new investment programme to promote business spin-offs and SME innovation capacity by providing access to coaching for business development as well as Venture Capital Funds and access to business accelerators for internationalisation.

3.8.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

It is relevant the role of COTEC Portugal - Business Association for Innovation. COTEC was established in April 2003 as a result of the then President of the Republic, Jorge Sampaio, and was supported by the Prime Minister and received the membership of a group of companies whose gross value added global represented in 2002 about 18% of GDP. Since the beginning of its activity the office of President of the General Assembly has been exercised by the President of the Republic. COTEC now has 290 Members.

COTEC aims to promote increased competitiveness of companies located in Portugal, through the development and dissemination of a culture and practice of innovation and the knowledge residing in the country. COTEC is a non-profit association that has the support of its Members and the institutions of the National Innovation System (SNI) for achieving its objectives through the implementation of initiatives in various areas.

3.8.5 National policies for stimulating demand for innovation

There is not specific strategy or policy for public procurement of innovation (PPI) in Portugal, although the general legal system in Portugal supports innovation procurement. Portugal's National Smart Specialisation Strategy (ENEI Framework) links PPI as a demand-side instrument for driving and supporting strategic innovation, and the National Reform Programme (NRP), Green Tax Reform and the Green Growth Commitment (GGC), which was signed in 2015 by the Portuguese government and 82 institutions from the public sector, academic business and financial sector, promote the procurement of innovations related to environmental sustainability and the efficient use of resources. The GGC mandates the establishment of a green public procurement programme; it also requires ensuring that sustainability criteria are included in all public procurement contracts[101].

3.8.6 Improving frameworks for innovation, including regulation and standards

As far as the information that was possible to collect, there are no initiatives in place or planned regarding the impact of regulation on innovation. This issue has been considered neither by national nor by regional authorities in Portugal. Furthermore, there have been no suggestions in the public debate on innovation regarding this topic. It might be helpful to pay more attention to this, especially on what concerns the effects of the austerity measures on innovation.

[101] http://www.oecd.org/sti/inno/48081293.pdf

3.9 Italy

3.9.1 Overall national R&I policy framework

Italy has continued the structural reforms and fiscal consolidation undertaken since 2011 to put the economy on a sustainable growth path based on sound macroeconomic fundamentals. In 2013, the government launched Destination Italy, the national plan to attract FDI and improve the competitiveness of Italian enterprises. Italy put in place a set of strong fiscal consolidation measures, but in doing so it did not preserve its public support for research and development (R&D). As a consequence, Italy did not implement a smart fiscal consolidation strategy.

The Ministry for Education, Research and Universities (MIUR) is the main player in research and innovation (R&I), in charge of coordinating national and international scientific activities, supervising the academic system, funding universities and research agencies, and supporting public and private research and technological development. The Ministry for Economic Development (MISE) manages industrial innovation. The R&I policy governance is the responsibility of MIUR together with MISE. Regions can also develop their own science, technology and industry initiatives on the basis of the concurrency principle. In Italy the national research programme 'PNR 2014-2020', delayed since early 2014, has not yet been officially approved. Italy has been without a national research strategy for nearly two years.

Italy's R&D intensity in 2014 was 1.34%, still far from the Europe2020 national target of 1.53%, which will not be reached if the current trends persist. To reach the Europe2020 target annual R&D investment should increase – assuming a constant GDP – by €4 billion, a much greater amount than the resources made available by present policies. Moreover, the share of gross domestic expenditure on R&D (GERD) performed by the business sector (54%) is low for industrialised economies (OECD, 2014) and much lower than the EU-28 average of 63.67 %.

Key developments in the R&I system in 2015 include:

- Implementation of the new R&D tax credit scheme. Businesses can benefit from a tax credit of 25% on incremental R&D expenditures; this percentage increases to 50% for extramural research carried out in collaboration with higher education institutions (HEIs) and public research organisations (PROs) or other businesses.
- New legislation on 'patent boxes', providing a 30% deduction from the corporation tax base on the incomes from patents, trademarks, licenses and software in 2015, 40% in 2016 and 50% in 2017.
- The launch of the new National Operational Programme 'Research and Competitiveness' (PONREC) 2014-2020, which will trigger €1.29 billion, part from the European Regional Development Fund (ERDF) and European Social Fund (ESF) (€930m) and the rest from national co-financing (€360 million) to the five Less Developed regions in the south (Basilicata, Calabria, Campania, Puglia and Sicily) and the three Transition regions (Abruzzo, Molise and Sardinia). The priorities are: large R&D projects, large ICT R&D projects and large R&D projects or sustainable industry.

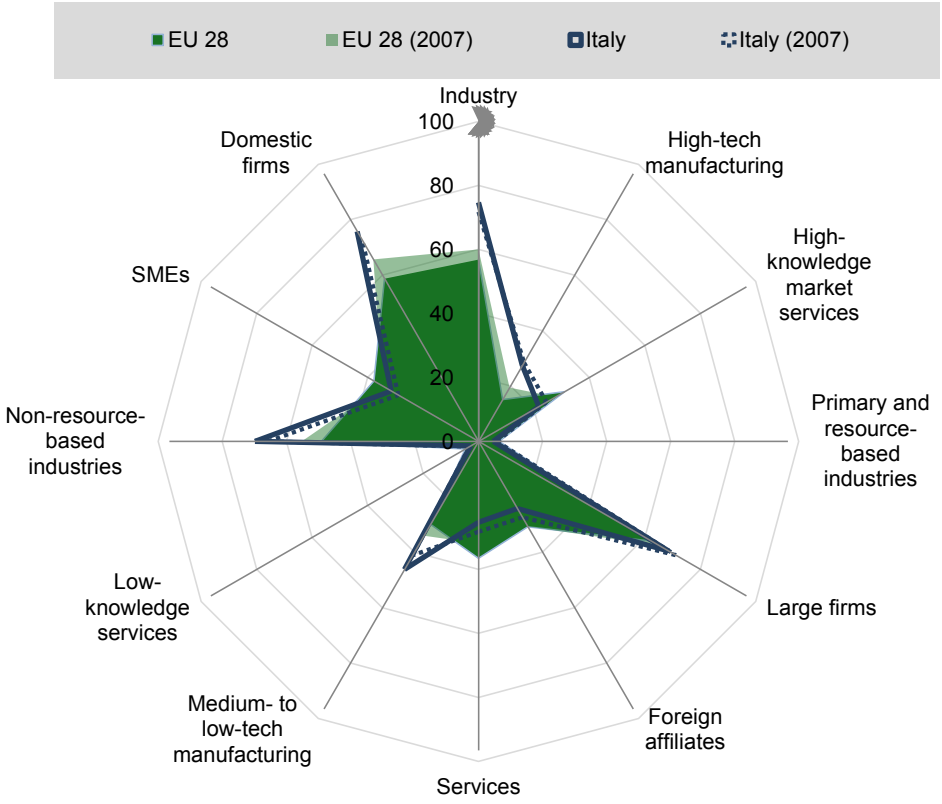
Table 9: Gross domestic expenditure on R&D by source of funds in Italy, 2010 and 2014

Indicator		Italy	EU
	2010	2014	2014
GERD as % of the GDP	**1.22 %**	**1.32 %**	**2.03 %**

BERD (by Business sector) as % of the GDP	**0.66 %**	**0.76 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.35 %**	**0.39 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.17 %**	**0.18 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

Figure 15: Structural composition of BERD in Italy, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

The intensity of business expenditures for research and development (BERD) in Italy was 0.76%, much lower than in other large EU economies such as France (1.46%), Germany (1.95%) or the UK (1.09%). The BERD in absolute values was €10.9 billion in 2013, a slight decline from €11.1 billion in 2012. It is worth noting that two firms alone – FIAT in the automotive and parts sector and Finmeccanica in the aerospace and defence sector – accounted for 60% of all R&D investment by Italian firms included in the EU top 1,000 Scoreboard ranking (edition 2013)[102]. 74.7% of business R&D expenditure is performed by industry, compared to 25.3% in the services sector. The Italian public sector's R&D intensity (HERD and GOVERD) is 0.57%, well below the EU average of 0.72%.

