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RIO COUNTRY REPORT 2015: Denmark

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Abstract

The 2015 series of RIO Country Reports analyse and assess the policy and the national research and innovation system developments in relation to national policy priorities and the EU policy agenda with special focus on ERA and Innovation Union. The executive summaries of these reports put forward the main challenges of the research and innovation systems.

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Foreword

The report offers an analysis of the R&I system in Denmark for 2015, including relevant policies and funding, with particular focus on topics critical for EU policies. The report identifies the main challenges of the Danish research and innovation system and assesses the policy response. It was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The quantitative data is, whenever possible, comparable across all EU Member State reports. Unless specifically referenced all data used in this report are based on Eurostat statistics available in February 2016. The report contents are partly based on the RIO country report, 2014.

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Executive summary

This country report provides an up-to-date overview of the research and innovation (R&I) system of Denmark. It examines the developments towards topics central to two EU policies: the European Research Area (ERA) and the Innovation Union (IU). The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites, etc. The quantitative and qualitative data are comparable across all EU Member State reports whenever possible.

Context

Denmark's overall economic situation is stable and has been improving since the financial crisis. GDP has grown in 2014 as has GDP per capita over the past couple of years. Both budget deficits and unemployment rates have decreased. However, the government deficit and consolidated debt are still much higher than before 2009.

In terms of 'smart fiscal consolidation', public support to R&I in nominal terms – both budgeted (GBAORD) and executed (GERD funded by the government) – saw slower increases in the aftermath of the 2008-2009 crisis and beyond. The structural balance of Denmark has been positive in recent years. Furthermore, budget appropriations and direct support for R&D from the government have not been reduced, in nominal terms nor as a percentage of GDP. However, the new Danish government, which came into office in June 2015, has reduced the budget allocated to research in 2016, so that it reaches 1.01% of the GDP corresponding to savings of approximately €187m. This may weaken Denmark's innovation capacity in the longer run.

The Danish research & innovation (R&I) system has expanded over the last 20 years and its R&D intensity is now one of the highest in the EU. The quality of scientific outputs in Denmark is among the top, however, there are some relative weaknesses on the innovation output side, particularly concerning high-tech exports and SMEs, and in the level and availability of human resources for R&I, notably in the private sector. More broadly, there are concerns in the Danish economy surrounding weak productivity growth. Denmark's Innovation Strategy 2012-2020 aims to shift to a demand-driven innovation policy, enhancing knowledge flows and improving education.

According to Eurostat, Denmark's gross domestic expenditure on R&D (GERD) reached 3.08% of GDP in 2014, representing the same level as in 2013, which is well above the EU average (2.03%) and above the 3% target set by the Danish Government for 2020. Business enterprise R&D expenditure (BERD) has been staying at 1.98% of GDP since 2011. BERD contributed with about two thirds to overall GERD. Public research is mainly performed by the university system, accounting for about one third of total R&D in 2014.

Denmark is aligned with many ERA policies, with a high quality science base, and thematic priorities as well as research infrastructures largely aligned with H2020 goals. There are recent efforts to increase the already good gender balance in research careers, boost internationalisation of R&I and improve open access to research. Measures to support R&D collaboration between the public and the business sector are administered by the Innovation Fund Denmark, established in April 2014, e.g. Industrial PhD and Industrial PostDoc programmes, InnoBooster, as well as public-private partnerships on innovation and strategic R&D projects. Over the last years technology transfer has been strengthened and possible conflicts of interests have been addressed in standard agreements on IPR and in strategic collaboration agreements between universities and industry partners.

There were no major R&I policy changes in 2015.

The main R&I challenges for Denmark's R&I system¹ are to:

- (1) Increase university-industry collaboration and improve commercialisation of public research
- (2) Increase the quality and availability of human resources in R&I
- (3) Support innovation to boost productivity

Challenge 1: Increase university-industry collaboration and improve commercialisation of public research

Description

Collaboration on R&D by universities and enterprises, as well as commercialisation of public research can optimise the impact of research and innovation for the economy and society. Denmark's scientific outputs are excellent in overall terms (scoring 81.1 in the EU excellence indicator, well above the 47.8 EU average) and it ranks top in the EU on percentage of highly cited publications. Moreover, of Denmark's eight universities, four are among the top 200 in the Leiden ranking system, three among those are also placed in the Times Higher Education ranking. However, the results for innovation outputs are relatively weak and have declined since 2010. In the EU innovation output indicator, Denmark ranks 5th, behind Sweden, Germany, Ireland and Luxemburg. The efficiency of inputs to outputs places Denmark 17th (see Edquist and Zabala-Iturriagoitia, 2015) in contrast to its 2nd place in the Innovation Union Scoreboard. Denmark's rate of public expenditure on R&D financed by business is one of the lowest in the EU and the rate of patents filed by universities and public labs by GDP is significantly below peers in Finland and Sweden and decreasing. Small and medium-sized enterprises (SMEs) are underperforming, particularly on introducing marketing or organisational innovations, as well as on new products or process innovations (both rank 13th). Evidence suggests many university researchers collaborate with industry and engage in knowledge and technology transfer (KTT) activities which is why the overall KTT framework seems to function well. Difficulties in collaboration nevertheless exist, particularly due to different 'institutional logics', i.e. university scientists are primarily rewarded for publication output and peer recognition which is not necessarily an outcome of industry-science collaboration, since industry may have an interest in keeping research results secret in order to commercialise.

Policy response

Initiatives that target private R&D investments and public research commercialisation are supported by the Innovation Fund Denmark with its InnoBooster program for SMEs to interact with public science, and innovation networks for SMEs, and support for large demonstration facilities. The strengthening of the GTS – Advanced Technology Group institutes (GTS) was also put in place along with innovation networks, the InnoBooster programme, and establishing Strategic Research Centres. Research collaboration with private companies plays an increasingly important role for Danish universities, usually organised as joint initiatives. Universities are building still more efficient and competent technology transfer offices with the aim of commercialising and ensuring that research results are brought to the market (Universities Denmark, 2013). Since one of the main concerns with such collaborations are intellectual property rights, as part of the growth plan adopted in April 2013, the government increased efforts to diffuse knowledge on intellectual property rights (IPRs) to companies and entrepreneurs, particularly to designers and creative industries, as well as to students. In addition, the independent Productivity Commission, set up from 2012 to 2014 to advise the Government, recommended in 2013 to improve university-industry collaborations on R&D and specifically to improve the legal framework for university knowledge transfer.

¹ Rankings are based on the European Commission's Innovation Scoreboard, 2015

Since July 2013, initiatives have also been launched to enhance enforcement of IPR rules by public prosecutors. Finally, standard contracts for commercialisation aim to make it easier for large and small businesses in creative industries to collaborate on the commercialisation of designs and ideas (OECD, 2014). Evidence shows EU funding schemes enabled Danish companies and universities to build successful collaborations. Funding for activities that would not otherwise have been implemented is perceived as the most important effect, closely followed by cooperation with foreign universities and research organisations and access to new knowledge. Small companies experience greater effects than medium-sized companies and large companies. As many as half of the participating companies launched new products or services as a result of their participation in FP6 and FP7 projects (Ministry of Higher Education & Science, 2015).

Assessment

The measures above build on more than a decade of policies seeking to turn knowledge into products or services by supporting the commercialisation of public research results. A 2014 evaluation concluded that the legal framework is adequate. Instead, barriers relate to university management, lack of economic and other incentives and cultural differences. The new policy measures address this, but it is too early to say if they are succeeding. An underlying weakness may be a lack of an entrepreneurial culture and education at Danish universities. Accreditation of new entrepreneurship education needs to be prioritised - this has been proposed by the government and an agreement reached in parliament (Grimpe, 2014). However, with the goal of increasing patents, the rather low patent intensity of Danish universities, with the exception of the Technical University of Denmark (DTU) and Aalborg University, remains a challenge. University technology transfer offices have different framework conditions and most are subcritical in terms of size of patent and technology portfolios to be commercialised (Grimpe, 2014). The formation of spin-off companies is rather low and only the DTU made significant profits from licensing. Only a few universities have defined specific targets on research commercialisation in their performance contracts. More broadly, while cooperation with the GTS institutes has developed very well and cooperation of firms with Danish universities is comprehensive, some Danish firms still prefer to cooperate with foreign universities.

Challenge 2: Increase the quality and availability of human resources in R&I

Description

An important prerequisite for sustaining growth in prioritised sectors is a critical supply of human resources. Engineers especially are perceived as being essential for future growth of new knowledge intensive sectors. Denmark's education spending is among the highest in the EU, but this is not matched by STI skills, which lie in the mid-range of advanced economies. Denmark's education system performs above the EU average on most counts, but it has a comparatively low share of highly skilled labour in the private sector. Denmark faces a growing challenge to ensure that more students and graduates will seek private sector employment. More specifically in terms of the research and innovation system, Denmark has a relatively low share of new doctoral graduates compared with Finland and Sweden, and slightly fewer foreign doctoral students. Denmark hasn't traditionally trained a high number of PhDs, and despite good levels, there is potential to increase this, including through enhanced international collaborations.

Policy response

Denmark's policy-makers have focused on this challenge for a number of years and the issue is pervasive in policy debates and documents. Denmark's national innovation strategy includes a range of initiatives to strengthen innovation capacity through education.

The government anticipates that at least 25% of youth cohorts will complete a master's degree by 2020, and that the uptake of PhD students will remain at the 2010 level of 2,400 a year. There is room for greater progress however - in 2012, 1,552 graduates completed their PhD.

At the end of 2013, the Danish government established the Quality Committee to look at ways to improve the quality and relevance of higher education (OECD, 2014), it presented recommendations in 2015. Denmark has also reformed study grants, as well as the Industrial PhD and the Post-Doc programmes to be more responsive to the needs of society and the economy. By including the educational system in the innovation strategy, committing to increase innovation-related and entrepreneurial skills in courses and programmes throughout the education system and setting targets for the share of highly skilled labour in the private sector, the Danish government is already on the right path. The shortage of human resources in STEM subject areas has also been addressed by stakeholders in the private sector.

Denmark's internationalisation strategy for research includes a number of targeted measures, such as innovation centres in R&D hotspots globally which aim to increase collaborations in R&D fields as well as attract collaborations with companies and universities. There is also Nordic University Cooperation, researcher exchange agreements with Japan and China, a Consortium for Global Talent in collaboration with Danish industry, the Science without Borders programme to bring Brazilian students to Denmark, as well as certain collaborations with developing countries. One example, the Sino-Danish Centre for Education and Research (SDC), was established in 2008 to promote and strengthen collaboration between Danish and Chinese learning environments and increase mobility of students and researchers between Denmark and China.

Assessment

Denmark is going in the right direction to fulfil its ambitious goals for tertiary education levels and has doubled the number of PhDs, increased university enrolment and improved the strategy for life-long learning. The Industrial PhDs and Post-Docs are an effective measure and have over time been instrumental in facilitating knowledge and technology transfer from academia to industry (Grimpe, 2014). However, making further information available on how the various strategies and programmes are monitored and evaluated would enable greater progress in this area by indicating strengths and weaknesses of current measures. One example is the analysis of the PhD training system in Denmark initiated in 2015, to be published during the course of 2016. In terms of increasing attractiveness of researchers to Denmark and boosting international exchanges and collaborations, the Innovation centres have succeeded in creating added value and growth as well as raising international awareness of Danish companies and higher education institutions. Furthermore, the centres facilitate stronger partnerships between Danish and local researchers, higher education institutions and companies (Oxford Research, 2015).

Challenge 3: Support innovation to boost productivity

Description

Renewing stronger productivity growth is a challenge for Denmark, as for many advanced economies. With a stagnating economy, and increasing costs from an ageing population and strong welfare provisions, remaining competitive is complex. Research and innovation can support increasing productivity when new technologies are taken-up by the public and private sector, and human resources are well allocated across the performing economic sectors. Infrastructure investment can also support labour productivity improvements. Many advanced economies score low in the level of investment in non-R&D expenditures. Denmark is ranked 27th, which is particularly low and signals a lack of upgrades across the R&D sectors.

On the other hand, public sector innovation in Denmark is among the best in Europe with successful initiatives such as MindLab - a cross-governmental innovation unit which involves citizens and businesses in creating new solutions for society. However, there is significant scope for R&I and infrastructure investments to support improvement in the business sector.

On the output side, exports of medium and high-technology products as a share of total product exports is also rather weak, ranked 19th, which signals a greater need for increasing domestic R&D in key sectors.

Policy response

The government set up an independent Productivity Commission which reported its findings in 2013 and 2014. It proposed a key task for the government is to lay the foundation for strong productivity growth throughout society; both in exporting companies, in domestic business and in the public sector. The objective is that the level of productivity in Denmark in the long term will be close to the top in the OECD. It also recommended improving the quality of training to boost the impact of public research and enhancing university-industry collaborations on R&D. Finally, it proposed giving impact evaluations of R&D programmes a higher priority. Denmark's new Innovation Fund aims to provide efficient and effective funding for R&I. The Growth Fund is aimed at supporting on-going business development in sectors of high societal importance. The Danish government commissioned eight growth teams with members from industry in areas where Danish businesses are or can be internationally competitive. Based on their recommendations the government published specific growth plans for each of the following seven areas: Blue Denmark; Creative Industries and Design; Water, Bio and Environmental Solutions; Health and Care solutions; Energy and Climate; Food Sector; and Tourism and Experience Economy. A growth plan for ICT and Digital Growth remains to be published. The plans address specific barriers to investment and focus on areas in which new markets can be developed. For example, the creation of a single, transparent and efficient means of access to Danish health data could attract medical research to Denmark (OECD, 2014). In terms of public procurement, the Market Development Fund works to promote methods of innovative public demand in order to spur job creation and growth in Danish companies, including boosting exports. Finally, Denmark's existing plans have been put together to form its smart specialisation strategy for R&D – including the Government's growth plans and the regional growth and development strategies of the regional growth fora.

Assessment

While most Productivity Commission recommendations are broader than R&I policy, some more recent R&I policy developments reflect the commission's insights. Denmark's new Innovation Fund is seen as a significant step forward in terms of providing efficient and effective funding for R&I (Grimpe, 2014).

According to the OECD, weak competition in some sectors and shortcomings in the innovation policy framework hold back productivity growth, notwithstanding high R&D spending, and can hinder participation in global value chains, which is one channel to achieve productivity gains. There is room to enhance innovation policies; including to make sure that some schemes provide efficient support to young and dynamic innovative firms (OECD, 2014b). The Growth Fund is an appropriate measure supporting business development in key sectors. Intelligent public procurement will probably strengthen R&D intensity through demand-pull innovation incentives (Grimpe, 2014). Without a single smart specialisation strategy, there may be an increased need for a coherent monitoring and evaluation system to support effective implementation, an important way to boost productivity growth through innovation.

1. Overview of the R&I system

1.1 Introduction

Despite being small – Denmark has only 5.6m inhabitants which corresponds to only about one percent of the total EU-28 population – Denmark has generally been characterised as an excellent example of a well-performing research and innovation (R&I) system (e.g. European Commission, 2015a). Denmark is one of the innovation leaders with above average performance according to the Innovation Union Scoreboard 2015, in which it ranks on the second place after Sweden. Denmark forms a group of peak performers with Sweden, Germany and Finland. The country possesses a strong international position in most science, technology and innovation (STI) indicators (European Commission, 2014). Considerable emphasis is placed on the education system with excellent higher education and research. Both the private and the public sector are committed to invest into education, research and innovation at a level necessary to maintain its current highly competitive position. Moreover, STI in Denmark are supported by a strong culture for innovation that reflects the country's open and dynamic welfare society. Despite this generally positive assessment, the Danish R&I system also exhibits several weaknesses, particularly regarding innovation outputs, that will be further elaborated upon throughout the report. Moreover, the new Danish government, which came into office in June 2015, has reduced the budget allocated to research in 2016, so that it reaches 1.01% of the GDP corresponding to savings of approximately €187m (Danish Government, 2015). This may be seen as a threat to Denmark's innovation capacity in the longer run.

Table 1 provides an overview of macroeconomic indicators. Denmark's overall economic situation is stable and it has been improving since the financial crisis. GDP has grown in 2014 as has GDP per capita over the past couple of years. Both budget deficits and unemployment rates have decreased. Except for GDP growth, Denmark has performed significantly better than the EU average. Denmark has also performed well in terms of investments into research and development (R&D). According to Eurostat, GERD as a percentage of GDP reached 3.08% in 2014, well above the EU average of 2.03% and exceeding the 3% target. The shares of employment in high-tech manufacturing and knowledge-intensive services sectors have remained rather stable with 5.0% and 49.5%, respectively, in 2014. While Denmark is below the EU average for high-tech manufacturing, it is significantly above of knowledge-intensive services, which indicates a relative specialization of Denmark's industrial profile. The average share of turnover that originates from innovative products was 13.9% in 2012, again considerably higher than the EU average. Finally, an increasing share of the total value added in Denmark is generated by the manufacturing and particularly the high-tech manufacturing sector.

Table 1: Main R&I indicators 2012-2014

Indicator	2012	2013	2014	EU-28 2014
GDP per capita	45,200	45,500	46,200	27,400
GDP growth rate	-0.1	-0.2	1.3	1.4
Budget deficit as % of GDP	-3.6	-1.3	1.5	-3.0
Government debt as % of GDP	45.6	45.0	45.1	86.8
Unemployment rate as % of the labour force	7.5	7.0	6.6	10.2
GERD in €m	7,589.59 9	7,803.00 1	7,951.52 1	283,009.388
GERD as % of the GDP	3.03	3.08	3.08	2.03
GERD (EUR per capita)	1360.0	1392.7	1413.0	558.4
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	5.1	5.0	5.0	5.7
Employment in knowledge-intensive service sectors as share of total employment	49.2	49.3	49.5	39.8
	2008	2010	2012	2012
Turnover from innovation as % of total turnover	11.4	15.0	13.9	11.9
	2011	2012	2013	2012
Value added of manufacturing as share of total value added (%)	22.9	24.0	23.7	26.2
Value added of high tech manufacturing as share of total value added (%)	4.7	5.3	5.2	2.5

Source: Eurostat, December 2015.

1.2 Structure of the national research and innovation system and its governance

1.2.1 Main features of the R&I system

The Danish research and innovation (R&I) system is highly centralised. The five Danish regions play only a small role for R&I funding. Overall, the business enterprise sector performed 1.98% of GDP in 2014, the government sector performed 0.07% of GDP, the higher education sector performed 1.03% of GDP, and the private non-profit sector performed 0.01%. Since about two thirds of GERD are performed by the business enterprise sector, the Danish R&D system can be said to be dominated by private R&I. Public R&I is mostly carried out by the university sector, including a few public research institutes, while the private non-profit research institutes only play a minor role in terms of budget. At the same time, the business enterprise sector funded 57.9% of GERD in 2014 (Source: Eurostat, 2015). The Danish Government is active in promoting research and innovation which is reflected in a well-established and centrally organized funding infrastructure.

About 25% of the business enterprise expenditure in research and development are attributable to small and medium sized companies (SMEs, i.e. firms with less than 250 employees). Most of the R&I is therefore performed by larger, often multinational, enterprises (Source: Eurostat, 2015).

The Danish economy has a specialisation profile characterised by a mixture of low-technology industries such as food, furniture, textiles and toys (Kallerud, 2008) and more knowledge-intensive service areas, such as software consultancy or supply and engineering consultancy. The manufacture of pharmaceuticals and medical chemicals as well as software consultancy and supply are the largest sectors regarding intramural R&D expenditures. The technical specialisation of Denmark as measured by patent specialisation has been changing.

When analysing patent applications to the European Patent Office (EPO) by priority year and by International Patent Classification (IPC) sections it becomes clear that some technology fields have gained more attention, such as mechanical engineering and here especially machines or engines for liquids, wind, spring, weight, or miscellaneous motors; and electricity, and here especially generation, conversion, or distribution of electric power and electric communication techniques. This trend shows Danish activities in the field of wind energy technology, smart grid, energy efficiency and related technologies. Patent specialisation in the field of human necessities is still the most important technology field, but its importance is decreasing. Only the fields of medical or veterinary science and hygiene keep their position at the same level.

1.2.2 Governance

The main responsibility for research and innovation is placed within the authority of the Ministry of Higher Education and Science. The Ministry of Business and Growth has certain tasks related to business development, and several sectoral ministries – the Ministry of Energy, Utilities and Climate, the Ministry of Environment and Food and the Ministry of Foreign Affairs – have larger R&I programmes. The ministries have specific agencies which implement the respective policies. Regions do not play a decisive role in the R&D governance process.

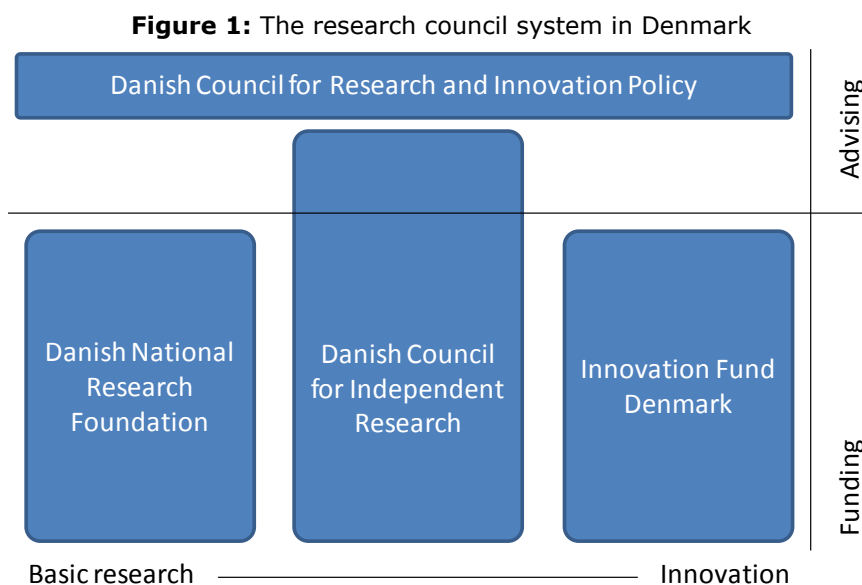
The funding system is composed of several actors, such as the Danish National Research Foundation ('Danmarks Grundforskningsfond'), the Danish Council for Independent Research ('Det Frie Forskningsråd'), and the Innovation Fund Denmark ('Innovationsfonden'). The Danish National Research Foundation provides primarily funding through a center of excellence approach. Funding is non-thematic and only oriented towards scientific excellence. The Danish Council for Independent Research finances research activities based on the researchers' individual interests. The Council is also engaged in R&I policy consulting to ministries, the government and the parliament. The Innovation Fund Denmark was established in April 2014 by joining research, technology development and innovation grants from the Danish Council of Strategic Research ('Det Strategiske Forskningsråd'), the Danish Council for Technology and Innovation ('Rådet for Teknologi og Innovation') and the Danish National Advanced Technology Foundation ('Højteknologifonden'). The reorganisation follows a recommendation made in the course of the ERAC peer review (European Commission, 2012). Overall, the Innovation Fund is intended to facilitate the development of knowledge and technology, including advanced technology, in order to foster growth and employment in Denmark. The Fund provides risk thematic funding for cooperation and innovation. Besides this reorganization, the government has reviewed the overall organisation of research under the auspices of the Danish National Research Foundation and the Danish Council for Independent Research, following international evaluations of the two bodies in 2013 and 2014. The conclusion of the evaluations and the political discussion is that the two bodies are well functioning and no major restructuring will be pushed through.²

The Danish Council for Research and Innovation Policy (DFIR, 'Danmarks Forsknings- og Innovationspolitiske Råd'), established in April 2014, promotes the development of Danish research, technology development and innovation for the benefit of society as a whole. The Council is responsible for providing the Minister for Higher Education and Science with high level, independent advice on research and innovation including future needs and is responsible for ensuring that the advice incorporates relevant national and international experience and developments. A majority of the Council members including the chairperson must be recognised researchers or research experts. The DFIR replaced the Danish Council for Research Policy (DFR) and the policy advice function from the Council for Technology and Innovation.

² See <http://ufm.dk/forskning-og-innovation/rad-og-udvalg/det-frie-forskningsrad/nyt-fra-radet/nyt-fra-det-frie-forskningsrad/dansk-forskning-nyder-godt-af-det-frie-forskningsrada6bb387820f34053be1baa4d8aa72c47>

The Council may identify its own projects or give advice, upon request, to the minister, government, Parliament or others. The major project of the Council in 2015 has been a project called 'world-class knowledge'. Recognising that bibliometric data shows that Denmark has increased its scientific impact steadily since the early 1990s, DFIR has identified six hypotheses that could explain why Danish research – relatively speaking – has increased its performance. The Council will report its findings in June 2016. Figure 1 gives an overview of the current research council system.

Figure 1 shows that basic research is funded by the National Research Foundation while Innovation is funded by the Innovation Fund. The Danish Council for Independent Research funds projects oriented to both more basic and more applied research. The latter council together with the Danish Council for Research and Innovation Policy also provide R&I policy advisory services.



Source: Ministry of Higher Education and Science (2014), www.ufm.dk

The Danish Agency for Science, Technology and Innovation (DASTI, 'Styrelsen for Forskning og Innovation') is the main actor responsible for evaluation of R&I policy. The production of analytical reports and evaluations has been strengthened substantially over the last couple of years. The agency has published a considerable number of evaluation studies with the aim to monitor and improve programmes and policy making. The evaluation system and main evaluations carried out are further described in section 2.2.1.

The new Minister, who has come into office after the elections in June 2015, is Esben Lunde Larsen (Venstre party). The government has implemented a couple of measures to reduce funding for research and education. In particular, Danish universities are required to save 2% every year from 2016 to 2019 in their education area, which has repercussions for the scientific personnel employed and consequently for the research activity. Moreover, the budget available annually to the Danish Council for Independent Research has been reduced markedly by about €36m.³

³ See <http://ufm.dk/forskning-og-innovation/rad-og-udvalg/det-frie-forskningsrad/nyt-fra-radet/pressemeddelelser-fra-dff/fundamentet-for-det-danske-forskningsmirakel-er-ved-at-vakle-det-frie-forskningsrads-kommentar-til-forslaget-til-finanslov-2016?searchterm=finanslov>

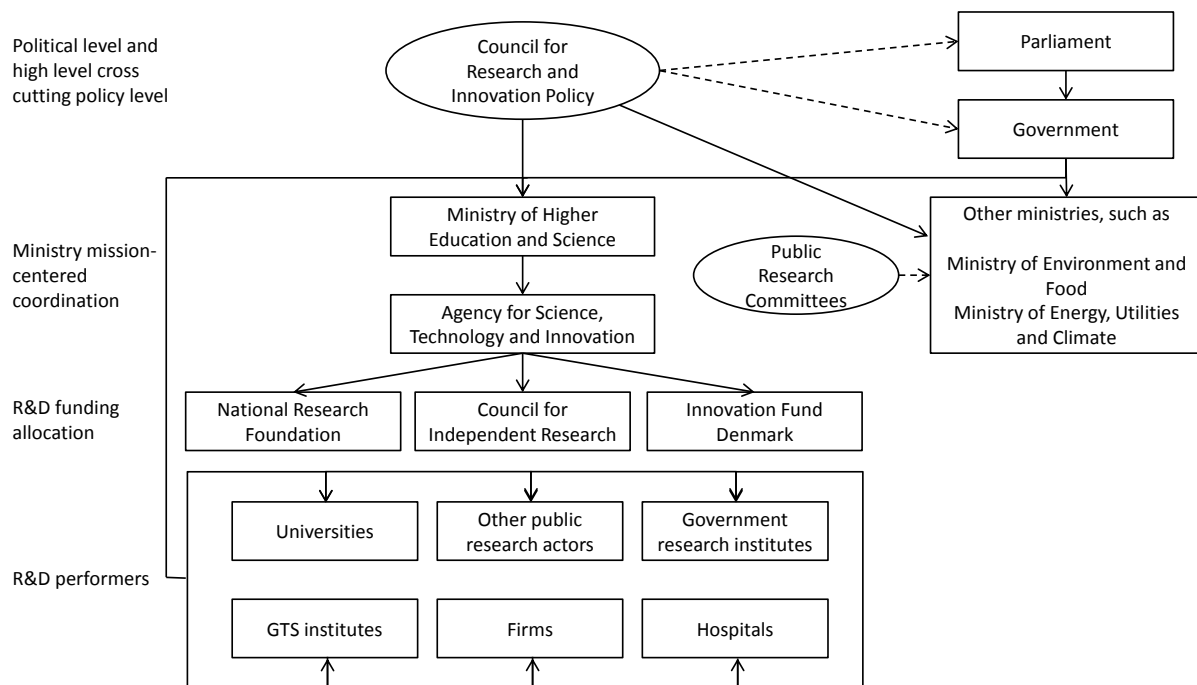
1.2.3 Research performers

The main research performers in the public sector are the eight universities: Copenhagen University, Aarhus University, the Technical University of Denmark, the University of Southern Denmark, Aalborg University, Roskilde University, Copenhagen Business School and the IT University. The universities are organised under their own stakeholder organisation, Universities Denmark. The nine GTS institutes ('Godkendte Teknologiske Serviceinstitutter') - Advanced Technology Group are non-profit R&D organisations and the main collaboration partners of the private sector. They are under the auspices of the Ministry of Higher Education and Science. Other central players in relation to ensuring a solid foundation for Danish research and innovation are several of the Danish hospitals, the national laboratory for sustainable energy and the nine independent academies of professional higher education.

According to Statistics Denmark, 46% of all companies in Denmark had innovation activities in 2013. Only about 32% were engaged in product or process innovation. In contrast, organizational innovation (30%) and marketing innovation (29%) were more widespread. Most innovative companies are located in the capital region of Denmark. As expected, most innovative enterprises are in high-technology sectors. Low-technology industries however exhibit a larger share of innovative companies than medium-technology industries. Innovative activity is moreover clearly concentrated in larger firms. 71% of all firms with 250 or more employees are innovative (all types of innovation) while only 44% of all firms with less than 10 employees are innovative. As in many other European countries, the vast majority of companies in Denmark are small and medium sized companies (SMEs).

Figure 2 shows the structure of the Danish R&I system and details the interrelationships between the different levels of analysis.

Figure 2: Organogram of the Danish R&I system



Source: Ministry of Higher Education and Science (2015); <http://www.ufm.dk>

2. Recent Developments in Research and Innovation Policy and systems

2.1 National R&I strategy

In 2013, the Danish Government launched Denmark's first comprehensive innovation strategy "*Denmark – a nation of solutions*" based on collaborative efforts between the involved ministries, i.e. the Ministry of Higher Education and Science, the Ministry of Business and Growth and other relevant sectoral ministries, as well as stakeholders from the Danish innovation system. The innovation strategy is the outcome of a strategy process that started in March 2012 and was completed by the end of 2012 (Danish Government, 2012b). The process involved an extensive consultation with relevant stakeholders and actors in the innovation system.

The vision of the new innovation strategy is that Denmark should become a nation of solutions, in which innovative solutions for the grand societal challenges are converted into growth and employment opportunities (Danish Government, 2012d). With the new innovation strategy, the Danish government sets a focus on three areas:

Innovation driven by societal challenges: Demand for solutions to concrete societal challenges must be given higher priority in public innovation policy;

- More knowledge translated to value: Focus on mutual knowledge exchange between companies and knowledge institutions and more efficient innovation schemes;
- Education as a means to increase knowledge capacity: A change of culture in the education system with more focus on innovation.