[102] Moncada-Paterno-Castello and Grassano (2014), Innovation, competitiveness and growth without R&D? Analysis of corporate R&D investment -A country approach: Italy' (2014).

3.9.2 National policies for increasing research and development investment:

The Italian economic fabric is characterised by a production specialisation model still focused on traditional labour-intensive sectors with limited intensity of research, development and innovation, and by the small size of Italian firms[103]. A small set of innovative firms coexist with a larger majority of small and micro enterprises with low productivity[104]. The low level of research and development (R&D) activity is both a consequence and a cause of Italy's relative specialisation in low- to medium- technology products.

In March 2013,[105] MISE reformed the system of firms' incentives, to target innovation for competitiveness and support investments in enabling technologies. Firms' incentives are financed by the Fund for Sustainable Growth (Fondo per la Crescita Sostenibile - FCS), which includes all the resources for technological innovation. The MISE has also developed a support strategy based on three pillars: promoting investments, access to capital markets and innovative entrepreneurship.

A new tax credit scheme (2015-2019), has been operational since summer 2015. It allows a 25% tax credit for incremental investments in R&D, up to a maximum annual amount of €5 million per beneficiary. The tax credit is increased to 50% in the case of R&D activities performed in collaboration with HEIs, PROs or other businesses. Incrementality is calculated upon the average of investments made in 2012-2014, and the annual expenditure should be at least €30,000. The forgone tax revenues have been estimated at about €2.5 billion for the 5 years of validity of the measures. Italy also introduced a patent box for the first time in 2015, which allows the deduction of 50% of the revenues originated from direct/indirect use of intellectual property (IP) rights (patents, trademarks, industrial designs and models). Moreover, a MISE–European Investment Bank (EIB) agreement, which allocates €100 million of the MISE Guarantee Fund for SMEs to cover the risk of losses in R&D projects of SMEs and Mid-Caps, is expected to trigger a loan portfolio of at least €500 million by the EIB.

In addition, measures have been taken to liberalise capital markets, allowing bond issuing by unlisted companies and lending to firms by securitisation (SPV) and insurance companies. It is worth noting that Italy was the first EU country to set up rules for the collection of risk capital through online crowdfunding platforms in 2013.

The Venture Capital Fund, managed by Invitalia Ventures SGR, aims to strengthen the Venture Industry with a focus on innovative start-ups. The investment strategy will focus on high-growth sectors such as: Internet & ICT, Logistics & Mechatronics, Biotech and Health, Clean Energy & Green Tech, Public Administration & Government, Social Impact and Sustainability, Food, Fashion, Life Style and Fin Tech.

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[103] "According to data from the National Institute of Statistics (ISTAT), only 3,470 out of more than 4.4 million registered businesses in Italy have more than 250 employees and qualify as large enterprises". See P. Moncada-Paternó-Castello and N. Grassano (2014) http://iri.jrc.ec.europa.eu/documents/10180/12238/Innovation%20Competitiveness%20and%20Growth%20without%20R%26D. It should be noted that FIAT (now FCA – Fiat Chrysler Automobiles) moved its headquarters to the Netherlands in 2014, so it is no longer registered as an Italian company.

[104] OECD, 2014

[105] MISE Inter-Ministerial Decree of 8 March 2013, http://www.sviluppoeconomico.gov.it/images/stories/normativa/decreto-8marzo2013-sen.pdf, The National Energy Strategy (SEN), approved by the Inter-Ministerial Decree of 8 March 2013, directs the efforts of the country to a substantial improvement of the competitiveness of the energy system together with environmental sustainability.

3.9.3 National policies for augmenting skills and better access to expertise

Italy has one of the lowest shares of adult population with tertiary-level qualifications and technology-related skills among EU countries. Tertiary education expenditure is also very low, and the most qualified people often pursue employment abroad. The multi-annual planning for 2013-15 addresses these issues and encourages universities to improve guidance and tutoring services for students. Poor correspondence between the higher education system and labour market needs further underscores a structural mismatch. To tackle the issue, the action plan for future youth employment – 'Italia 2020' - aims to align higher education curricula with the changing demands of industry and to promote technical vocational education. Since 2011, academics' salaries and advancement has been frozen to contain public spending. However, to avoid further erosion of the human resource base for S&T and innovation due to unattractive career prospects and pay cuts, the most recent cuts in the public research budget safeguarded the jobs of professors, researchers and technicians. Since the university reform approved in 2010, significant efforts have also been made to strengthen researchers' careers. A reform of doctoral education in 2013 focused on creating a stimulating research environment, collaborative doctorates and internationalisation. Moreover, the financial law 2014 includes a commitment to encourage inter-institutional mobility of Italian researchers. The Ministry for Education, Research and Universities has recently adopted measures to encourage the mobility of researchers between universities and PRIs and to attract researchers from abroad.

Innovative start-ups, certified incubators and businesses located in areas particularly affected by the economic crisis have a 35% tax credit on all costs for hiring highly qualified personnel (PhDs or technical/scientific Master's degrees engaged for R&D). Contracts must last longer than 3 years, or 2 years in the case of SMEs.

3.9.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

Italy's public R&D expenditure is below the OECD median, as is its research output in terms of international publications in top scientific journals and its level of international co-authorship. However, it has a relatively high share of top universities. Industry-science linkages are poorly developed and PRIs and universities do not actively patent their research results. To improve public research performance, a reform of funding mechanisms for and management of universities was approved by Parliament in 2010 and is being implemented, as is the reform of PRIs under MIUR launched in 2009. In 2013, MIUR allocated new resources under the Cohesion Action Plan (CAP) to strengthen public research infrastructures, particularly in the country's southern regions.

National policies that strengthen capabilities and increase potential exploitation of complementarities identify variation in business innovation performance across regions and the concentration of R&D and innovation capacity in Italy's northern and central regions. For instance, there are very huge gaps in R&D intensities between leading regions such as Piedmont (1.51%), Emilia-Romagna (1.09%) and Lombardy (0.94%) and the four Convergence regions, Campania (0.54%), Calabria (0.01%), Puglia (0.19%) and Sicily (0.23%)[106]. The numbers of innovative start-ups as a proportion of the total number of corporations[107] also shows that the convergence regions are lagging behind the northern ones. In Piedmont and Emilia-Romagna, innovative start-ups represent, respectively, 0.45% and 0.49% of corporations, compared with

[106] http://www.opencoesione.gov.it/progetti/temi/ricerca-e-innovazione/
[107] http://startup.registroimprese.it/report/3_trimestre_2015.pdf

0.19% in Campania, 0.24% in Puglia and 0.25% in Sicily (Calabria, on the other hand, shows a surprising relatively high value, at 0.34%).

The National Operational Programme for Research and Competitiveness 2007-2013 (PONREC) has been the main strategy to boost the R&I-driven competitiveness of southern regions, with a total allocation of nearly €4.6 billion in five priority areas: (1) industrial research, (2) structural/infrastructural strengthening, (3) clusters and laboratories, (4) smart cities and communities and (5) social innovation. The Agency of Territorial Cohesion was established following the PONREC experience to coordinate the management of EU structural Funds and other cohesion policies, including R&I regional actions, for the 2014-2020 programming period. In 2012 MIUR launched also a national call for the creation and strengthening of technological clusters[108] and a project to support regional governments to design and implement Smart Specialisation strategies was also launched in 2013. The 2013 Stability Law (L228/2012) introduced a tax credit on costs of R&D incurred by enterprises or enterprise consortia through contract R&D with public research bodies or direct investment in R&D to encourage collaboration and cross-fertilisation.

A set of innovative firms coexists with a large majority of small or micro enterprises with low productivity. The new Fund for Sustainable Growth, which replaced in 2013 the former Fund for Technological Innovation, supports business R&D with significant potential to affect national competitiveness.

3.9.5 National policies for stimulating demand for innovation

Italy does not possess a national innovation procurement action plan. The Ministry of Education, University and Research (MIUR) and the Agency for Digital Italy (AGID) recently defined a pre-commercial procurement programme for the procurement of research, development and innovation services by public bodies, and in 2016 the Ministry of Education, University and Research (MIUR) passed the National Research Plan (NRP) 2015-20 which fosters policies that sustain research through the promotion of public demand for innovative solutions, and makes pre-commercial procurement an integral part of Italian national research policy[109].

3.9.6 Improving frameworks for innovation, including regulation and standards

During 2012-14, Italy made efforts to reduce the tax burden on and strengthen fiscal incentives for SMEs. Destination Italy also includes several measures to facilitate small and micro enterprises' access to bank credit and equity financing, to support their internationalization and to encourage venture capital investment. Italy also established the legal definitions of innovative start-ups (2013) and innovative SMEs (2015). These companies are defined on the basis of their R&D expenditure (15% of costs for innovative start-ups and 3% for innovative SMEs), qualified personnel (proportion of personnel holding a PhD and/or a master's degree) and IP ownership/licensing. Innovative start-ups and innovative SMEs benefit from reduced red tape, tailor-made labour law, tax relief, the possibility of raising investments through equity crowd-funding, etc.

[108] Each of the eight Clusters, announced by MIUR call, is a wide and inclusive network of Italian excellence operating everywhere in Italy, in technological areas which are strategic for the national economic system: Intelligent Factories, Green Chemistry, Life Sciences, Surface and Marine Mobility and Transport, Agrifood, Aerospace, Smart Communities Technology, Life Environment Technology, https://www.researchitaly.it/en/news/national-technological-clusters-266-million-allocated-to-30-applied-research-projects/

[109] http://www.oecd.org/gov/ethics/procurement-innovation-practices-strategies.pdf

Italy's position on the Ease of Entrepreneurship Index is near the top of the EU ranks, the sign that this type of activity is creating a favourable business environment for entrepreneurial activities and innovative ventures. While young firms are reasonably active in patenting, venture capital is in severe short supply, which hinders the commercialization of innovative ideas. A 2012 Act of Parliament provided a new legislative framework to promote start-ups.

3.10 United Kingdom

3.10.1 Overall national R&I policy framework

The United Kingdom is a very open economy, and its STI system is characterized by a high level of funding and participation by foreign firms. Overall, the UK is a R&D leader, both among the EU28 and globally on many measures. The UK STI system is building on its generally strong performance, notably in research infrastructures, open access, international cooperation and researcher mobility (addressing European research area –ERA- priorities). There is some scope to improve on this in order to boost STI performance and economic and societal wellbeing. The UK's R&I system has demonstrated successes in knowledge exchange with extensive collaboration between the public, private and not-for-profit sectors through formal programmes, ad hoc activities, as well as in the large numbers of science parks, incubators and similar ventures.

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 across the UK comes via the Research Councils which have a UK-wide remit.

In 2012, the government launched an Industrial Strategy[110], which focuses innovation policy on areas where government action has potential to create impact, and through strategic industry partnerships in 11 sectors[111] in which the United Kingdom leads or has the potential to be a global leader show potential to stimulate economic growth. The most significant of these are the co-funded Aerospace Technology Institute (GBP 2 billion), the Automotive Advanced Propulsion Centre (£1 billion) and the Centres for Agricultural Innovation and an Agri-Tech Catalyst (£160 million). The Industrial Strategy also prompted government investment of €676 million (£600 million) in 2012 in eight cross-platform emerging technologies in which the UK has developed significant research expertise and business capability. As part of direct measures measure to address weak research and innovation investment in recent years Innovate UK provides support funds for industry and SMEs, and runs the UK 10 'Catapult centres' set-up along the lines of the Fraunhofer model in Germany. The centres give businesses access to specialist equipment and emerging technologies and connect them to other companies and to academic expertise.

The UK spends 1.68% of GDP on R&D in 2014, representing a gross expenditure on R&D (GERD) of €34 billion (around 12% of total EU-28 GERD). Of this, 28% is from public sources, 21% from abroad and 51% from the private sector. Although there is no current official R&D target, the Government's 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. An important limiting factor in achieving this target was the effect of the economic recession and ongoing recovery.

Supporting the scale-up of high growth enterprises, including SMEs is gaining attention in the UK, along with measures such as improving innovation in the public sector through procurement, as part of policy efforts to address the broader problem of weak productivity. While the UK performs well overall in many

[110] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/306854/bis-14-707-industrial-strategy-progress-report.pdf

[111] Aerospace, agricultural technologies, automotive, construction, information economy, international education, life sciences - see also the one year on update, nuclear, offshore wind, oil and gas, professional and business services

composite innovation rankings, the efficiency of UK R&D inputs to outputs puts it in 10th place, despite a strong improvement since 2014 (placed 18th)[112]. It registers weaker performance on SMEs and innovation, with average-to-low levels of new-to-market innovations, and low numbers of innovative SMEs, ranking 23rd for SMEs introducing product or process innovations[113]. At the same time, the UK has a relatively strong share of exports of medium and high-tech products and in services and a high share of exports in knowledge intensive services[114].