Within these focus areas, 27 individual policy initiatives are defined that the government has implemented in 2013 (although it was the strategy of the former government). In order to measure the effectiveness of the innovation strategy, the Danish government translates the vision of the innovation strategy into the following R&I policy goals:

- The share of companies introducing innovation should be increased, such that Denmark by 2020 is among the five European OECD countries with the highest share of innovative enterprises;
- Private investments into R&D should be increased, such that Denmark by 2020 is among the five OECD countries with the highest private investments into R&D as a share of GDP;
- The share of highly educated employees in the private sector should be increased, such that Denmark by 2020 is among the five European OECD countries with the highest shares of highly educated employees in the private sector.

It is worth noting that the research policy goals set out in the innovation strategy aim at a 'moving target' in the sense that the goals are oriented towards the 'best in class' in terms of innovation performance.

The innovation strategy presents an ambitious vision for the integration of innovation and entrepreneurial skills in courses and programmes throughout the Danish education system. The purpose is twofold: first, to ensure that the future Danish workforce has the competences required in a context where companies' competitiveness increasingly depends on their ability to be innovative; second, to ensure that students, also while they are studying, are being viewed as a resource that can benefit society and companies with their skills and knowledge. Among key initiatives, the strategy aims to extend practical elements to all educational programmes on all levels, e.g. in the form of internships, theses written in collaboration with companies etc. Moreover, the strategy seeks to strengthen innovation and vocational skills among talents on higher education programmes, including PhDs. Since 2013 there have been no major revisions to the innovation strategy, although a new government took office in June 2015.

2.2 R&I policy initiatives

In connection with the new innovation strategy the Danish Government started a process that led to the creation of the first INNO+ catalogue "*INNO+: The Innovative Denmark*" presented in September 2013 (Danish Government, 2013). Based on the involvement of a multitude of actors from the innovation system and made in arm's length to the politicians, INNO+ identifies 21 concrete focus areas for research and innovation that are geared towards finding solutions to the grand societal challenges. The thematic focus is on transportation, environment, urban development, food, bio-economy, health, production, digital solutions and energy. In that regard, INNO+ shares many of the main areas of the EU Framework Programme Horizon 2020. In 2013 the Parliament used the catalogue in the negotiations on the Budget Bill for prioritisation of five societal partnerships on innovation:

- Blue jobs via green solutions
- Intelligent, sustainable and efficient plant production
- Denmark as preferred country for early clinical testing and new medicines
- Water-efficient industrial production
- Innovatorium (i.e. an innovation incubator) for building renovation of world class standard

In 2014 two new priority areas were added:

- Advanced materials as a basis for growth and the solution of societal challenges
- A smart society based on the exploitation of 'big data'
- Funding for the partnerships has been allocated from Innovation Fund Denmark. Public authorities are contributing with knowledge and regulation.

INNO+ complements the previously introduced RESEARCH2020 initiative in that the catalogue focuses on the innovation policy that results from many of the same societal challenges and Danish strongholds in academia and industry that are outlined in RESEARCH2020. The RESEARCH2020 catalogue which was based on the involvement of a multitude of actors from the research system and made in arm's length to the politicians was published in June 2012 and contains a presentation of five visions for Danish strategic investments in research (Danish Government, 2012c):

- **A society with a green economy**

This vision is intended to push Denmark to adopt a green agenda as a cross-cutting theme through many different policy fields. Research is aimed at finding technological and knowledge-based answers to global challenges that ideally should contribute towards growth, welfare and employment in Denmark. Moreover, research should be able to contribute towards an efficient, competitive, and sustainable and health-promoting production of food and other biological products. Tackling the challenges of climate change and increasing competition for limited global resources is another priority within this vision.

- **A society with health and quality of life**

The vision is to create a society focused on health and the quality of life that is characterised by cost-effective healthcare and a health care sector that is oriented towards the individual citizen. Research should therefore be geared towards a fulfilment of these objectives. This is partly done by creating a connection between basic biological and medical research and the clinical research in order to more rapidly find targeted solutions to treatments. And partly it is done by developing innovative and citizen-centred welfare-technological and organisational solutions

- **A high-tech society with innovation capacity**

The vision is to develop Denmark into a high-tech society that develops knowledge, technologies and competences in order to secure long-term economic competitiveness.

Research should therefore be directed towards exploring strategic growth technologies – such as the Key Enabling Technologies – as well as future production systems and new digital solutions. Being at the technological forefront has frequently been characterised as a cornerstone to competitive advantage.

- **An efficient and competitive society**

This vision is about creating an efficient and competitive societal organisation that is characterised by good resource utilisation, high productivity and strong competitiveness. Research should in this regard primarily be targeted towards preventing cost-intensive diseases and social problem, as well as strengthening productivity development and competitiveness. Such research should enable a high quality of life for the citizens while at the same time ensuring that more people remain in the labour market. Moreover, research should aim at allowing safe and efficient mobility for people and goods and the development of an attractive infrastructure.

- **A competent, cohesive society**

The last vision focuses on the level of education and competence of the individual citizen which should generally be raised in order to make use of the opportunities that the globalisation provides to Denmark. Research efforts should therefore be directed towards a well-functioning education system that holds opportunities for everybody to get involved as a citizen in a globalised world and that allows the acquisition of relevant competences and qualifications. The vision also aims at strengthening cultural understanding and cross-cultural competences so that businesses and society in general will be prepared to make proactive use of globalisation.

The RESEARCH2020-catalogue has been used to prioritise strategic research investments on the annual Budget Bills since 2013. Most of the funding has been allocated for research within the vision of a society with a green economy. Funding also includes investments in research infrastructure. While the funding cuts implemented by the new government described above will affect bottom-up research at the Danish Council for Independent Research as well as general university funding, top-down research funding with strategic priorities will not be negatively affected but even strengthened. On the one hand, this can be interpreted as a higher emphasis on research funding that clearly serves the (politically defined) needs of society and companies in Denmark. On the other hand, it may be seen as undermining the foundations for investing into more basic research that is consequently more distant from immediate application.

While INNO+ and RESEARCH2020 focus on research and innovation and not on education, the innovation strategy treats all three aspects in an integrated manner as evidenced by the three R&I policy goals.

Evaluations, consultations, foresight exercises

Evaluations provide essential information to policy makers with regard to the viability of policy measures and their effectiveness and efficiency for reaching the stipulated goals. In this regard, the production of analytical reports and evaluations has been strengthened substantially over the last years by the Danish Agency for Science, Technology and Innovation (DASTI). A higher number of evaluations has been carried out in order to support evidence-based policy making.

Several evaluations have been commissioned in 2014 and 2015. In 2014, DASTI commissioned an evaluation of the knowledge and technology transfer (KTT) activities of the Danish universities (DASTI, 2014a). The evaluation concludes that many university researchers already collaborate with industry, that all universities have support infrastructures in place, and that the overall KTT framework functions well. Nevertheless, university researchers and industry personnel may face difficulties collaborating because they may have different motives and interests and do not always 'speak the same language'.

Recommendations focus on a higher political prioritisation of KTT, involving the inclusion of KTT-related objectives in the university development contracts, on the recognition of researchers who engage in KTT, the enhancement of the societal impact of KTT projects, improving the access to proof-of-concept funds to foster KTT-based entrepreneurship, and lastly a new national scheme for co-financing new concepts and initiatives at universities to deliver research-based knowledge service.

Another recent evaluation has been carried out by the GTS system (GTS, 2014) on the functioning of the GTS system as service institutes for contract research commissioned by industry. The evaluation shows that after falling numbers of research contracts for several years, the number of commissioned research projects has increased from 2012 to 2013. However, the numbers have not yet reached again the pre-financial crisis level of 2010, during which many companies scaled down their contract research expenditures.

In 2014, the Danish Ministry of Higher Education and Science also commissioned an evaluation of the performance of the Danish Council for Independent Research (DASTI, 2014c). The council was evaluated by a panel of six distinguished experts from Europe and North America that analysed the role and function of the council in the Danish research system employing a bibliometric study, a self-evaluation report, desk studies and numerous interviews with researchers and stakeholders. The evaluation concludes that the council plays a key role in the Danish research funding system. It succeeds in supporting the most qualified applicants and most talented researchers.

Moreover, in 2014 DASTI published a collection of systemic analyses of the Danish innovation system and the Nordic business investments in R&D. The first study, entitled 'The Short-run Impact on Total Factor Productivity Growth of the Danish Innovation and Research Support System', is the first attempt to estimate the economic impact of innovation and research support programmes in Denmark. The study finds that firms which make use of the research and innovation support system show higher growth rates than those not making use of it. The analysis also allows a closer look at individual programmes, which makes it easier to implement adjustments to the programmes in the future in order to make them more effective (DASTI, 2014c). The second study, entitled 'Economic Impacts of Business Investments in R&D in the Nordic Countries', offers insights regarding the effect of investments in private R&D across the four Nordic countries. The results show that there is a positive return on additional investments in R&D. This implies that in each of the four Nordic countries for the average company an additional euro invested in R&D has a positive net-return while Danish companies obtain the highest marginal rate of return on R&D (DASTI, 2013b).

In 2015, the Danish Centre for Studies in Research and Research Policy, Aarhus University, performed an analysis of the impact of Danish research since the 1980s and compared the development with that of other countries, in particular with the "innovation leaders" from the Innovation Union Scoreboard (Germany, Sweden and Finland) as well as other selected countries like the United States, Japan and China. The study was commissioned by the Danish Council for Research and Innovation Policy (DFIR) and concluded that the standards in terms of publication output and impact of Danish research declined in the 1980s. However, they have improved since 1990 (DFIR, 2015).

Moreover, the six Danish innovation centres abroad (in the United States, Brasil, Germany, India, Korea and China) were evaluated in 2015. The objective of the evaluation was to determine the degree to which the centres contribute to knowledge exchange and collaboration between Danish companies and leading international research, innovation and commercial environments. The three main areas in which the innovation centres are active are (1) research, education and innovation, (2) commercialisation of innovation, and (3) joint investments.

The evaluation concludes that Danish educational institutions and companies make great use of the innovation centres and that they in fact facilitate collaboration between Danish and international researchers as well as educational institutions and companies (Oxford Research, 2015a).

In 2015, DASTI published two studies that are aimed at providing a comprehensive overview of the Danish R&I system, outlining its strengths and weaknesses, but without making explicit policy recommendations. The first study is called Research Barometer 2015 and is based on a collection of different data sources with the objective to provide an overview of the Danish research profile by analysing a number of key indicators. The analysis concludes that Denmark is ranked 6th among the OECD countries in terms of GERD. The research output in terms of publications is high: only Switzerland and Iceland have higher numbers of publications per inhabitant. Danish publications are also highly cited and research education in terms of awarded PhD degrees is highly prioritised. Denmark also has – only after Israel – the highest share of university research that is funded by sources abroad, by the private sector and by private non-profit foundations and organisations (DASTI, 2015b). The second study analyses the commercialisation of research results in 2014 and hence focuses particularly on industry-science interaction. The study shows a high correlation between highly-cited publications and public-private co-publications among the EU and associated countries. Denmark occupies, together with Switzerland, a top-ranking position on both dimensions. The statistics further show that the 2014 research output of Danish research institutions in terms of patents, inventions, licenses or spin-outs is about at the level of the 2013 output, but markedly higher than a few years ago (DASTI, 2015c).

In 2015, IRIS Group conducted an evaluation of the so-called UNIK program, which was commissioned by DASTI. UNIK (Investment Capital for University Research) was an ambitious research excellence initiative launched in October 2009 that funded four interdisciplinary research programmes at three Danish universities. The aim of UNIK was to promote challenge-driven, cross-disciplinary and excellent research, as well as to enhance the capacity of Danish universities to host such research programmes. The evaluation concluded that UNIK had fulfilled the high expectations in that it increased the scientific output and research capacity. The evaluation lists numerous points for fine-tuning the funding instrument (DASTI, 2015d).

In 2014, the Danish Council for Independent Research also commissioned an evaluation of the YDUN (Younger women Devoted to a UNiversity career) research programme. The main objective of the programme is to foster gender equality in research and to better integrate female research talents into the research system. The evaluation is meant to provide an immediate impression after the first application round in 2014. It finds that YDUN had encouraged women to apply for funding who otherwise hadn't applied for funding from the research council or other sources. Moreover, the evaluation concludes that YDUN funding has been an important source for the successful applicants to foster their research career (DAMVAD, 2015).

Evaluations conducted in previous years have consistently been followed up by major policy initiatives such as the Government's innovation strategy and the creation of the new Innovation Fund Denmark. It can therefore be concluded that the evaluation system functions well in terms of providing guidance for R&I policy making. It is unclear whether monitoring and performance analysis is always built into new programmes.

2.3 European Semester 2014 and 2015

Denmark received no R&I-related country specific recommendations in 2014 and 2015. In the National Reform Programmes 2014 and 2015, the Danish government has specified a target of investing 3% of the GDP in R&D. Moreover, at least 1% of GDP should be publicly financed research. The innovation strategy 'Denmark – a nation of solutions' also formulates the objective that Denmark should be among the five OECD countries in which private businesses invest most into R&D as a share of the GDP.

Similarly, the share of innovative enterprises and the number of persons with a higher education employed in the private sector should be among the top five European OECD countries by the year 2020 (Danish Government, 2014a; Danish Government, 2015b).

As outlined before, Denmark has achieved the 3% target, and publicly financed R&D amounts to slightly more than 1%. Since 2014, several new initiatives have been agreed and implemented. These include a capital injection of €402m into the Danish National Research Foundation as part of the Growth Package 2014 in order to continue with the funding of high-level excellent research projects. The amount is intended to finance 10 additional centres of excellence until the years 2026/2027. The Growth Package also includes a program for innovation in manufacturing industries and particularly in SMEs. Moreover, support was granted to 28 international collaboration projects between Danish and foreign networks and clusters that are aimed at fostering collaboration between more than 700 SMEs. Also in 2014, a program promoting younger women for a university career was launched. In connection to this, a task force was set up to investigate the role of women in science. A program called EUopSTART was launched to provide seed funding for applications to Horizon 2020. In September 2014, construction of the European Spallation Source (ESS) began in Lund (southern Sweden), one of the world's largest and most advanced research facilities. The government expects to devise a national ESS strategy during 2015. Under the auspices of the Innovation Fund Denmark, two societal partnerships on big data and on advanced materials were established. Finally, the upper limit of the R&D tax credit has been increased from about €670,000 to €3.3m (Danish Government, 2015b).

2.4 National and Regional R&I Strategies on Smart Specialisation

During the programming process Denmark justified the fulfilment of this ex ante conditionality by arguing that there is not a single combined Danish strategy for smart specialisation but a series of strategies which jointly describe Denmark's actions for smart specialisation. These strategies are e.g. the government's growth plans, the annual growth partnership agreements between the government and the regional growth fora, and the regional growth and development strategies of the regional growth fora. It also includes the National innovation strategy and national cluster strategy. Furthermore the Danish Growth Council coordinates and promotes cooperation and development between the national growth strategy and the regional growth and development strategies contributing to an effective and continuous process enhancing growth and business development in the whole of Denmark. There are five regions in Denmark: the Capital Region, Region Zealand, the North Denmark Region, the Central Denmark Region, and the South Denmark Region. Within the Capital Region the Baltic island of Bornholm has its own regional growth forum.