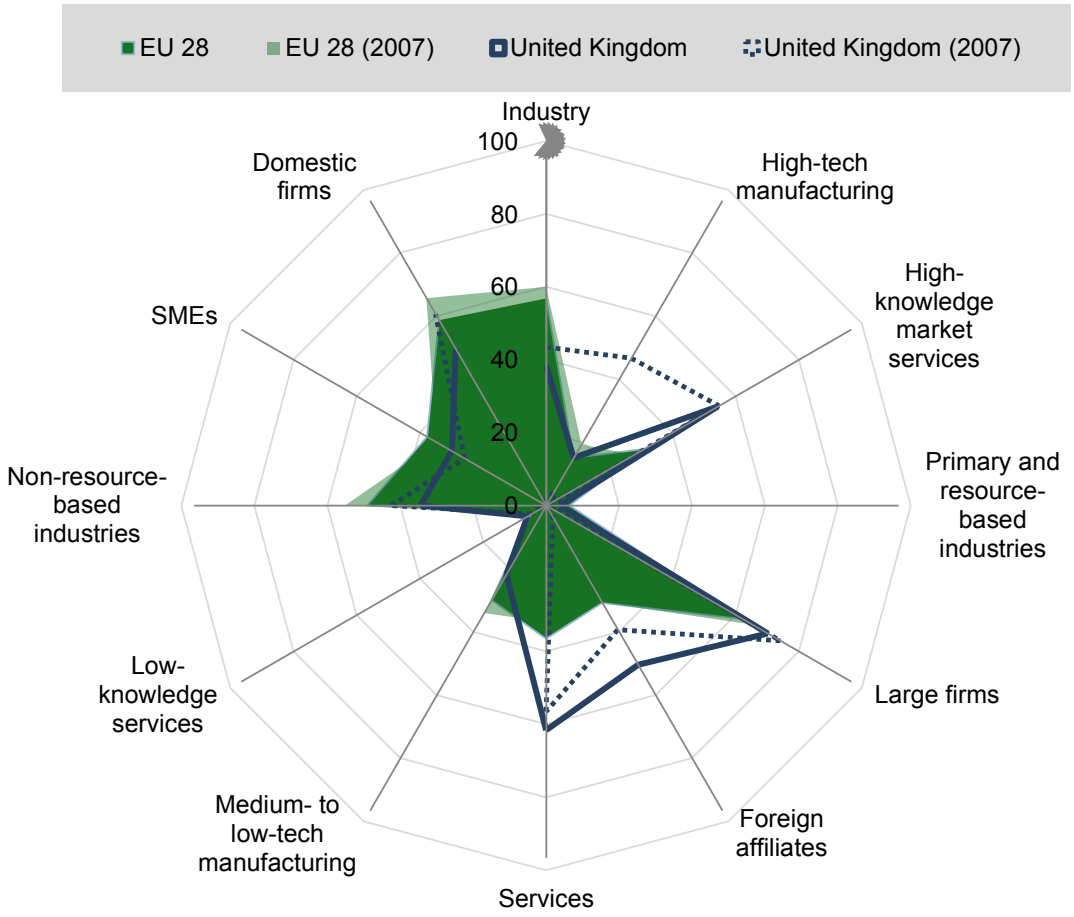
Table 10: Gross domestic expenditure on R&D by source of funds in the United Kingdom, 2010 and 2014

Indicator	United Kingdom		EU
	2010	2014	2014
GERD as % of the GDP	**1.70 %**	**1.68 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**1.02 %**	**1.09 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.45 %**	**0.43 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**016 %**	**0.12 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

[112] Edquist C. & Zabala-Iturriagagoitia, JM: The Innovation Union Scoreboard is Flawed: The case of Sweden – not being the innovation leader of the EU. Lund University. Papers in Innovation Studies no. 2015/16.
[113] Innovation Union Scoreboard 2015: http://ec.europa.eu/growth/tools-databases/newsroom/cf/itemdetail.cfm?item_id=8264&lang=en&title=Innovation-Union-Scoreboard-2015-
[114] https://rio.jrc.ec.europa.eu/en/file/8445/download?token=cQ2HCOec

Figure 16: Structural composition of BERD in the United Kingdom, 2007 and 2012, as a % of total BERD or sub-parts of BERD



Source: OECD, ANBERD database, 2016, www.oecd.org/sti/anberd; OECD, Activity of Multinational Enterprises (AMNE) Database, 2016, www.oecd.org/industry/ind/amne.htm; OECD, Research and Development Statistics (RDS) Database, 2016, www.oecd.org/sti/rds; OECD, Main Science and Technology Indicators (MSTI) Database, 2016, www.oecd.org/sti/msti.

3.10.2 National policies for increasing research and development investment

The Government of the UK aims to boost private sector funding largely through indirect measures such as the R&D tax credits for large companies and SMEs (introduced in 2007). An R&D expenditure credit (RDEC) scheme was introduced in 2013 and is slightly more generous than the large company R&D tax relief. It will replace the current tax credits from 2016. The R&D Allowance (RDA), formerly known as the scientific research allowance, gives relief for capital expenditures on R&D. There are also a smaller range of awareness promotion, prizes, and advisory service measures. Schemes include: the UK Innovation Investment Fund (IIF) - a venture capital fund that aims to drive economic growth and create highly skilled jobs by investing in innovative businesses where there are significant growth opportunities. The Enterprise Finance Guarantee (EFG) is a loan guarantee scheme to encourage additional lending to viable small and medium-sized enterprise, extended autumn 2014. The Venture Capital Trusts; the Business Angel Co-Investment Fund, the Enterprise Investment Scheme, the Seed Enterprise Investment Scheme and Bank-led Business Growth Fund are targeted at high growth companies.

In terms of direct measures, Innovate UK (formerly the Technology Strategy Board) provides support funds for industry and SMEs, and runs the 10 Catapult Centres set-up across the UK to enhance industry funding to public R&D along the lines of the Fraunhofer model. In 2012, the Innovation Vouchers programme was formally launched to enable start-ups and SMEs to access advice and expertise from universities, research organisations or other private-sector knowledge providers. A new national development bank, the British Business Bank aims to increase the supply and diversity of finance available for UK SMEs[115].

The main competitive direct-funding 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. Additionally, the UK government supports a large number of public-private research networks including Knowledge Transfer Networks, Collaborative R&D and Knowledge Transfer Partnerships – that are funded through Innovate UK, the Technology Strategy Board and the Research Councils'. Many of these schemes involve variable elements of co-funding from industry and are not always eligible for the definition of 'direct funding'[116]. The United Kingdom is also currently setting up a new national development bank, the British Business Bank, to increase the supply and diversity of finance available for UK SMEs[117].

3.10.3 National policies for augmenting skills and better access to expertise

The United Kingdom is among the top performers in publication counts and boasts a large share of the world's leading universities, which are active in research and patent applications. Academic excellence plays a large part in university research funding, with block grant allocations dependent on the results of the Research Excellence Framework (REF) exercise for assessing research quality.

Addressing the future skills needs of industry, particularly in regard to high-end and complementary skills sets is a challenge for the UK. Policies to ensure the future supply of human resources in S&T (HRST) include continuing support for research training (through the Research Councils) although universities have seen modest cutbacks in their funding for teaching activities - the government will reduce the teaching grant by GBP 120m in cash terms by 2019 to 2020, but allow funding for high cost subjects to be protected in real terms. There are a number of schemes to respond to the skills gap, e.g. an existing range of research training through Research Councils (including CASE awards), 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; increased support for Apprenticeships schemes in 2011 – with further expansion announced in the 2014 Plan for Growth.

UK researchers are well integrated in international networks. Several initiatives promote strong links with emerging countries. For example, the Technology Strategy Board (TSB) has launched two jointly funded collaborative R&D programmes with China (on sustainable manufacturing technologies) and with India (on affordable health care and clean technology, particularly energy systems), worth a total of GBP 10m. The government is also investing GBP 80m in the Global Collaborative Space Programme over five years to cooperate with emerging countries in developing space capabilities and technology.

In 2012, the Innovation Vouchers programme was formally launched to enable start-up, micro, small and medium-sized UK businesses to access up to GBP 5,000) worth of advice and expertise from universities,

[115] OECD (2014)
[116] Cunningham and Mitchell, 2016
[117] https://annualreport2016.british-business-bank.co.uk/the-board/chairmans-statement

research organisations or other private-sector knowledge providers. The focus and eligibility criteria of the Vouchers scheme changes periodically[118].

3.10.4 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

The UK approach to supporting innovation and science focuses on optimising value from strong and/or emerging R&D areas. Greater targeting of investments and prioritising key areas could increase economic growth and societal well-being. While the UK's basic science is strong in a number of areas, commercialisation of publicly funded research into commercial products, process and services remains an important focus for improvement[119]. To improve commercialisation an extensive range of measures have evolved. 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 different modalities to sustain collaboration for innovation. The Launchpads scheme supports the development and strengthening of clusters of high-technology companies in specific technologies and geographical locations. Launchpads provide base funding through approved R&D projects and act as a catalyst to help the companies behind the projects to attract more investment. Moreover, the Research Councils support substantial translational activity including follow-on funding 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 encouraging university-business connections. A number of 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[120]. Various initiatives also make specific provisions to attract SMEs into research consortia involving a range of knowledge sector and private sector actors and also into cluster-type initiatives.

While UK science funding is mostly allocated through a bottom-up approach and assessed for excellence, it is increasingly important to target priority areas due to limited resources allocated towards strategic fields of economic, environmental and societal importance. The Industrial Strategy has started this approach by focusing on strategic partnerships in 11 sectors and investing in eight cross-platform emerging technologies. At regional level, the Local Enterprise Partnerships (LEPs), under the Government's 2014 innovation strategy, could play a stronger facilitating role in processes for the definition of R&I priorities through the prominence of the concept of 'place' and new regional innovation plans. The devolved administrations are developing Smart Specialisation plans as a way to boost investment across regions, notably by R&D industries, and the Smart Specialisation in England submission to the European Commission [121] started the process of more systematically linking science and innovation policy at EU and national level to the LEP areas. The UK Government's "Productivity Plan[122] also included provisions for regional Science and Innovation Audits to map the strengths of different regions and evidence where globally competitive activity is based.

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[118] https://www.gov.uk/government/news/innovation-vouchers-for-all
[119] https://rio.jrc.ec.europa.eu/en/file/8445/download?token=cQ2HCOec
[120] For example: https://www.gov.uk/start-up-loans
[121] BIS (2015) Annual Report and Accounts 2014-15. HC75, Department for Business, Innovation and Skills. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/444896/BIS-15-421-BIS-Annual-Report-15-web.pdf
[122]HM Treasury 2015 Fixing the foundations: Creating a more prosperous nation https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443898/Productivity_Plan_web.pdf

The UK government has taken several measures to increase innovation in companies and support SMEs, especially through TSB programmes. The Launchpads scheme[123] supports the development and strengthening of clusters of high-technology companies in specific technologies and geographical locations. Launchpads provide base funding through approved R&D projects and acts as a catalyst to help the companies behind the projects to attract more investment.

3.10.5 National policies for stimulating demand for innovation

The 2015 UK RIO Report cited a limited number of demand-side innovation policy instruments being used in the UK, which was attributed to a lack of understanding and evidence about their role in addressing market and system failures (Cunningham and Mitchell, 2016). The Small Business Research Initiative (SBRI)[124], which seeks to drive innovation through public procurement and is the United Kingdom's main vehicle for public innovation procurement, modeled on the US Small Business Innovation Research programme, which is generally considered to be the leading model for public innovation procurement from SMEs[125]. SBRI competitions are managed by Innovate UK, the United Kingdom's innovation agency that provides opportunities for companies to engage with the public sector to develop and provide new products and services for policy and operational challenges. SBRI provides 100% R&D funding to support companies to develop solutions, and they retina the intellectual property rights to enable wider commercialisation. The United Kingdom's SBRI was established in its current structure in 2009, and is currently being evaluated.

3.10.6 Improving frameworks for innovation, including regulation and standards

The United Kingdom is increasingly investigating the feasibility and advantages of systems evaluations because it considers that evaluations of individual policy tools may not reveal the true extent of their impact in complex contexts. The TSB's review of the Low Carbon Vehicles Innovation Platform (Innovate UK, 2015) is an early example of the systems approach to evaluation.

New legislation on copyright will be in force from 2014 to reflect the radical changes the digital revolution has brought to the creation and distribution of creative, scientific and academic material. The legislation extends the existing exceptions to copyright, but with suitable safeguards for rights holders. Other measures that can help IP holders improve the efficiency of IP application and protection include the Intellectual Property Office IP for Business toolkit and the Intellectual Property Enterprise Court.

The UK Government provides general support and governance of the overall innovation framework by introducing and ensuring compliance with standards and regulations, and has consistent and high regulatory quality according to the World Bank Worldwide Governance Indicators dataset[126]. Analysis shows that over 1996-2014 the UK scored an average of 1.77 for regulatory quality (-2.5 being weak and 2.5 being strong) compared to 1.5 for the USA, 1.79 Netherlands, 0.87 Italy, 1.51 Germany, 1.13 France.

Recent concern that unnecessary regulation could hamper innovation have been met by attempts to reduce bureaucracy, particularly that encountered by SMEs. An example is the Cabinet Office 'Red Tape

[123] https://www.gov.uk/government/collections/launchpad-directories
[124] https://sbri.innovateuk.org/
[125] http://www.oecd.org/gov/ethics/procurement-innovation-practices-strategies.pdf
[126] http://info.worldbank.org/governance/wgi/index.aspx#home

Challenge'[127]. There are also concerns that regulations do not create disadvantages to any businesses, such as the 'One-In, One-Out' rule[128] for new regulation.

[127] http://www.redtapechallenge.cabinetoffice.gov.uk/home/index/
[128] https://www.gov.uk/government/collections/one-in-two-out-statement-of-new-regulation

3.11 Ireland

3.11.1 Overall national R&I policy framework

Ireland has been severely hit by the economic crisis, with dramatic repercussions on its public finances. This led to the agreement with European Commission (EC), European Central Bank (ECB) and International Monetary Fund (IMF) upon an Economic Adjustment Programme [129]which included a joint financing package of €85 billion covering the period 2010-2013. After successfully exiting the Programme in December 2013, the Government has sought to maintain the reform momentum to achieve the goals of creating more jobs to enhance living standards and ultimately to achieve full employment.

The economic crisis left its mark on the public support for R&D: the shares of both the GDP devoted to the R&D appropriations (and to a lesser extent to the GERD funded by the government) have not been preserved. In fact, a declining trend of both indicators from 2009 onwards can be seen, only partially compensated by the indirect funding provided by the tax credit on R&D performed by businesses. Therefore, Ireland did not fully implement a smart fiscal consolidation strategy.

The business R&D landscape in Ireland is dominated by foreign multinationals, which account for over two-thirds of the total BERD. Key developments in the R&I system in 2015 included: The Innovation 2020, the new five-year (2016-2020) Strategy for Research and Development, Science and Technology, was released in December 2015, following a consultation with stakeholders in early 2015. The Government's new capital investment plan, Building on Recovery: Infrastructure and Capital Investment 2016-2021 outlines an exchequer spend of €27 billion over the next six years. And the introduction in the Budget 2016 of a Knowledge Development Box (KDB) scheme, operational as of January 1, 2016; will implement a competitive corporate tax rate of 6.25% (half of the corporate tax rate applicable to trading income of 12.5%) on profits arising from intellectual property assets.

The Irish R&D intensity for 2014 is 1.52 %, which is below the Europe2020 target of 2.0%. The BERD at €2.107 million in 2014 accounts for the majority, overcoming the threshold of 70% of GERD. Ireland's R&D expenditure in the higher education sector as a percentage of GDP was calculated at 0.43% in 2010, which is lower than the EU average percentage of 0.47%. GERD increased from 1.63% GDP in 2010 to 1.65% in 2014, mainly thanks to the rise in BERD from 1.10% to 1.2 % of GDP during the years of financial crisis and economic recession. Owing to the impact of the recent crisis, however, public support for R&D and innovation is likely to remain under pressure in the years ahead.