In 2015 the government launched a strategy called "Growth and development in the whole of Denmark". Its focus is on key-strengths in the regional areas outside of the larger Danish cities including the food and agriculture sector, better framework conditions for industry and production and unrealised potentials within the area of tourism. Through the regional growth partnerships further coordination and synergy can be ensured between the Danish Government's growth strategy and the specific regional key-strengths. Furthermore the regional growth fora and the Danish Government have agreed that the regional growth fora must contribute in following up on the growth plans in areas which also support the unique regional positions of strength (regional smart specialisation). It will be possible for the regional growth fora, on the basis of the regional growth and development strategies, to target their actions in relation to regional business strengths and to address special challenges in the area, thus supplementing and contributing to the implementation of national growth actions based on the possibilities within the individual areas.

In this way, the regional growth fora contribute to converting the government's growth plans in selected business areas into specific actions under consideration of the strengths existing within the region. Denmark has registered the following S3 Priorities:

- The maritime sector – the blue Denmark
- Creative industries including design
- Water, bio- and environmental sectors
- Health and welfare sectors
- Energy and climate
- Tourism and experience based economies
- Food
- ICT and digital growth

The regions also have their priorities, (see more in <http://s3platform.jrc.ec.europa.eu/map>).

The regional growth fora have the right of recommendation over most of the European Regional Development Fund (ERDF) and European Social Funds (ESF) appropriations. The resources must be used within the framework of the ERDF and ESF programmes, both of which emphasize the significance of supporting regional strengths, and they must be used within the regional growth and development strategies which enumerate the regional strengths. Against this background, it must be expected that ERDF and ESF resources will in essence support smart specialisation in Denmark. Funding from ERDF will finance clusters and collaboration between SMEs and Academia where the aim is to have multi-actor collaboration. Denmark's actions for smart specialisation have not changed substantially in 2015.

2.5 Main policy changes in the last five years

Main Changes in 2011

None

Main changes in 2012

Launch of the RESEARCH2020 initiative

Main changes in 2013

Re-introduction of an R&D tax credit

Launch of innovation strategy 'Denmark – A Nation of Solutions'

INNO+ catalogue identifying priority areas for R&I

Main Changes in 2014

Establishment of the Innovation Fund Denmark

Establishment of the Danish Council for Research and Innovation Policy

Main Changes in 2015

New Minister appointed for higher education and science, June 2015

Roadmap for R&I infrastructures, due end of year

Proposal on tax on foundations

3. Public and private funding of R&I and expenditure

3.1 Introduction

Over the past couple of years, private organizations and public institutions in Denmark have consistently invested large amounts into research and innovation, as evidenced by the increasing gross domestic expenditures in research and development. As a result, Denmark has, after having recovered from the financial crisis, achieved the 3% target since 2012. The current government, which has come into office in June 2015, is committed to meet the target in the future but has nevertheless implemented funding cuts in the university sector and the Danish Council for Independent Research. Although the level of investment is high and continues to be so compared with other EU member states, both universities and the Danish Council for Independent Research have warned that the cuts could seriously affect the possibilities to provide funding for excellent research projects and teaching, and to undermine the foundations of the Danish "research miracle".⁴

Table 2 gives an overview of basic R&D investment indicators. R&D funding in the business enterprise sector has been rather stable since 2011. Most of the increase in GERD is due to government funded R&D. Total government budget appropriations (GBAORD) have increased considerably since 2011, but only marginally during the period from 2013 to 2015. Most R&D, about two thirds, is performed by the business enterprise sector, followed by the higher education sector which has considerably increased.

Denmark has successfully participated in the Research Framework Programs FP6, FP7 and the current Horizon2020. Between 2.4% and 2.7% of the total EU contribution have been allocated to Danish participants. Within FP6, Danish participants were allocated €382m. They were involved in 1121 projects with 1747 participants and 207 coordinations. Within FP7, Danish participants were allocated €1,085m. They were involved in 2049 projects with 2833 participants and 528 coordinations. As of October 2015, Danish participants have been involved in 395 Horizon2020 projects with 516 participants and 169 coordinations. In 2014, Danish participants received about €147m from Horizon 2020 which corresponds to about 2.3% of the total 2014 budget allocated (DASTI, 2015a).

In terms of European Structural and Investment (ESI) funds during the period from 2014 to 2020, Denmark will spend €300m for SMEs in industry, services, agriculture, aquaculture and fisheries to be more innovative and better at turning innovation into profit. ESI funds will also be used to develop regional smart specialisation strategies. Moreover, Denmark will spend €270m in ESI funds on issues of social inclusion and employability, as well as €635m in environmental investments. Overall, Denmark will spend 46% of its total ESI funds allocation on combating climate change (European Commission, 2015b).⁵ Of the total ESI funds, 21.2% are spent on research, development and innovation activities, in Denmark within the following categories of intervention "Technology transfer and university-enterprise cooperation primarily benefiting SMEs", "Research and innovation infrastructure, processes, technology transfer and cooperation in enterprises focusing on the low carbon economy and on resilience to climate change" and "Cluster support and business networks primarily benefiting SMEs" (in the order of importance).

⁴ See <http://ufm.dk/forskning-og-innovation/rad-og-udvalg/det-frie-forskningsrad/nyt-fra-radet/nyt-fra-det-frie-forskningsrad/fundamentet-for-det-danske-forskningsmirakel-er-ved-at-vakle-det-frie-forskningsrads-kommentar-til-forslaget-til-finanslov-201624247e9e00ad41d1897285d14d8d1135>

⁵ Including agricultural innovation. Denmark has €413m in ESI funds.

Table 2: Basic indicators for R&D investments

Indicator	2011	2012	2013	2014	2015*	EU average (2014)
GERD (as % of GDP)	2.97	3.03	3.08	3.08	n.a.	2.03
GERD (Euro per capita)	1312.7	1360.0	1392.7	1413.0	n.a.	558.4
GBAORD (€m)	2458.889	2517.229	2612.143	2637.469	2674.035	92828.145
R&D funded by BES (% of GDP)	1.81	1.81	1.79	1.79	n.a.	n.a.
R&D funded by PNP (% of GDP)	0.11	0.11	0.13	0.13	n.a.	n.a.
R&D funded by GOV (% of GDP)	0.84	0.88	0.94	0.94	n.a.	n.a.
R&D funded from abroad	0.21	0.22	0.23	0.23	n.a.	n.a.
R&D performed by HES (% of GDP)	0.92	0.96	1.03	1.03	n.a.	0.47
R&D performed by GOV (% of GDP)	0.06	0.07	0.07	0.07	n.a.	0.25
R&D performed by BES (% of GDP)	1.98	1.98	1.98	1.98	n.a.	1.30

* provisional data

3.2 Smart fiscal consolidation

Smart fiscal consolidation describes policy making in which cost-cutting programmes as a result of unforeseen events such as the financial crisis should minimise the potentially negative short-term effect on economic activity, while at the same time establish a foundation for long-term growth, with growth-enhancing public expenditure such as those on research and innovation safeguarded from cuts, or even increased (Veugelers, 2014). Although it is difficult to assess whether public budgets are eventually consolidated in a smart way, it can be concluded that Denmark's innovation capacity has not suffered in times of economic recession. While there have been reductions in public R&I funding, these have been short term and have not jeopardised the ranking of Denmark as an innovation leader.

3.2.1 Macroeconomic context⁶ and public R&D

The immediate impact of the crisis on the Danish economy was a moderate total loss of real GDP during 2008-09 of about 6%. However, the decline was followed by a protracted sluggish recovery. Five years after the crisis, there are signs that the Danish economy is picking up on the back of high private savings surplus, improved labour market conditions, strong consumer confidence, and low interest and inflation rates. Gradual improvement in the main trade partners as well as in private consumption and investments is likely to accelerate growth during the next two years. The Commission's projects a real GDP growth of 1.7% in 2016 and 1.9% in 2017 driven both by domestic demand and exports.

Before the crisis Denmark had protracted and high budgetary surpluses (around 5%) as well as low and decreasing public debt (Figure 3). As an impact of the crisis the budgetary surplus has sharply deteriorated and turned into a deficit of almost 2.7% in 2010. The fiscal consolidation has not proved to be a steady process and in 2012 the deficit jumped up again to 3.5%.

⁶ Sources: DG ECFIN, http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_denmark_en.pdf

However, a one-off pension taxation measures and high revenues from the pension yield tax helped the fiscal balance to turn into a surplus by 2014 (+1.5%), but it turned again into a 2% deficit due to lower revenues from the same measures and due to lower pension yield tax and public revenues from oil and gas production. In 2017 a further worsening is expected (deficit up to 2.7%) due to declining pension yield tax and cease of revenues from the restructuring of capital pension taxation income. In 2017 a slight improvement is expected (deficit down to 1.9%) due to improving economic situation. The structural balance in Denmark is often strongly influenced by very large and volatile revenue items, such as revenues from oil and gas production and from pension–yield taxes, which are not included in the corrections for calculating the structural balance. The general government gross debt level is expected to decrease gradually from 44.6% of GDP in 2013 to 38.8% in 2017.

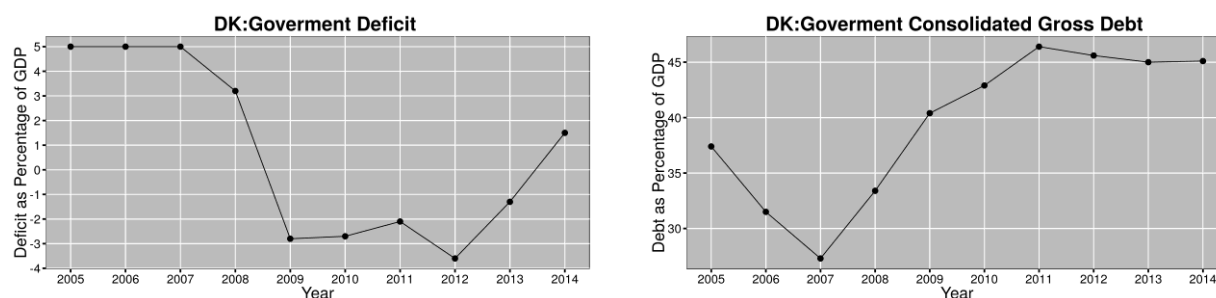


Figure 3: Government deficit and public debt

Data source: Eurostat

Total GERD in Denmark was 7,803MEUR in 2013. There are three main sources of R&D funding: the business sector (4,516 MEUR), the government (2,371 MEUR), and foreign funding (578 MEUR⁷). Direct funding from the government goes to the business enterprise sector (173 MEUR), the government (143 MEUR) and the higher education sector (2,052 MEUR).

Table 3: Key Danish Public R&D Indicators

	2007	2009	2013
GBAORD, % of gov. exp.	1.56	1.70	1.80
GERD, % of GDP	2.51	3.07	3.08
out of which GERD to public, % of GDP	0.74	0.91	1.10
Funding from GOV to, % of GDP			
Business	0.04	0.06	0.07
Public (GOV+HES)	0.61	0.74	0.87
Total	0.65	0.80	0.94
EU funding, % of GDP	0.04	0.04	0.06

Source: Eurostat

3.2.2 Direct funding of R&D activities⁸

The sources of R&D funding according to the Frascati manual are: Government sector (GOV), Higher education sector (HES), Private non-profit sector (PNP) and Abroad (including EC). In this analysis the public sector as source of funding is given by the GOV part of the total intramural R&D expenditure (GERD), whereas the public sector as a sector of performance is the aggregation of GOV and HES. Figure 4, below shows the historical evolution of GERD financing in current prices in Denmark.

⁷ EU funding in 2013 was 156 MEUR.

⁸ The sources of R&D funding according to the Frascati manual are: Government sector (GOV), Higher education sector (HES), Private non-profit sector (PNP) and Abroad (including EC). In this analysis the public sector as source of funds is given by the GOV part of the total intramural R&D expenditure (GERD), whereas the public sector as a sector of performance is the aggregation of GOV and HES.

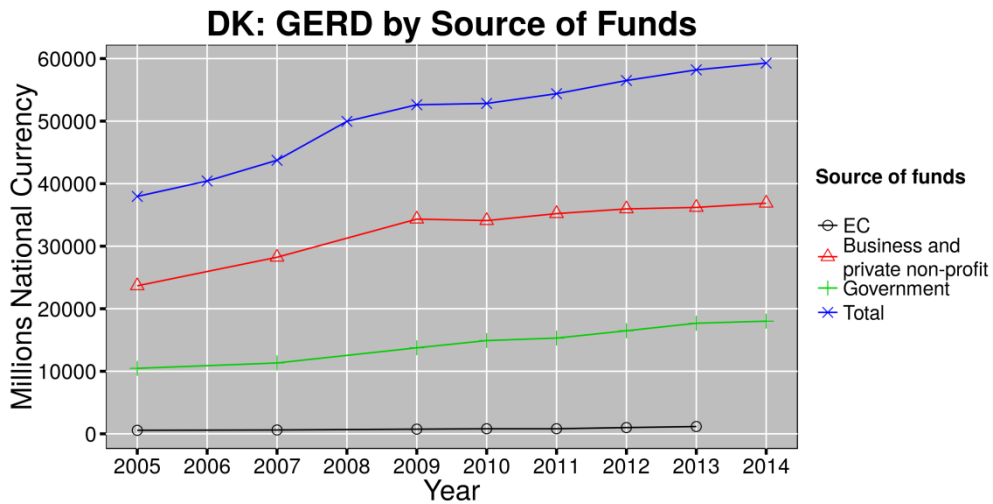


Figure 4: Development of government funding of the total GERD
Data source: Eurostat

The government's and private sector's (meant as the aggregated funding from business and private non-profit) contributions to the total GERD are the most relevant, with the private sector's contribution amounting to more than twice the funding from the government along the period under scrutiny. The contribution from the private sector and the government grows rather modestly after 2009 when compared to the period 2005-2009. This has clear repercussions on the total GERD. As can be seen from the figure above, the contribution from the European Commission to the Danish GERD plays a small role in comparison to the funds coming from the private sector and the governance. As it will be shown in section 2.2 the EC contribution accounts annually for 5%-6% of the GERD funded from the government.

3.2.2.1 Direct public funding from the government

Direct public funding is usually the main source of the total governmental support to R&D. Figure 5 shows the evolution of the total R&D appropriations (GBAORD) and the GERD directly funded by the government in units of millions of national currency. The EC contribution, aggregated to the funding provided by the government, is also shown in Figure 5.

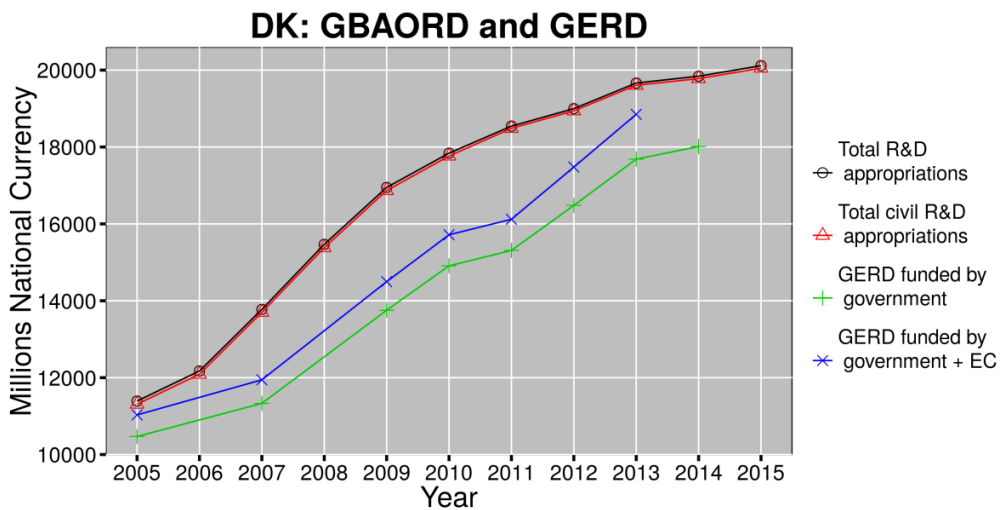


Figure 5: R&D appropriations and government funded GERD in millions of national currency
Data source: Eurostat

The total appropriations follow an overall increasing trend in the period under scrutiny, though one notices their slowing down from 2009 onwards. The total and total civil appropriations are essentially equal, since the military R&D appropriations are negligible in Denmark.