Table 11: Gross domestic expenditure on R&D by source of funds in Ireland, 2010 and 2014

Indicator		Ireland	EU
	2010	2014	2014
GERD as % of the GDP	**1.63 %**	**1.56 %**	**2.03 %**
BERD (by Business sector) as % of the GDP	**1.10 %**	**1.09 %**	**1.28 %**
HERD (by higher education sector) as % of the GDP	**0.42 %**	**0.35 %**	**0.47 %**
GOVERD (by governmental sector) as % of the GDP	**0.08 %**	**0.07 %**	**0.25 %**

Source: EUROSTAT 2016, Research and development expenditure, by sectors of performance % of GDP

[129] Economic Adjustment Programme for Ireland Autumn 2013 Review

3.11.1 National policies for increasing research and development investment:

Ireland performs relatively well in terms of innovation outputs, both in the Innovation Output Indicator and on the Innovation Union Scoreboard. This is mainly due to its economic structure, geared towards several high-tech manufacturing sectors and knowledge-intensive services. However, research and development activity is largely carried out by foreign multinationals and there have been limited spill-overs to SMEs. Statistics published by the Central Statistics Office show that expenditure on R&D by the enterprise sector is dominated by multinational companies: 400 companies accounted for 65% of total R&D expenditure in 2013[130]. Indigenous SMEs show also slightly lower levels of formal collaborations with HEIs compared to foreign-owned businesses.

The predominance of foreign companies in the Irish business R&D landscape has been acknowledged by the Government in its Medium Term Economic Strategic document, which notes that indigenous SMEs need to improve their innovation capacity. The main support measure for research-performing Irish businesses is the R&D tax credit, introduced in 2004, which provides a 25% credit on corporate tax for qualifying R&D expenditure. However, official figures show the credit is used predominantly by multinational firms and other large employers in the high tech and manufacturing sectors

The Knowledge Development Box will be introduced in 2016 and has a similarly broad application for all types and sizes of firms. The Industry Research & Development Group (IRDG), a representative body for research performing organisations, recommended that the funding provided under the Innovation Voucher scheme (currently €5,000) could be extended to €20,000-50,000 so as to increase collaboration between companies and the higher education institutions.

3.11.2 National policies for augmenting skills and better access to expertise

Ireland has a relatively strong skills base for innovation: the share of the tertiary-qualified adult population, the performance of 15-year-olds in science and doctoral graduates in science and engineering are all above the OECD median[131]. Going forward, Ireland has initiatives – a new Junior Cycle, new science curricula at post-primary level, a review of mathematics curriculum at primary level and ongoing implementation of revised mathematics specifications at post-primary as well as bonus points for mathematics – for strengthening science education in primary and post-primary schools in order to improve education outcomes and increase throughputs to higher education.

The weakness of the Irish R&I system in terms of low degree of collaboration between business-academia has been recurrently highlighted in recent years. Science Foundation Ireland (SFI) and Enterprise Ireland (EI) have been providing a range of funding opportunities for public-private collaborative research projects in recent years. Moreover, as already pointed out in Challenge 1, Irish indigenous companies show a lower rate of collaboration with academia compared to foreign MNC. Science Foundation Ireland (SFI) and Enterprise Ireland (EI) have been providing a range of funding opportunities for public-private collaborative research projects in recent years.

In particular, the SFI Research Centres programmes[132] supports 12 research centres, involving collaboration between HEIs and over 200 companies (split approximately 50/50 between MNCs and SMEs). A joint

[130] http://www.cso.ie/en/releasesandpublications/er/berd/businessexpenditureonresearchdevelopment2013-2014/
[131] OECD 2015
[132] http://www.sfi.ie/investments-achievements/sfi-research-centres/

Enterprise Ireland–IDA Ireland Technology Centres programme[133] supports 15 industry-led Technology Centres, generally based in a university with support from partner universities to deliver on the research needs of enterprise. Finally, one major novelty has been the creation in 2013 of a central TTO called Knowledge Transfer Ireland[134] programme (KTI). KTI's mission is to deliver an efficient and productive research and technology transfer system, to make IP and expertise within public research organisations visible for companies, and to act as a central point of contact. It supports the public research organisations' (HEIs') research and technology transfer infrastructure and provides services complementary to already existing TTO structures. The regular reporting by KTI using knowledge transfer metrics and indicators (including the subjective assessment provided by businesses) will allow monitoring the progress of business-academia cooperation in Ireland in the years to come.

3.11.3 National policies for strengthening innovation eco-system capabilities and exploiting complementarities

Ireland has a large number of top corporate R&D investors, thanks to the strong presence of high-technology multinational companies. The bulk of Ireland's BERD (71%) is performed by foreign affiliates, owing to Ireland's supportive environment for FDI. Entrepreneurship has been given a strong policy focus. New programmes – the Credit Guarantee Scheme; the Microenterprise Loan Fund; the National Intellectual Property Protocol; the second phase of the Technology Transfer Strengthening Programme (TTSI2); the SFI Industry Fellowships Programme, and the SFI Investigators Programme – have been introduced to support innovation in all categories of firms.

3.11.4 National policies for stimulating demand for innovation:

Innovative public procurement has been mentioned in a number of Irish STI strategy documents over the years[135], but this instrument has been largely under-utilised, despite the recommendations made by the Procurement Innovation Group established in 2008 in the report "Using Public Procurement to Stimulate Innovation and SME Access to Public Contracts". Irish policy makers seem to have not yet exploited the potentials of using demand-side instruments such as PCP and PPI as tools to stimulate the innovation capabilities of Irish SMEs and to boost the growth of young companies in the more knowledge-intensive sectors of the economy. The Office of Government Procurement (OGP) was officially launched in 2013 as part of a Government drive to reduce costs and achieve better value for money through reform of public procurement. The OGP issued a Circular 10/14 (April 2014) which sets out positive measures that public sector buyers should take to promote SME involvement in public sector procurement, includes a specific provision that contracting authorities should consider new and innovative solutions, where possible and appropriate.

The first pilot project was launched in 2014 by the Sustainable Energy Authority (SEAI) launched in collaboration with Enterprise Ireland (EI), i.e. a SBIR[136] (Small Business Innovation Research) competition, to develop a smart technology solution for charging Electric Vehicles (EVs) in shared access parking areas.

[133] https://www.enterprise-ireland.com/en/research-innovation/companies/collaborate-with-companies-research-institutes/technology-centres.html
[134] http://www.knowledgetransferireland.com/
[135] Department of Enterprise, Trade & Employment (DETE) (2009), Using Public Procurement to Stimulate Innovation and SME Access to Public Contracts, Report of the Procurement Innovation Group, http://etenders.gov.ie/Media/Default/SiteContent/LegislationGuides/Report%20of%20the%20Procurement%20Innovation%20Group.pdf
[136] http://www.seai.ie/SBIR

Ireland has implemented measures on innovation procurement much later than other EU countries, also taking into consideration the strength of its high-tech and ICT sectors. The SBIR calls launched in 2014 and 2015, together with the plan to engage in a learning process of other countries' procurement practices can be considered as positive developments.

3.11.5 Improving frameworks for innovation, including regulation and standards

In 2014, the policy research functions of Forfás, Ireland's policy advisory board for enterprise, trade, science, technology and innovation[137], will be integrated into the Department of Jobs, Enterprise and Innovation (DJEI) to strengthen the Department's capacity for job-creation policy and for evaluation. The current membership of the Advisory Council for Science, Technology and Innovation (ACSTI) stood down with effect from September 2013, pending the results of the Forfás integration process and overall policy on public service reform. This does not rule out the option of establishing an Advisory Council of a similar nature on an alternate footing, if this is deemed appropriate in the future. Following publication of the Research Prioritisation Steering Group report in March 2012, the Prioritisation Action Group (PAG), involving all relevant departments and funding agencies, was established to drive implementation of research prioritisation. Action plans for each of the priority areas, as well as a Framework of Metrics and Targets, were drawn up and approved by government in summer 2013. The Action plans represent the detailed blueprint for actions to be taken to re-align the majority of competitive public research funding around the priority areas over the following five years and include a vision, key objectives and specific actions, along with timelines and responsibilities for leading and supporting delivery of the action.

[137] OECD, 2014 and also in https://djei.ie/en/Publications/Publication-files/Forf%C3%A1s/Forfas-Annual-Report-2014.pdf

4 List of Tables

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6 Annex 1: Policy Framework Table

(1) National Policies for increasing research and development investment	Fiscal measures: tax incentives	Corporation tax incentives (early stage R&D)
		Corporation tax incentives (later stage commercialisation/production of innovations)
		Payroll and social contributions tax incentives
	Fiscal measures: grants and loans for industrial R&D	Subsidised loans (including interest allowances)
		Grants for R&D (early stage)
		Grants for R&D (later stage commercialisation and production of innovations)
		Reimbursable loans
		Innovation Inducement Prizes
		Small project grants, awards
		Studentships, Fellowships, cluster awards.
	Fiscal measures: providing equity support	Publicly Supported Venture Capital (including subordinated loans)
		Guarantees
		Support risk capital
		Supporting development pilot lines/prototype creation
		Mixed or subsidised private venture funds
	Fiscal measures: supporting public sector research	University funding
		Laboratory funding
		Collaborative grants
		Strategic Programmes for Industry
		Equipment sharing
(2) augmenting skills and enabling access to expertise	Measures for improving and increasing the supply of skills	Policies for Training and Skills on Improving Innovation Capabilities in Firms
		Schemes and activities supporting structured innovative doctoral training
		Schemes and activities supporting career prospects of PhD students
		Schemes or activities to expose PhD students to industry
		National policies fostering the adoption and higher degree of implementation measures, related to female researchers recruitment, retention and career
	Measures for improving demand for skills	Strengthening market valuation of training and competences
		Skills formation policies (e.g. STEM policies)
		Schemes and support actions for industrial PhDs (e.g. placement, private
		Support to hire professors or staff whose primary occupation is in the private
		Recruitment of researchers (e.g. fiscal incentives)
	Measures for enabling access to expertise	Technology advisory services provide information, technical assistance,
		Schemes/policies to advise firms on innovation management and adoption
(4) National Policies for strengthening innovation eco-system capabilities and exploiting complementarities	Measures for exploiting complementarities	Cluster Policy on Innovation
		Schemes supporting R&D cooperation between business and higher education/RTOs
		Schemes supporting Knowledge Transfer projects
		Schemes supporting Knowledge Transfer networks
		Support for technology transfer between firms
		Support for technology transfer between sectors/platforms
		Schemes/policies targeting specific sectors
		Schemes/policies targetting KETs
		Schemes/policies targeting specific Research and Technology Fields
		Schemes/policies supporting the creation of a favourable innovation climate
	Measures supporting capabilities: entrepreneurship	Support the creation, management and/or follow-up of spin-offs
		Promotion of entrepreneurship/start up (including incubators)

	policy	Promotion of innovative start-ups incl Gazelles
	Measures supporting capabilities: exploiting Intellectual Property	Schemes supporting commercialisation of innovation (including IPR)
		Schemes supporting the use of consultancy to exploit IPR
		Schemes supporting the use of financial incentives to exploit IPR
		Schemes to advise firms on innovation management and adoption issues
(5) enhancing innovation demand	Measures for triggering innovation-driven competition	Support measures for public procurement of innovation
		Pre-Commercial Procurement
	Measures to Stimulate Demand for Innovation	Public Sector use of Policy Advisory services (e.g. technology foresight)
		National Public Procurement Policies (e.g. procurement pipelines)
		Sectoral Public Procurement Policies (e.g. procurement compacts, procurement pipelines, public procurement of innovation measures)
		Support for the use of innovative/state of the art standards in public
(6) improving frameworks for innovation, including regulation and standards	Measures for improving innovation framework	Support for the development and use of innovative standards and standardisations
		Regulation
		Funding linked to an assessment/evaluation exercise that conforms to
		Evidence of evaluations that conform to international peer-review standards as
(7) Facilitating exchange and dialogue about innovation.	Measures for facilitating exchange and dialogue	Awareness raising amongst firms on innovation
		Support for networking and communication activities with the private sector
		Policy Advisory services (e.g. technology foresight)
		Schemes and support actions for international networking (e.g. collaborative
		Schemes and support actions fostering interdisciplinary research (e.g. shared

Source: OECD (2014), OECD Science Technology and Industry Outlook 2014, OECD Publishing, Paris.

7 Annex 2: Comparative table of national STI strategies or plans

Austria	
Becoming an Innovation Leader: Realising Potential, Increasing Dynamics, Creating the Future	2011-20 Be one of the EU's most innovative countries EU by 2020 and among the "Innovation Leaders": *i)* a well-equipped education system; *ii)* basic research as a fertile ground for the innovation system; *iii)* intensified R&D activities in companies ensured by knowledge transfer between scientists and businesses; *iv)* new framework conditions and funding governance structures, and distribution of responsibilities in a multi-level political system, from regional coordination to internationalisation; *vii)* efficiency and effectiveness of funding, as well as the principle of competition-based funding allocation. *Quantitative target:* ● Raise R&D expenditures to 3.76 % of GDP by 2020.
Czech Republic	
National Innovation Strategy	2012-20 Raise the importance of innovation and use top-of-the-range technologies as a source of competitiveness and increase their contribution to long-term economic growth, high-quality jobs creation and the development of quality of life in the Czech Republic through *i)* excellent research; *ii)* cooperation between research institutions and enterprises; *iii)* innovative entrepreneurship; *iv)* human resources as originators of new ideas and initiators of changes.
Reform of the Research, Development and Innovation System	Since 2008 Increase the competitiveness of the Czech economy and improve the quality of life in the Czech Republic through institutional arrangements, legislative changes regarding public support of R&D and funding to: *i)* improve efficiency and simplify R&D support; *ii)* support excellence in R&D and facilitate application of R&D in innovation; *iii)* strengthen cooperation with users of R&D results based on co-financing from public and private resources; *iv)* improve organisational flexibility of public research institutes; *v)* ensure a supply of HRST; an *vi)* increase involvement in international cooperation.
Estonia	
Knowledge-Based Estonia (KBEIII)	2014-20 Create favourable conditions for increased productivity and standard of living, good education and culture, preservation and development of Estonia. *Quantitative targets (by 2020):* ● Raise R&D expenditures to 3 % of GDP. ● Raise business expenditures on R&D to 2 % of GDP (2/3