Publically funded R&D, i.e. GERD funded by the government, follows a very similar trend. Expressed in relative terms, it represents 0.89% of the GDP in 2013, which is one of the highest percentages in EU. The gap between the total appropriations and the GERD funded by the government tends to grow from 2005. The aggregation of the EC contribution to the government funded GERD makes the gap with the appropriations almost constant in time. We do not know if this effect is purely accidental or a deliberate choice of the Danish government.

3.2.2.2 Direct public funding from abroad

In Denmark, business is the most important source of R&D funding from abroad, as shown in Table 4, below. The abroad contribution from the business sector has been affected by the 2008-2009 financial crisis, since the peak (in nominal terms) of 2009 has not been reached again in later years. Table 4 clearly shows that the EC funding is the most important external source of direct public funding. Although far from as important as the business contribution, it has almost doubled from 2005 to 2012, whereas the abroad contributions from the government, higher education sector and other international organizations are negligible.

Table 4: Public Funding from Abroad to Danish R&D (in millions of national currency)

Source from abroad	2005	2007	2009	2010	2011	2012	2013	2014
Total	3822.02	4173.40	4528.50	3823.90	3864.06	4049.00	4309.00	4389.10
BES	3013.43	2991.90	3374.73	2528.60	2489.73	2497.70	2570.60	
EC	561.694	612.5	743.796	807.31	810.40	997.70	1166.20	
GOV	8.39	26.30	78.77	65.40	65.90	55.40	62.50	
Total as % GERD	10.07	9.54	8.61	7.24	7.11	7.17	7.4	7.4
EC as % GOVERD	5.37	5.41	5.41	5.41	5.29	6.05	6.59	

Figure 6, below shows how the distribution of public funding to sectors of performance evolved over time:

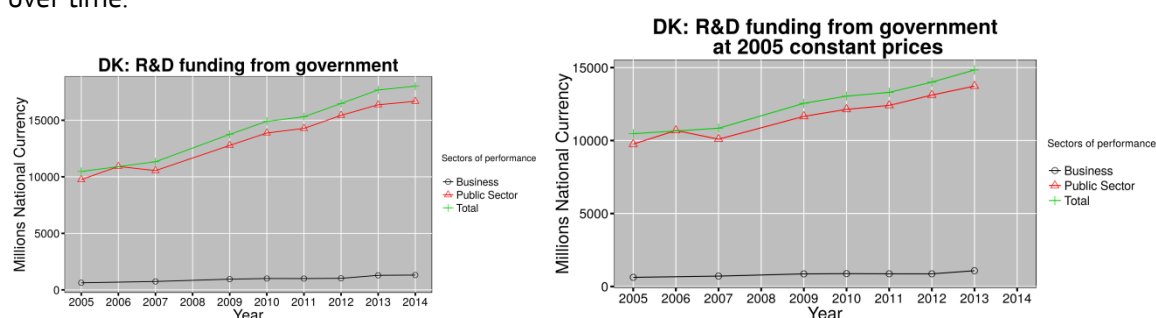


Figure 6: Government intramural expenditure by sectors of performance

Data source: Eurostat

The public sector (GOV + HES) is the main recipient of government funded GERD. After 2007 the direct support to businesses slightly increases but it is still very low compared to the share of public funding going to the public sector. When resorting to constant prices at 2005, the modest growth of the total government funding is further flattened.

3.2.3 Indirect funding – tax incentives and foregone tax revenues

Considering the absence of harmonisation of the tax regimes in EU law, data in this section comes directly from national sources, using domestic definitions. Attention should be paid when interpreting data from different sources.

Denmark has a mix of R&D tax incentives for firms, and direct government support to business R&D. The value of the incentives increased significantly in 2014 following a series of amendments to the law. A tax refund for losses stemming from R&D costs has been available to Danish businesses since 2012. To be eligible the costs must relate to developing new or significantly improved materials, mechanisms, products, processes, systems or services. The refund will consist of the tax value of the loss incurred. In 2012 and 2013, the maximum loss for which the R&D refund could be claimed was DKK 5 million (approx. EUR 670,000), meaning that the maximum refund was DKK 1.25 million (approx. EUR 168,000). Along with other business incentive schemes, including reductions to the Danish corporate income tax rate, amendments to the R&D refund rules were made in 2013. According to a law adopted on 28 June 2013 it should be possible to request a refund equivalent to the tax value of losses up to DKK 25 million (approx. EUR 3.35 million) from 2015. When taking the reduced corporate income tax rate into account, the maximum refund would in 2015 be DKK 5.875 million (approx. EUR 787,000).

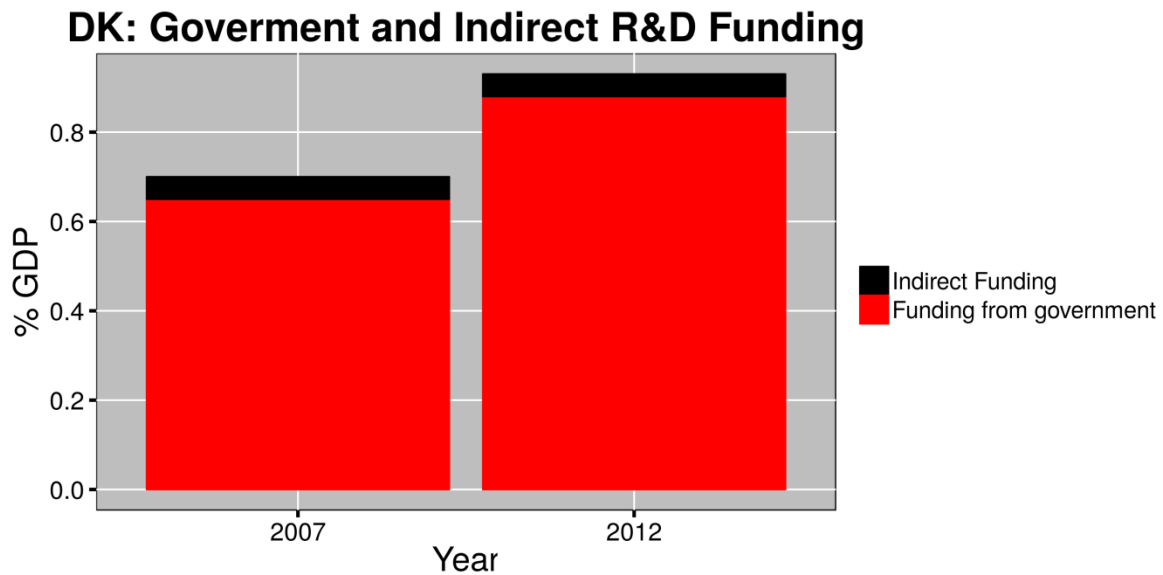
On 29 January 2014, a second amendment to the Danish R&D tax credit scheme was adopted by the Danish Parliament, as a result of which the amendments made in June 2013 now will include the income year 2014. Given that the Danish corporate income tax rate was set at 24.5% for 2014, the maximum refund to be claimed by a group in 2014 will therefore be DKK 6.125 million (approx. EUR 820,000). Intended for a developing business, the R&D refund is a valuable aid as it will provide a loss making business a cash payment equivalent to the tax value of the loss. With the significant increase in the basis for the R&D refund, the scheme has an even greater value for businesses carrying out R&D activities in Denmark.⁹

The maximum tax credit that could be given in 2013 was 1.225 Mio DKK per year (24.5% of 5 Mio DKK). A new tax credit ceiling will be effective as of January 2015: 5.9 Mio. DKK per year (23,5% of 25 Mio. DKK), and as of 2016: 5.5 Mio. DKK (22% of 25 Mio. DKK). If the income year is less than 12 months, the tax credit is reduced proportionally. Tax credits paid out to firms are not included in taxable income.¹⁰

⁹ Source: <http://www.taxand.com/taxands-take/news/danish-rd-tax-credit>

¹⁰ 'Measuring R&D Tax Incentives', OECD, 2013

Figure 7: government and indirect funding to R&D in Denmark (source: OECD).



Unfortunately, only very sparse quantitative data is available about the foregone tax revenue for R&D funding in Denmark. According to figure 7, in 2012 the indirect funding expressed as a percentage of GDP was similar to 2007 and it had little importance for the overall level of government funding of R&D.

3.2.4 Fiscal consolidation and R&D

Figure 8, below shows the scatterplot of the structural balance and a relevant measure of the R&D (GBAORD as % GDP, first panel and GERD as % GDP, second panel)¹¹:

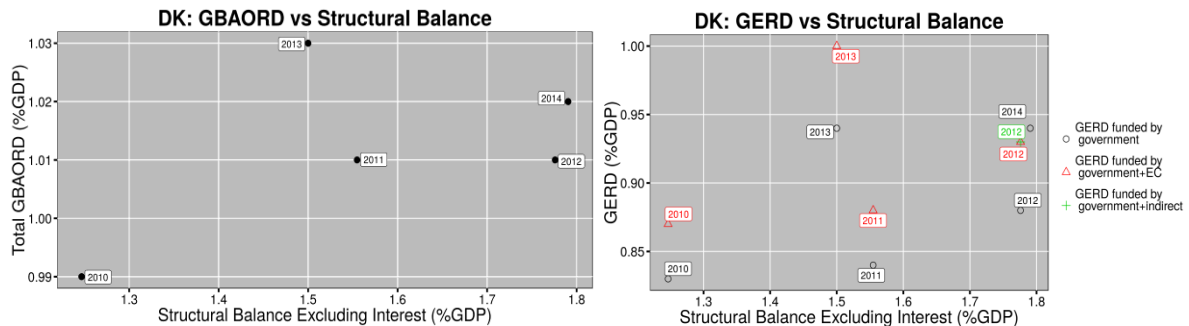


Figure 8: Fiscal consolidation and R&D

Data source: AMECO, Eurostat, OECD

While the government budget balance has improved in the post-crisis fiscal consolidation period (with the a few fluctuations especially in 2013) both budgetary appropriations (GBAORD) and government funded GERD increased. Although there are significant volatile elements in the Danish budget affecting its structural balance, steps done so far towards fiscal consolidation have not come at the expense of public R&D expenditures.

The quality of data concerning indirect financing through R&D tax incentives is not sufficiently robust in order to be able to take it into account in this analysis. On the contrary, funding from the European Commission through structural funds and framework programmes for R&D during the reference period (2010-2014) account for up to 7% of the total GERD annually i.e. 0.06% of GDP.

¹¹ Structural balance data comes from the AMECO database the other indicators were taken from Eurostat.

Despite the crises, Denmark has preserved or increased the appropriations and the government support to R&D while still managing to improve the structural balance. As a consequence, Denmark can be considered as having implemented a smart fiscal consolidation strategy as far as R&D is concerned.

3.3 Funding flows

3.3.1 Research funders

As described in section 1.2.2, the main responsibility for research and innovation and its funding is placed within the authority of the Ministry of Higher Education and Science. Certain other ministries like the Ministry of Climate, Energy and Building, the Ministry of Food, Agriculture and Fisheries, the Ministry of Environment and the Ministry of Foreign Affairs have larger R&I programmes. These R&I programmes have had stable funding over the past couple of years and at the same time overlap only to a very limited extent with the major funding instruments under the Ministry of Higher Education and Science. The ministries have specific agencies which implement the respective policies.

The funding system under the auspices of the Ministry of Higher Education and Science is composed of the Danish National Research Foundation ('Danmarks Grundforskningsfond'), the Danish Council for Independent Research ('Det Frie Forskningsråd'), and the Innovation Fund Denmark ('Innovationsfonden'). All three funding bodies have considerably increased their funding amounts from 2013 to 2014. In 2014, the Danish National Research Foundation awarded grants in the order of €92m, representing about 19% of the total funding that the funding bodies managed. The Danish Council for Independent Research provided (generic) grants amounting to €183m in 2014, representing 37% of the institutions' funding. The grants handed out by the Innovation Fund Denmark amounted to about €217m in 2014 (DASTI, 2015a).

R&I funding by private not-for-profit organisations is common in Denmark. There are about 12,000-14,000 foundations in Denmark with an estimated capital endowment of over €56b (but many are not relevant for R&I funding). Each foundation awards grants (interest returns on endowments) according to their own aims, principles, procedures and instruments, and there is no overview of this at general level. Many foundations focus on the usefulness of the proposed research project to society. Research projects should therefore have an applied part. Examples of prominent foundations include the Novo Nordisk Foundation, A.P. Møller Foundation, the Carlsberg Foundation, the Industry Foundation, the Rockwool Foundation, or the Velux-Villum Foundation.

3.3.2 Funding sources and funding flows

Danish public R&I funding is mostly concentrated at the national level. In 2014, funding at the national level according to the budget bill amounted to €2.2b (78%) while funding at the regional and local level amounted to €347m (12%). The Danish National Research Foundation contributed about €58m (2%) and the Nordic Council of Ministers about €9m (0.3%). Finally, the EU's research programs contributed €206m (7%) (DASTI, 2015a). Of the EU's research programs, Danish participants received about €147m from Horizon 2020 which corresponds to about 2.3% of the total 2014 budget allocated in Horizon 2020 (DASTI, 2015a). This composition did not change significantly over the last couple of years. Research, development and innovation related ESI Funds for the period from 2014 to 2020 amount to about €88m, which corresponds to about 3% of the annual R&I funding at the national and regional level.

Multinational companies that choose to locate in Denmark with R&D facilities are another important source of funding. However, no comprehensive data on R&D-related funding flows are available. According to the UNCTAD FDI statistics, Denmark's FDI inflows were €-8,428m in 2010, €10,544m in 2011, €384m in 2012, €-682m in 2013 and €3,359m in 2014.¹² The Danish business investment authority "Invest in Denmark" estimates that one third of the investments are R&D-related.

3.4 Public funding for public R&I

3.4.1 Project vs. institutional allocation of public funding

The legal framework for the allocation of R&D project and institutional funds has been rather stable. The only major change has been the establishment of the Innovation Fund Denmark. In April 2014 the Innovation Fund Denmark was created by joining research, technology development and innovation grants from the Danish Council of Strategic Research, the Danish National Advanced Technology Foundation and the Danish Council for Technology and Innovation into one new focused organisation. With an annual budget of approximately €200m, the Fund provides risk thematic funding for cooperation and innovation. This budget reflects the sum of the individual budgets of the predecessor institutions.

The main share of government funding (as included in the budget bill) is traditionally channelled via institutional funding to universities and other research institutions: In 2014, 62% of the government funding was allocated as so-called basic funds ('basismidler') while the remainder is handed out on a competitive basis ('konkurrenceudsatte midler'). The most important competitive funding instruments are managed by the Danish Council for Independent Research (DCIR), the Danish National Research Foundation and the Innovation Fund Denmark (DASTI, 2015a). The funding allocated on a competitive basis can largely be characterised as project funding.

3.4.2 Institutional funding

In June 2009 a political agreement was reached on a distribution model of core funding to universities that is performance oriented. This a modification of the former model, which covered indicators for education, external funding and PhD graduates. The model also includes bibliometric indicators and was introduced stepwise over the period 2010-2012. In 2013 it was agreed to continue the distribution model for five more years.

Up until 2009, the Danish government funded universities on the basis of a model that covered indicators for education, external funding and PhD graduates. The education part of public funding is strongly based on education metrics and particularly on the number of students who passed an exam. The amount of funding per exam varies between different fields of study (Van Dooren et al, 2014). The amount of organisation-level research funding is mainly based on historical grounds (98% based on the previous year's budget). Each year, 2% of the research funding is retained in a "restructuring fund" and redistributed among the universities. Over the years the importance of this cumulative performance based element has become substantial.

The European University Association's DEFINE project estimated that the cumulative share of organisation-level funding in 2012 was for 54% based on historical principles, for 27% on research performance, for 15% on a PhD performance model and for 4% on earmarked research funding. The Danish Ministry of Higher Education and Science estimated that in 2013 the historical principle based part was 50%, while 30 % was based on (accumulated) research performance and 20% came from investments in PhD programmes (De Boer et al, 2015).

¹² See <http://unctadstat.unctad.org/EN/>; exchange rate: 1.00 USD = 0.92 EUR

Modality of the assessment

Until 2010, the redistribution was based on a 50-40-10 ratio. That is, 50% was based on the level of educational funding, 40% was based on the amount of external research funding, and 10% was based on the number of PhD graduates (Van Dooren et al, 2014, Kalpazidou Schmidt et al, 2006). In June 2009, a political agreement was reached on a new distribution model for the allocation of organisational funding to universities. This new model also includes bibliometric indicators and was introduced stepwise over the period 2010-2012 at the expense of the weighting for external research funding. In 2013 it was agreed to continue the distribution model for five more years (Grimpe, 2015; Van Dooren et al, 2014).

From 2012 onwards instead of the 50-40-10 model, 45% of the (2% of variable) funding was distributed according to earned education related indicators, 20% was distributed according to research activity financed by external funds (project funding from research councils or EU funding), 25% was distributed based on bibliometric indicators, while 10% was based on the number of PhD graduates (Kalpazidou Schmidt, 2010; personal communication Kalpazidou Schmidt, 2015).

The principles for the bibliometric indicator are summarised in a report published by the DASTI in October 2009 (Grimpe, 2015). This system drew inspiration from the Norwegian system (Hansen, 2009b). There are several publication types such as books, book chapters, journal articles, PhD-and doctoral-theses, and patents and each publication is worth points – at two levels (the elite level and the other level) (De Boer et al, 2015). The system is journal based: publications are counted in around 20,000 peer reviewed journals and publishing houses. The journals and publishers have been selected by a panel of 68 researchers. The publications are divided into two groups, where publications in the top 20% receive a higher weight than publications in the other outlets (Fosse Hansen, 2009). The most recent results for the bibliometric indicators are published on the homepage of DASTI. In addition to the performance based funding the government has also engaged in the signing of development contracts with the Danish universities.

3.4.3 Project funding

Project funding is largely channelled through the Danish Council for Independent Research, the Danish National Research Foundation and the Innovation Fund Denmark. The Danish Council for Independent Research consists of five area-specific research councils, a group of chairmen from each of the five research councils and a board of directors. The Council supports research projects (competitive funding) based on the research initiatives of the researchers themselves. Research is funded without predefined focus, thematic areas or policy-related goals. The success rate in 2014 was 14% in terms of the number of applications and 10% in terms of the budget allocated (DASTI, 2015a). The main source of funding is the Ministry of Higher Education and Science.

The five area-specific research councils are:

- The Danish Council for Independent Research | Humanities;
- The Danish Council for Independent Research | Natural Sciences;
- The Danish Council for Independent Research | Social Sciences;
- The Danish Council for Independent Research | Medical Sciences;
- The Danish Council for Independent Research | Technology and Production Sciences.

Project funding is also provided by research programmes, such as the programmes managed mainly by the Innovation Fund Denmark, the Energy technology, development and demonstration programme (EDDP, launched in 2008) under the Ministry of Climate, Energy and Building, and the Green Development and Demonstration Programme (GDDP) under the Ministry of Food, Agriculture and Fisheries (launched in December 2009).

The Innovation Fund Denmark finances research based on politically defined programmes. Programme committees allocate funding. The success rate in 2014 was 44% in terms of budget allocated which is mainly due to very high success rates for the InnoBooster and Talents funding instruments (DASTI, 2015a). Thematic priorities are:

- Sustainable Energy and Environment;
- Individuals, Disease and Society;
- Health, Food and Welfare;
- Strategic Growth Technologies;
- Transport and Infrastructure ;
- Peace and Conflict.

The research activities are carried out in public-private collaboration and with the involvement of end-users and international researchers. For all project funding, expert evaluations and international peer review standards are applied according to the six principles formulated at the 'The May 2012 Global Summit on Scientific Merit Review'.

3.4.4 Other allocation mechanisms

A notable further allocation mechanism are the societal partnerships. Funding is provided for collaboration between private sector enterprises, public sector research institutions and authorities on developing new innovative solutions in response to specific societal challenges. Societal partnerships may include elements of research, development and commercialisation. The Innovation Fund Denmark has financed four societal partnerships in 2014. The partnerships are the following:

- Blue jobs via green solutions
- Intelligent, sustainable and efficient plant production
- Denmark as the preferred country for early clinical testing of new medicines
- Water-efficient industrial production

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

Direct R&I funding through funding organisations

Most of the direct funding for private R&I is channelled through the Innovation Fund Denmark which administers strategic research programmes in areas of political priority. It funds research projects and gives advice to applicants. The Innovation Fund is also contributing to increased university-industry collaboration.

There are three main funding instruments available: Large-scale projects ('store projekter'), InnoBooster and Talents ('talenter'). Large-scale projects are projects with a typical size of more than €700,000 and in some cases of up to €7m. They are typically carried out collaboratively in a public-private partnership. Strategic research project within certain politically prioritised areas fall within this category. About €90m were allocated to strategic research projects in 2014 within the areas mentioned in section 3.4.3.

InnoBooster particularly targets R&D and innovation in SMEs. It includes mainly two instruments which were previously referred to as knowledge pilot and knowledge voucher. Until August 2014 the knowledge pilot regulation was in effect. A grant could be given to SMEs with limited experiences in hiring highly educated employees to cover some of the salary of a new employee with a higher education and who was to execute a development or innovation project in the enterprise. The measure was to enhance the cooperation between SMEs and knowledge institutions and to increase the share of highly educated employees at SMEs. The enterprise could be given €1,333 a month for the salary of the new knowledge pilot, for a period of 6-12 months. The new Innovation Fund has taken over this measure and integrated it into a new program called InnoBooster. InnoBooster now also includes a measure that was known as innovation voucher.

The measure consisted of a 40% co-funding of development projects applied for by SMEs who wished to use the funding for knowledge acquisition from a public research organisation or a member of the GTS-network. It is an objective to expand the utilisation of collaboration with knowledge organisations to a wider group of the Danish SMEs and to raise the attention of SMEs of the opportunities within utilisation of the knowledge of public research and technology institutions. The voucher could fund a maximum amount of about €14,000. In 2014, the Innovation Fund received 198 applications to the new InnoBooster scheme. The success rate was 67% in terms of the number of applications and 64% in terms of the budget allocated (DASTI, 2015a).

Talents is a new type of instrument which combines the previously offered Industrial PhD and Industrial Post-Doc schemes. The Industrial PhD Programme was established in Denmark in 1970 and has been a growing success ever since. It is internationally recognised for its combination of industrial experience and academic research. Since 2002, it has been part of the Danish Council for Technology and Innovation's umbrella of innovation promotion initiatives, and has been run on behalf of the council by the Danish Agency for Science, Technology and Innovation. The programme has been evaluated several times and in 2011 an impact assessment was conducted. It was found that the programme has contributed to an increased absorptive capacity in the private sector that can be expected to facilitate knowledge and technology transfer from academia to industry and hence to foster innovation in firms. The Industrial PhD program has since 2014 been administered by the Innovation Fund Denmark. The Industrial Post-Doc scheme focuses on creating career paths in the private sector for personnel who have already accomplished their doctoral degree in public research activities.

Besides the Innovation Fund Denmark, a Market Development Fund (previously Business Innovation Fund) of €100m was established in the period 2010-2012 with the aim of supporting innovation and market maturity within the green and welfare areas. The Fund has since then been concerned with assisting firms to bring their new products to the market faster. An amount of €18m was allocated for the Market Development Fund each year from 2013 up to and including 2015. For 2016 the Market Development Fund was allocated a total of €7.6m.

With the establishment of the Innovation Fund Denmark in 2014, the funding landscape has been considerably streamlined. Moreover, fragmented programs and schemes have been combined and reorganised. Funding for private R&I can thus be considered to be more accessible for applicants. Together with the Market Development Fund, the entire R&I process from basic research to market innovation is covered. Programs sometimes require but in any case stimulate public-private collaboration.

Public Procurement of Innovative solutions

The total value of public procurement in Denmark was €34.49b Euro in 2012, equal to approx. 14.06% of GDP.¹³

Legal Public Procurement framework

The EU Directives 2004/17/EC and 2004/18/EC have been transposed into the Danish legislative framework. The new EU Procurement Directives were to be implemented from 1 January 2016 with the entering into force of the new Danish Procurement Act. The Bill to amend the Danish Public Procurement Act was originally tabled in March 2015 by the former Government. Directive 2014/24/EU must be implemented into Danish law on 18 April 2016 at the latest. With the new Danish Public Procurement Act, a project is launched under the auspices of the Market Development Fund which focuses on the new tendering process "Innovation Partnerships". In cooperation with a number of municipalities and the Danish Competition and Consumer Authority the Fund tests the new tendering process "Innovation Partnerships" with a focus on care/welfare.

¹³ 2014, European Commission, DG Internal Market study:
http://ec.europa.eu/internal_market/publicprocurement/docs/modernising_rules/20141105-indicators-2012_en.pdf

PCP/PPI landscape

Every year the Danish public sector spends approximately €40b on goods and services provided by private companies. It corresponds to 15% of the Danish GDP. The local municipalities are overall the largest public purchaser in Denmark. Public procurement in Denmark has mainly been driven by efficiency and cost-effectiveness concerns.. Until a few years ago, little consideration was given to innovative public procurement. However, this situation is currently changing due to several initiatives that aim at using public procurement as a means of stimulating innovation. More details are set out in Denmark's strategy on intelligent procurement (in Danish)¹⁴.

PCP/PPI initiatives

An example of innovative public procurement that was established in 2011 in the Nordic region is a program on innovation in the health sector¹⁵. Based on the observation that the health sector is by far the most important buyer and consumer of health care products the program seeks to exploit the opportunity for demanding new and innovative products and services from the private sector. The program is one of the six so-called lighthouse projects that the Nordic Ministers of Trade and Industry agreed on for the Nordic cooperation program for innovation and industry policy and it was planned to run until the end of 2015. About €1m have been allocated by Nordic Innovation together with its partners Tekes, Vinnova, the Danish Business Authority, Innovation Norway and Rannis to provide funding for three projects concerned with innovative public procurement:

- Nordic Public-Private Innovation Net
- Value-based procurements in primary and social care
- Integrated training program and demand dialog network for Innovative Nordic Health care Procurement

In 2013 the Market Development Fund¹⁶ (formerly 'Business Innovation Fund') was restructured to a market maturation fund to ensure that more innovative products and solutions reach the market for the benefit of growth and job creation in Denmark. The Business Innovation Fund was established in 2010 under the Danish Ministry of Economic and Business Affairs to inter alia focus on public-private partnership and public procurement. The Fund was administered by the Danish Enterprise and Construction Authority. Its aim was to promote growth, employment and export by supporting business opportunities within green growth and welfare as well as providing support for transformation of less favoured areas of Denmark by exploiting new business and growth opportunities. Less favoured geographical areas of Denmark are areas with unemployment significantly above the national average, or where it is extremely difficult for the unemployed labour to find new employment. The Fund prioritised projects within green solutions and welfare. The budget of the Fund was €101.5m for the period 2010–2012.¹⁷ The Market Development Fund provides grants and guarantees to business projects which need support for market maturation. To be eligible for support these solutions must be ready to be launched in the market, but encounter barriers to reach the market. A prototype must have been developed, and the product or service must have gone through a successful phase of demonstration to qualify for support. The Fund is the only fund of its kind in Denmark and meets important needs, especially in the aftermath of the financial crisis. About €18m is allocated for the Market Development Fund each year from 2013 up to and including 2015.

¹⁴ <https://www.evm.dk/publikationer/2013/31-10-13-strategi-for-intelligent-offentligt-indkoeb>

¹⁵ See <http://www.nordicinnovation.org/projects/public-procurement-and-innovation-within-the-nordic-health-sector/>

¹⁶ http://markedsmodningsfonden.dk/in_english

¹⁷ http://ec.europa.eu/enterprise/policies/innovation/files/countryreports/denmark_en.pdf

The main areas of support are:

*Testing and adaptation: before the sales process*¹⁸

Funding is provided to test whether a prototype or concept works in a realistic environment or at a prospective customer's site and to adapt the prototype/concept to strengthen the solution's commercial market potential.

Guarantee: when ready to start-up the sales process

Enterprises with innovative products can be assisted by the Market Development Fund's guarantee to mitigate buyers' uncertainty about investing in new technology, thereby boosting a solution's commercial market prospects. The guarantee applies to the unique situation where the product's innovative aspect does not function up to par or have the standard of quality which a customer could reasonably expect based on the product specification in the sales agreement. The buyer has a 20% own risk, which means that if the buyer chooses to redeem the guarantee, the maximum refund will be 80% of the purchase price.

*Innovative public-sector purchases*¹⁹

The purpose of this action area is to make it easier for public-sector institutions to obtain innovative new solutions. By specifying requirements in new ways, the public sector can help to target enterprise innovation, so enterprises develop better solutions that may even cost less. An innovative purchase could involve buying familiar products but combined with innovative new services to reduce operating costs and provide better service for citizens at the same time. It could also involve demanding brand-new solutions not yet available on the market or which require the public-sector partner to enter into public-private development cooperation.

Lead Markets: The Danish business investment authority "Invest in Denmark" under the auspices of the Ministry of Foreign Affairs is actively promoting Denmark as a test market, particularly in the ICT industry.²⁰ The authority argues that Denmark is particularly suitable as a test market because it allows international companies to quickly adjust and improve a product at low costs before releasing it on the world market. Since Denmark is a small, highly integrated and homogenous society, with consumers who are quick at adopting new technologies, it can be considered an attractive test market. International companies may not only profit from the high level of education in Denmark, but also from the long-standing tradition of user-driven innovation and close relationship with customers. Moreover, the Danish reputation as a "design hub" allows companies to draw conclusions about aesthetics and design of their new products. Denmark can be characterised as a lead market and not only a test market to the extent that the adoption of a new product in Denmark by consumers can predict adoption also by consumers abroad (Cleff et al., 2007). Cleff et al. (2007) find that Denmark has particularly high lead market advantages in the ICT industry, in machinery and equipment, but not in the chemicals industry. A midterm evaluation of effects shows that DKK 1 million (€0.13m) in funding from the Market Development Fund generates 8.5 jobs in Danish companies. The evaluation estimates that enterprises that have received co-financing from the Fund collectively will increase turnover by DKK 3.5 billion (€470m), exports by DKK 2.7 billion (€360m) and create 2,000-2,300 jobs by 2018.²¹

¹⁸ http://markedsmodningsfonden.dk/faster_to_market

¹⁹ http://markedsmodningsfonden.dk/innovative_purchases

²⁰ See <http://www.investindk.com/Clusters/ICT/The-worlds-best-test-market>

²¹ http://markedsmodningsfonden.dk/in_english

Green public procurement: The Danish Environmental Protection Agency set aside about €0.67m²² to develop and demonstrate how PCP can work in connection with environmental technology. The effects of green public procurement²³ have been assessed through seven business cases that allow both suppliers and procurers to quantify and articulate the potentials of green procurement. The use of life cycle costing, performance based procurement, reuse and recycling of materials, as well as a change from purchase of product to purchase of service has helped create the many positive effects.