	of GERD). Entrepreneurship Growth Strategy 2014-20 Raise productivity and employment through a single strategic framework that ensures coherence of entrepreneurial and innovation policies. Focuses on areas (Smart Specialisation) and groups of enterprises with major potential
R&D and Innovation Strategy Knowledge-Based Estonia (KBEII)	2007-13 Ensure high-quality R&D, increase business-sector innovation and value added and establish Estonia as an innovation-friendly country through: *i)* development of human capital; *ii)* more efficient organisation of public sector R&D&I; *iii)* increased innovation capacity of enterprises; *iv)* Policy making aimed at long-term development of Estonia. *Quantitative targets (by 2020):* ● Raise R&D expenditures to 3 % of GDP. ● Raise business expenditures on R&D to 1.6% of GDP (half total R&D expenditures).
Research Infrastructures Roadmap	Since 2010 Focus on 20 research infrastructures of national importance, either new or in need of upgrading and Estonian priorities in pan-European partnership projects.
Finland	
Action Plan for Research and Innovation Policy (TINTO)	Since 2012 i) Encourage constant renewal and the transcending of boundaries and the courage to experiment and take risks; ii) Make faster, more efficient use of research outcomes and strengthen the social impact of STI policy by broadening the scope of innovation activities; iii) ensure long-term basic funding for universities and public research institutions; and iv) use competitive research funding more strategically to boost the exploitation and social impact of research outcomes.
Research and Innovation Policy Guidelines 2011-15	Enhance competitiveness and the knowledge base to create a world-class basis for expertise and business activities through: i) a change the public sector's operating culture to match the new role of government in R&D and innovation; ii) a broad-based innovation policy (e.g. tools for demand and user-driven innovation; public procurement; regulatory framework issues, lead market initiatives); iii) a new R&D tax incentive scheme for companies and tax incentives for private VC investors; iv) support for new growth-oriented young companies; v) continued structural development of PRIs and establishment of a national infrastructure policy. Quantitative targets: ● Maintain R&D intensity at 4 % of GDP to 2020 (public R&D funding at 1.2 %).

Germany	
High-Tech Strategy	2006-13 Gear research and innovation policy towards a number of central missions and adopt an integrative approach by i) identifying key technologies that support the emergence of lead markets; ii) linking up topics in various fields of innovation policy across federal ministries; iii) addressing aspects of funding in connection with efforts to improve general conditions; and iv) defining specific missions, so-called "forward-looking projects" (Zukunftsprojekte). Related innovation strategies form the basis of roadmaps for achieving interim milestones. Priority areas: health, nutrition, energy, climate change, mobility, communication and security. In the first phase of the High-Tech Strategy (2006 to 2009), the main focus was on key technologies and lead markets.37 Yet even here, reference was made to the need to use new technologies to overcome major societal challenges. These became a priority in the High-Tech Strategy's second phase (2010 to 2013). Science has coined the term "new mission orientation" to describe an R&I policy that is geared towards the great societal challenges and thus intends to specifically exert influence on the direction of technological change. Quantitative targets: ● Raise R&D expenditures to 3 % of GDP by 2020.
The New High-Tech Strategy - Innovations for Germany	According to the Federal Government, the new High-Tech Strategy aims to merge the "threads" of the first two phases. The new High-Tech Strategy is to be further developed into a "comprehensive inter-ministerial innovation strategy" The concept of innovation has been extended and now also includes social innovations. The new High-Tech Strategy contains five core elements: I. Priority challenges with regard to value creation and quality of life; II. Networking and transfer; III. The pace of innovation in industry; IV. Innovation-friendly framework; V. Transparency and participation. Priority challenges set policy guidelines In the new High-Tech Strategy, the policy guidelines associated with the new mission orientation can be found in the core element "priority challenges". A total of six priority challenges have been defined: 1. The digital economy and society, 2. Sustainable economy and energy, 3. Innovative world of work 4. Healthy living, 5. Intelligent mobility, 6. Civil security.
Ireland	
Strategy for Science, Technology and Innovation	2006-13 *i)* Improve competitiveness, *ii)* remain attractive

(SSTI)	for FDI and maximise social cohesion; *iii)* promote R&D to become an innovation-driven economy. *Quantitative targets:* ● Raise R&D expenditures to 2.5 % of GNP by 2013.
Italy	
National Research Plan (2014-16)	Forthcoming Strongly based on the so-called "Major Societal Challenges" in Horizon 2020, it has produced Horizon 2020 Italy to improve alignment with EU instruments.
National Research Plan 2011-13	Promote knowledge-driven research; *ii)* strengthen the involvement of the business sector and cooperation with the public sector; *iii)* support the internationalisation of research; *iv)* promote centres of excellence in the national/international context; *v)* concentrate efforts on large projects and research infrastructure. *Quantitative targets*: ● Raise R&D expenditures to 1.53 % of GNP by 2020.
Netherlands	
Science Strategy 2025: Choices for the Future	The government's new science policy is set out in Science Strategy 2025: Choices for the Future. The government has set three general aims: • Dutch science must be world-class; • Dutch science must have stronger links with and maximum impact on society and industry; • Dutch science must be a breeding ground for talent. Parliament must still approve the plans.
Enterprise Policy – "To The Top"	Since 2011 Strengthen Dutch competitiveness and make the Netherlands one of the top five knowledge economies in the world (by 2020) through: *i)* fewer subsidies in exchange for lower taxes; *ii)* fewer and less complicated rules; *iii)* broader access to corporate financing; *iv)* better utilisation of the knowledge infrastructure by the business sector; and *v)* better alignment of the tax system, education and diplomacy with the needs of the business sector. *Quantitative targets*: ● Raise R&D expenditures to 2.5 % of GDP by 2020. ● Establish top consortia for Knowledge and Innovation to which public and private parties contribute more than €500 million, at least 40 % of which is financed by the business sector (by 2015).

Strategic Agenda for Higher Education, Research and Science 2011-15	*i)* Strengthen the quality of education; *ii)* focus on specific economic sectors (such as water, energy); and *iii)* strengthen curiosity-driven (fundamental) research through promotion of cooperation in the so-called "golden triangle": education, research and entrepreneurship.
Portugal	
Research and Innovation Strategy for Portugal 2014-20	Multi-level research and innovation strategy to inform the design of national programmes for 2014-20. *Quantitative targets:* ● Raise R&D expenditures to 3 % of GDP by 2020.
Spain	
Spanish Strategy for Science, Technology and Innovation (EECTI)	2013-20 Set out long-term STI policy and approaches to maximize economic and social benefits. Outline "service to society" as the driving force behind S&T advancement and the need to accelerate the flow of research and knowledge into the economy.
State Plan for Scientific and Technical Research and Innovation (PEICTI)	2013-16 Overarching mechanism under the 2011 STI Act that includes all programmes and initiatives in the area of STI and defines the key implementation mechanisms. *Quantitative targets:* ● Raise R&D expenditures to 2 % of GDP by 2020.
Science, Technology and Innovation	Act 2011 New strategic framework based on the Spanish Strategy for Science and Technology (EEI) for research funding and governance with: *i)* a state research agency, comprehensive reform of PRIs and new excellence programmes; *ii)* greater incentives for technology transfer and researcher mobility (e.g. technological centres and S&T parks); *iii)* a new model of governance that ensures coordination between the autonomous communities and the central government and better links with the European Research Area; *iii)* more attractive and stable career paths for research and technical staff and better gender balance.
United Kingdom	
UK Industrial Strategy	competitive advantage to build on in the next 20 years based on the government's commitment to a long-term partnership with business through: *i)* access to finance (e.g. the new national British Business Bank to provide SMEs lending and guarantee solutions); *ii)* skills (giving businesses more say over how funding for skills is spent, e.g. through the Employer Ownership Pilot and the Employer Ownership Fund); *iii)* procurement (e.g. Small Business Research Initiative to support pre-commercial

procurement, simpler and more transparent public procurement and strengthening of private-sector supply chains); *iv)* eleven key sectors: aerospace, agri-tech, automotive, construction, information economy, international education, life sciences, nuclear, offshore wind oil and gas, and professional and business services; *v)* catapult centres and eight great technologies: big data, space, robotics and autonomous systems, synthetic biology, regenerative medicines, agri-science, advanced materials, energy.

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