Finally, the Danish Programme for User-Driven Innovation²⁴ ran from 2007 to 2009. The budget for the programme was €13.5m a year. The government sponsored Programme funded development and testing of user-driven innovation methods in Danish companies and public institutions. Costs up to the prototype stage can be covered and some knowledge from a project must spread beyond the project participants. As a general rule the programme funded up to 50% of expenses (mainly salaries) of a project. The programme was administered by the Danish Enterprise and Construction Authority and had calls for applications two or three times a year. By September 2009 the Programme had funded 74 projects.

3.5.2 Indirect financial support for private R&I

As outlined in the previous sections, most government funding for R&D is direct while indirect funding plays a relatively small role. In 2013, a new system came into force that features a tax credit on R&D expenditures. The tax credit had been reintroduced in 2013 after a few years without such a regulation. In 2014, the upper limit of the R&D tax credit has been increased from about €670,000 to €3.3m (Danish Government, 2014a). The tax credit is a permanent legislation. The introduction and increase of the tax credit have however not led to a reduction in direct R&I funding. Another fiscal incentive is a reduced taxation rate of 26% for international researchers and expatriates (above a certain threshold income) for a period of up to five years.

For both fiscal incentives it is difficult to assess the amount of tax revenue foregone by the state because a thorough assessment would require establishing a counterfactual situation, i.e. how much tax revenue would have been generated if certain R&D projects would not have been carried out or if certain researchers had not chosen to relocate to Denmark due to the absence of the fiscal incentive. To date, there have been no evaluations of the impact of these tax incentives.

3.6 Business R&D

3.6.1 The development in business R&D intensity

Figure 9 shows that Denmark's BERD intensity is high (the EU 28 average is around 1.3%). It grew steadily between 2006 and 2009 and stabilised at 1.98% of the GDP from 2010 onwards. Manufacturing and business services are almost equal contributors to BERD, with the former having a slightly higher share than the latter (i.e. ca. 0.1-0.15% of GDP).

²² <http://cordis.europa.eu/fp7/ict/pcp/pcp-survey.pdf>

²³ <http://mst.dk/media/mst/68594/All%20cases%20UK%20endelig.pdf>

²⁴ <http://www.oecd->

[ilibrary.org/docserver/download/9211031ec010.pdf?expires=1397201868&id=id&accname=id24042&checksum=7BEB9FA D2857E7FA9D514813E4A80681](http://www.oecd-ilibrary.org/docserver/download/9211031ec010.pdf?expires=1397201868&id=id&accname=id24042&checksum=7BEB9FA D2857E7FA9D514813E4A80681)

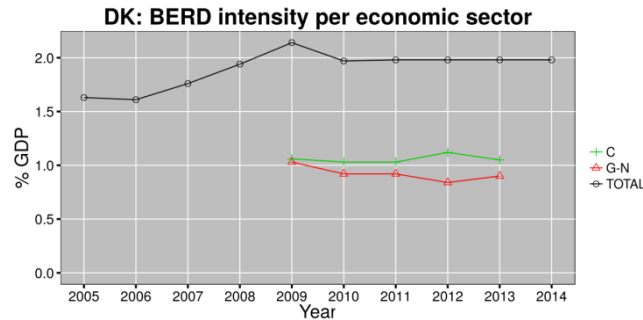


Figure 9: BERD intensity broken down by most important macro sectors (C= manufacture, G_N=services)

The private sector is the main funder of the Danish BERD as shown in figure 10. Approximately 90% of funding comes from business resources in 2014. The private sector increased its funding during the crisis. However, after a slight drop in 2010 funding from businesses stabilised at the level of 1.76-1.78% of GDP. Funding from abroad and the government sector is fairly stable (especially after 2010), but of less importance. The Danish government aims to facilitate the framework conditions for enterprises and support the build-up of Danish innovation capacity. Its strategy explicitly aims to increase private investments in R&D by 2020 to be in the top 5 OECD countries as a % of GDP²⁵. Most public funding for private R&D is direct, and indirect support such as tax incentives play a relatively small role, though a tax credit for R&D was introduced in 2013 and its upper limit increased in 2014. Based on Eurostat data, the share of private resources are decisive also in the financing from abroad, in line with Denmark's open and export-oriented economy (ca. 85%).

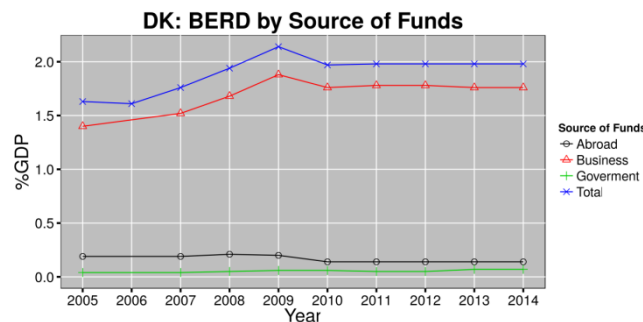


Figure 10: BERD by source of funds

3.6.2 The development in business R&D intensity by sector

Based on figure 11, the three highest in terms of BERD sectors in manufacturing between 2009 and 2013 were pharmaceuticals – C21, computer, electronic and optical products – C26 and machinery and equipment sector – C28, all high-technology or medium-high tech sectors. Their cumulative share in total BERD is 37-42% (data source: Eurostat). In terms of top ranked R&D business expenditures, Novo-Nordisk (R&D intensity in 2013 at 14%;), H Lundbeck (10%), Novozymes (11.8%), GN Store Nord (9%) and NKT (1.9%) are top companies in Denmark among these sectors and they have all increased their R&D expenditures.

²⁵ Denmark – a nation of solutions strategy

Pharmaceutical BERD is the highest and seems to be on an ascending path (26% growth in four years). It has grown strongly in 2012, which could also be due to the increasing demand through exports in which this sector is a leading international player. On the other hand, machinery and equipment BERD has been declining since 2011 which may be in part due to a lack of investment during the financial crisis. Computer and electronics BERD is practically stagnating on a lower level (i.e. ca. 7% of total BERD). Therefore, traditional sectors such as machinery and equipment suffered more from the financial and economic crisis and have not recovered, reflected in declining R&D intensity.

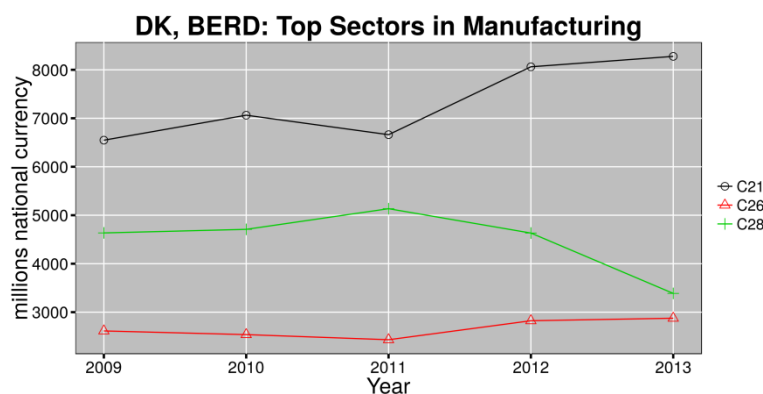


Figure 11: top sectors in manufacturing (C26= computer, electronic and optical products; C28= machinery and equipment; C21=basic pharmaceutical products and pharmaceutical preparations)

In the business services sector professional, scientific and technical activities, ICT, as well as financial and insurance activities are the top sectors in terms of BERD. Professional activities BERD had a U-shaped development with a significant decrease (25%) in 2010, followed by a two years of stagnation and a significant growth in 2013 (37%). ICT BERD is declining since 2010 (with an average rate of 13% p.a.). Financial sector BERD stagnated except for an important drop (23%) in 2012. An explanation for the sharp decline in R&D conducted in the financial services sector in 2012 may relate to a tax incentive for R&D introduced in that year, in which R&D activities may no longer have been eligible for government support (which only applied in loss-making cases).

Due to the size and the rather divergent trends, the cumulative share of the top three sectors varied considerably less, around 40-43% of total BERD, except for a drop to 34% in 2012.

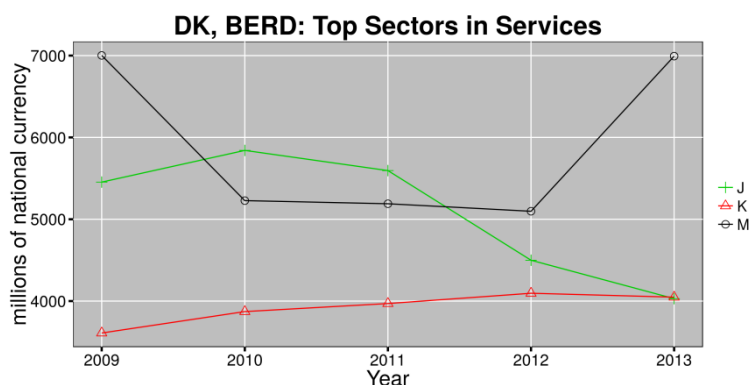


Figure 12: top service sectors (J=information and communication, M=professional, scientific and technical activities, K=Financial and insurance activities)

3.6.3 The development in business R&D intensity and value added

The contribution of the various sectors to the total gross value added (GVA) can be seen below. Data reveals that wholesale and retail trade, healthcare, manufacturing as well as real estate activities were the top four sectors providing the highest GVA to the Danish economy in 2012 (they all have a share of above 10% of the total GVA).

Comparing the graphs shows that while both wholesale & retail trade as well as healthcare activities are top contributors to GVA, neither of them is BERD intensive. However, BERD intensive sectors like ICT and professional & scientific activities are not among the top GVA contributors.

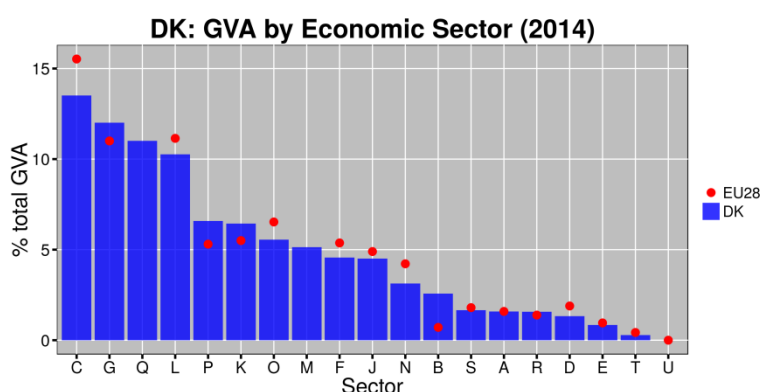


Figure 13: economic sectors as percentage of the total GVA. Top 6 sectors in decreasing order: 1) Wholesale and retail trade; repair of motor vehicles and motorcycles; 2) Human health and social work activities; 3) Manufacture; 4) Real estate activities; 5) Financial and insurance activities; 6) Public administration and defence; compulsory social security.

Except for the manufacture of food & beverages & tobacco, top six manufacturing sectors in terms of share of GVA are medium high to high technology intensive sectors, which shows the strong growth potential of the Danish economy. Consistently with their importance in the manufacture in terms of BERD, all three highest in BERD sectors appear to be important also in the GVA.

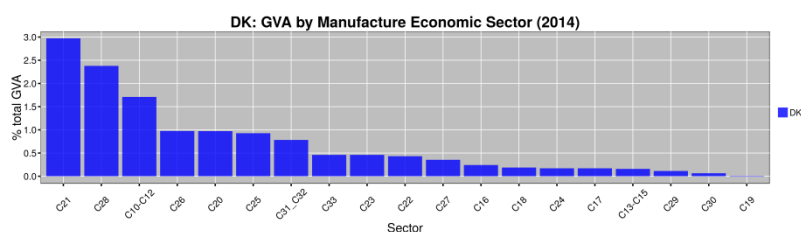


Figure 14: GVA in manufacturing. Top 6 manufacturing sectors: 1) machinery and equipment; 2) basic pharmaceutical products and pharmaceutical preparations; 3) food products; beverages and tobacco products; 4) chemicals and chemical products; 5) computer, electronic and optical products; 6) electrical equipment

During the period under scrutiny, GVA at factor cost was systematically higher (and increasing) in the business services sector than in manufacturing. While the share of various sectors changed throughout the period, there is no change in the importance of the sectors (i.e. no two lines are crossing each other) in terms of value added, and increasing in the financial services sector.

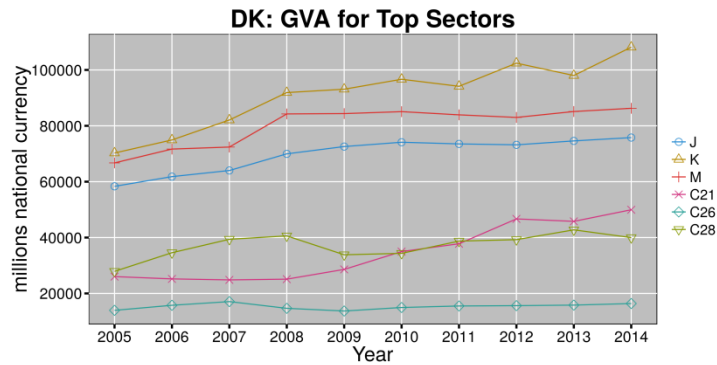


Figure 15: Value added for the leading sectors

According to the above figure 15, the top sectors in gross value added are as follows:

K: Financial and insurance activities

J: Information and communication

M: Professional, scientific and technical activities

C21: Manufacture of basic pharmaceutical products and pharmaceutical preparations

C28: Manufacture of machinery and equipment n.e.c.

C26: Manufacture of computer, electronic and optical products

There is evidence too that the numbers of high-growth enterprises increased in all sectors, except for the manufacture of computers and electronics, and remained the same for manufacture of basic pharmaceutical products. Most sectors increased their number of employees between 2008-2013, with the exception of the manufacture of machinery and equipment, but overall the indications are that parts of the manufacturing sector have recovered from the economic and financial crisis. The numbers of highly-skilled workers increased in all sectors from 2008-2014.

3.7 Assessment

Overall, the public R&I funding system in Denmark can be considered as a well functioning system. The last major change occurred with the establishment of the Innovation Fund Denmark in 2014 by joining research, technology development and innovation grants from the Danish Council of Strategic Research, the Danish Council for Technology and Innovation and the Danish National Advanced Technology Foundation. The reorganisation follows a recommendation made in the course of the ERAC peer review (European Commission, 2012) which had criticised the bewildering variety of funding instruments and research councils. The reorganisation has considerably streamlined the overall funding system and assigned clear responsibilities to the three current major public funding bodies as depicted in Figure 1 in section 1.2.2.

The current balance between institutional and project funding can be considered as appropriate. On the one hand, a considerable share of the total budget is allocated on a competitive basis, providing strong incentives for researchers in both public and private research organisations to apply for a grant. Most of the institutional funding to universities is also connected to certain output and quality criteria like publications in international scientific journals. On the other hand, the share of the total budget dedicated to project funding allows setting political priority areas on which resources and research activity should be concentrated.

Several funding instruments of the Innovation Fund Denmark are constructed in a way that facilitates collaboration between public and private organisations, like for example the Industrial PhD and Industrial Post-Doc schemes that aim at fostering the transfer of knowledge between academia and industry.

A recent evaluation of the Danish Council for Independent Research concluded that the council is functioning well. No substantial changes in the current funding system are therefore expected in the near future.

Private R&D intensity increased in total over the period 2005-2014, from 1.63% to 1.98%, well above the EU average of 1.28%, however there was an overall decline in services share of this total. Lack of data prior to 2008 makes it difficult to analyse what accounts for this increase. Employment in the sectors analysed here increased (with the exception of the manufacture of machinery and equipment) as did the numbers of highly-skilled workers in all sectors. Denmark's private R&D intensity is one of the highest in the EU28 and its strategy up to 2020 aims to increase the levels of BERD in relation to other OECD countries.

4. Quality of science base and priorities of the European Research Area

4.1 Quality of the science base

In terms of publications, Danish researchers are highly productive compared to the EU average. In 2013, Danish researchers published more than 2.5 times as many publications per thousand inhabitants than the EU average. The share of international co-publications in 2013 is almost twice as high as the EU average, indicating a high degree of collaboration (although, again, researchers in a small country will typically have to reach out to other researchers across borders). In a similar vein, Danish researchers achieved about four times as many international publications compared to the EU average.

Another important output indicator are citations to articles in scientific journals. Citations are indicators of how researchers receive and use research from fellow researchers and are internationally often used as a proxy for research quality. On the one hand, Danish researchers achieved on average an about 50% higher share of publications in the top 10% cited publications compared to the EU average. On the other hand, this share has also increased by 23% over the period from 2000 to 2010 while the EU average share has increased by 16%. This suggests an increasing quality, relevance and impact of research carried out by Danish researchers.

Finally, the share of public-private co-publications in Denmark is about 3 times as high as the EU average during the period from 2011 to 2013. This indicates a high degree of public-private collaboration in scientific research projects that lead to a publication. In sum, Denmark performs well in terms of output indicators but it has to be taken into account that smaller countries typically find it easier to score highly because of the low size of the population. There are no recent policy measures that have been taken to significantly improve the governance of the science system.

Table 5: Indicators for quality of science base

Indicator	Denmark (year)	EU average (year)
Number of publications per thousand of population	3.63 (2013)	1.43 (2013)
Share of international co-publications in %	56.3 (2013)	36.4 (2013)
Number of international publications per thousand of population	2.05 (2013)	0.52 (2013)
Percentage of publications in the top 10% most cited publications	15.29 (2000) 17.74 (2008) 18.83 (2010)	10.55 (2000) 11.68 (2008) 12.25 (2010)
Share of public-private co-publications in %	4.7 (2011-2013)	1.8 (2011-2013)

An analysis using bibliometric indicators derived from the Thomson Reuters database from 1989 to 2008 concludes that, compared with the world average, Danish scientific publications are highly specialised in clinical medicine, biomedicine and agriculture (Schneider, 2010). Denmark has a lower scientific specialisation in chemistry, material science, physics, mathematics, ICT and engineering, and Denmark is close to world average in geosciences and social sciences. In terms of scientific impact, Danish publications perform above average on a number of research fields, when it comes to citation impact. Citations are indicators of how researchers receive and use research from fellow researchers and are internationally often used as a proxy for research quality.

It is especially within the subject fields of physics and mathematics, agriculture, fisheries and forestry and biology that the Danish research performance is extraordinary high, around 50% or higher above world average. But also within chemistry, engineering and materials science, geosciences and health sciences do Danish researchers perform well, around 40% above world average (Piro, 2014).

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

Overall, Denmark is found to have a stronger tradition of bilateral cooperation in comparison to European-level programs. Nevertheless, Denmark is actively cooperating with other Nordic countries in joint programmes and institutions within the Nordic Council of Ministers. Moreover, Denmark is active in a number of ERA related cooperative actions, such as European Technology Platforms (ETP), Joint Technology Initiatives, Article 169 initiatives, ERA-NETs, and ERA-NET Plus. The Ministry of Higher Education and Science initiated several collaboration agreements and other policy measures to ensure an improved knowledge exchange between Danish and knowledge communities outside Europe.

According to the JOREP project report, Denmark has participated in 22 joint programs in 2009 which corresponds to a total funding volume of 24m EUR or slightly more than 1% of GBAORD (JOREP Consortium, 2012).

Further, Denmark participates actively in the pan-European network EUREKA. EUREKA is an intergovernmental organisation for market-driven industrial R&D. It is a decentralised network facilitating the coordination of national funding on innovation aiming to boost the productivity & competitiveness of European industries, for instance by means of the Eurostars support program. The network integrates over 40 pan-European economies, but also includes Israel, Turkey, South Korea, South Africa and Canada. During Eurostars 1 (2008-2013), 113 Danish companies and research institutions have participated in approx. 78 projects financed via the Eurostars program.

Eurostars 2 was launched in 2014 (to run until 2020) with a three-times higher budget than Eurostars 1.

The aforementioned INNO+ catalogue shares many of the main areas of the EU Framework Programme Horizon 2020. It identifies 21 concrete focus areas for research and innovation that are geared towards finding solutions to the grand societal challenges. The thematic focus is on transportation, environment, urban development, food, bio-economy, health, production, digital solutions and energy.

4.2.2 RI roadmaps and ESFRI

Denmark started a process for the creation of a new roadmap for research infrastructure in November 2014. The new roadmap was launched in December 2015 and included a catalogue with 22 proposals for new national research infrastructures.²⁶ The roadmap was created in collaboration between the Danish Ministry of Higher Education and Science and Danish research institutions, i.e. universities and other public research institutions, which were invited by the Ministry of Higher Education and Science to identify and submit proposals for new national research infrastructures. In 2015, Denmark's direct investments in research infrastructures totalled approx. €106m. The objective until the year 2020 is to make investments into at least 15 proposals for new research infrastructures from the roadmap (DASTI, 2015e).

²⁶ See <http://ufm.dk/forskning-og-innovation/indsatsomrader/forskningsinfrastruktur/danske-roadmap-for-forskningsinfrastruktur/roadmap-2015?searchterm=roadmap>

The proposals must involve all relevant and interested research institutions. Moreover, they must ensure that all researchers, independent of their institutional affiliation, have the opportunity to gain access to the research infrastructure. For that reason, every proposal had to be submitted on behalf of national consortia consisting of multiple research institutions. Proposals must also be sufficiently mature for the research infrastructures to be realisable scientifically, technologically and financially within a period of a few years. The proposals must lastly be realised with substantial co-funding – as a point of departure 50 per cent – from the research institutions that are also expected to assume responsibility for the operation of the research infrastructures once established and for any decommissioning.

The European Strategy Forum for Research Infrastructures (ESFRI) is a forum with representatives from the EU member states, associated countries and the European Commission which aims at establishing larger research infrastructures across several countries in Europe. The first ESFRI roadmap was presented in 2006 and updated in 2008 and 2010. In September 2014, the European Commission initiated a process for the next update of the European roadmap for research infrastructure. The roadmap was launched in March 2016. Projects included in the roadmap are expected to be implemented within the following 10 years. A criterion for the inclusion of projects in the ESFRI roadmap was that each project must receive support from at least three member or associated states. However, it should be noted that inclusion in the roadmap does not guarantee funding of the projects.

There is a close connection between the Danish roadmap for research infrastructures and ESFRI. Several proposals in the 2015 Danish roadmap catalogue include Danish membership of European research infrastructures (DASTI, 2015e). Most projects are established under the EC legal framework of the European Research Infrastructure Consortium (ERIC) regulation, which was adopted in order to facilitate the establishment of research infrastructures of European interest by the member states and associated countries. Under the 7th Framework Programme (FP7), financial support could be granted for the preparation of projects on the ESFRI roadmap but not for the actual construction and operation of new research infrastructures.

It is therefore a very important decision of the individual countries to decide on the extent they would like to participate in the realization of a certain research infrastructure project. The Danish government considers the Danish roadmap a key instrument in enabling an active Danish involvement in European research infrastructures collaboration.

Denmark participates in the establishment of multiple projects on the ESFRI roadmap as well as in already established ERIC projects, including CLARIN, ESS, DARIAH, EPOS, EATRIS, ELIXIR, ESRF-upgrade, ILL20/20 Upgrade, XFEL CESSDA, ESS-social, EU-Openscreen, SHARE, INSTRUCT, PRACE, Windscanner, E-ELT, ICOS, MIRRI, Infrafrontier, ANAEE, EURO-Bioimaging, ECRIN.

From 2011 to 2015, Denmark has been involved in the following large-scale international research infrastructures, which apart from the European Spallation Source are all based on international treaties.

- The European Molecular Biology Laboratory - EMBL
- European Spallation Source - ESS
- The European X-ray Free-Electron Laser Facility - European XFEL
- The European Synchrotron Radiation Facility - Institut Laue-Langevin - ILL
- European Organization for Nuclear Research - CERN
- European Southern Observatory - ESO
- The European Space Agency - ESA

The Danish financial contributions to these partnerships amount to about €33m. Among the partnerships, the European Spallation Source (ESS) stands out because Denmark will, together with Sweden, co-host the infrastructure. The ESS facility will be located in Lund, Southern Sweden, and the ESS Data Management and Software Centre will be located in Copenhagen, Denmark, and thus within the Dano-Swedish Øresund region. In the period 2014-2022, Denmark for its part will be investing approx. €268m in ESS (DASTI, 2015e).

4.3 International cooperation with third countries

There are mainly two areas in which the Ministry of Higher Education and Science has initiated globalisation initiatives to increase the internationalisation of Danish science. On the one hand, these are bilateral cooperation agreements, as well as via joint EU programmes, and on the other hand innovation centres located abroad.

The Ministry of Higher Education and Science has established and maintains bilateral agreements with Brazil, India, Israel, Japan, China, USA, and South Korea in order to promote the contact and the network to researchers and high technological businesses. These bilateral agreements seek to exploit the strengths of Danish research and innovation while at the same time learn from the partners abroad. Denmark is part of the EU's Strategic Forum for International Scientific and Technological Cooperation (SFIC) which aims at facilitating the further development, implementation and monitoring of the international dimension of ERA. This implies the sharing of information and consultation between the partners (member states and the European Commission) with the aim to identify common priorities which may lead to coordinated or joint initiatives. SFIC also aims at coordinating activities vis-à-vis third countries and within international fora. Denmark has, for example, identified synergies between Danish research on food and agriculture and Brazil as a large producer and exporter of food. In 2011, the Danish government has signed a Memorandum of Understanding with Brazil on research cooperation. There is also a Memorandum of Understanding on higher education "Science without Borders" in which all Danish universities are involved (SFIC, 2013).

Denmark has established innovation centres in hotspots around the world; in Silicon Valley, Munich, Shanghai, New Delhi/Bangalore, Seoul and São Paulo plus a satellite office in Tokyo. The innovation centres assist Danish companies and research and education institutions in surveying the market for technologies, potential research and innovation partners, assessing companies' business model and growth potential as well as offering advice on global growth opportunities. In addition the innovation centres work for establishment of partnership agreements with leading foreign research environments, attracting talent and collaboration on student mobility in a broader sense, facilitation of exchange agreements, organization of various network activities such as workshops, conferences, delegation visits locally, etc.

4.4 An open labour market for researchers

4.4.1 Introduction

Danish universities enjoy high institutional staffing autonomy (JRC-IPTS, 2013). Providing attractive employment and working conditions are priority areas in Denmark, since the employment system for public researchers generally displays a high level of flexibility (Steering group on human resources and mobility, 2009). When considering the cost of living, the level of remuneration for researchers in Denmark is high, but still below remuneration levels in the U.S. International researchers however benefit from a reduced taxation rate of 26% over a period of up to five years. Nevertheless, there are huge differences between the remuneration levels for the different levels of education in the public and the private business sector, both for employees with long-cycle higher education and for employees with PhDs.

The promotion of talent at higher education institutes is one of the priorities in the innovation strategy. A better framework for the development of a culture of talent shall be developed, which will mainly be the responsibility of the Danish universities.

In fact, the labour market for scientists and engineers has been continuously improving over the past couple of years. The number of persons employed in science and technology as a share of the total population has increased from 26.5% to 27.5%, even though it has been 27.7% in both 2012 and 2013. The increase in neighboring countries like Germany has, however, been steeper and even more continuous, i.e. from 22.5% in 2010 to 25.3% in 2014 which indicates a certain stagnation of the labour market in Denmark – even though at a high level. The financial crisis in 2008/2009 did not have an impact on the science and technology labour market in Denmark. The same patterns can be observed when persons with tertiary education or scientists and engineers are considered. The unemployment rate of persons with tertiary education has been fairly stable over the past years and reached 3.1% in 2014, below the EU average of 4.5%. It is however considerably higher than the unemployment rate in Germany, which has been 1.5% in 2014.²⁷

4.4.2 Open, transparent and merit-based recruitment of researchers

Open and competition-based recruitment of researchers is implemented at Danish higher education institutions and other public research organisations. In fact, Denmark has attracted increasing numbers of researchers from EU-28 and third countries. About 80% of the new international PhD students 2012/2013 enrolled in natural sciences or engineering came from abroad. Of the total number of PhD students in 2012/2013 about 33% came from outside of Denmark, and here mostly from the EU-28, Norway, Iceland and Asia.²⁸

The Danish language is mostly not an important obstacle because of the high level of English proficiency in the country. The Danish Agency for Higher Education was established in 2013 as a merger of two agencies concerned with higher education, education support, universities and internationalisation. The agency oversees the evaluation of foreign educations and the awarded degrees in accordance with the Lisbon convention. Danish universities largely follow a tenure-track system in which researchers, domestic and foreign, are recruited on a contract that foresees an evaluation of the candidate's performance after a certain period of time (usually five years). If the evaluation is positive, the candidate is granted a permanent position. Tenure in the Danish context does not mean, however, that the researcher cannot be dismissed. It only refers to a working contract without a termination date that is governed by the same rules and regulation as contracts for private sector employees. In sum, given the low language barriers, the high level of sophistication of the research infrastructure, the tax break for foreign researchers and a general ambition of the Danish Government to recruit and retain foreign talent, the Danish labour market for researchers can be considered highly attractive.

Universities Denmark declared its commitment to the European Charter for Researchers and the Code of Conduct for the recruitment of researchers in January 2009. Prior to this endorsement, the Charter and Code were debated by the Human Resources group, the Danish Committee of University Directors and the Danish Rectors' Conference. Universities Denmark and the Danish Agency for Universities and Internationalisation (now part of the Danish Agency for Higher Education) both argued that, overall, Danish universities met the European Commission's standards with regard to the Charter and the Code of Conduct. However, to date only two of the eight Danish universities, Copenhagen Business School (CBS) and the University of Copenhagen (KU), have been added to the list of 'HRS4R Acknowledged Institutions'.

²⁷ Source: Eurostat (2015).

²⁸ Source: Statistics Denmark (2015).

The reform of the university system in Denmark has led to a high level of autonomy regarding management of research budgets and hiring of research personnel. To achieve a balance between institutional autonomy and centralised planning, the universities sign development contracts with the Minister of Higher Education and Science, lasting for 3 years. These contracts are based on mandatory and self-imposed targets and describe the level of ambition for the universities in the included areas. A share of the universities' funding is based on performance indicators, with funding received as a lump sum, allowing autonomy to decide on its distribution. The government is not involved and does not interfere with the appointment of new researchers, but has defined the overall framework for how to proceed. However, this management process is due to the reforms of the university sector and not based on staff democracy but on professional management. Decisions about researchers' salaries are delegated to the universities, but salary negotiations are determined by an agreement between the government and trade unions. The decision on research agendas or research specialisation is reserved by the university to ensure that the research is independent. However, the increased share of competitive funding for mission-oriented research, based on strategic priorities, means that universities in these strategic areas have an incentive to align their research specialisation with nationally agreed priorities.

4.4.3 Access to and portability of grants

Danish funding schemes are open to researchers based abroad, regardless of their nationality, provided that their research is judged to be of benefit to Danish research. Accordingly, the Danish Council for Independent Research and the Innovation Fund Denmark welcome applications that comprise elements of international research cooperation, to support the best researchers and groups of researchers in their efforts to coordinate and develop their cross-border research collaboration. Both funding bodies therefore make no requirements regarding the applicant's citizenship, to the registered office of the research institutions or to a specific geographical location for the implementation of the research activities in question, but in all events, the application will be assessed on the basis of whether the project applied for benefits Danish research. All the strategic research programmes with recent calls promote this openness. The rationale for this openness is to strengthen Danish research groups through cooperation with excellent researchers from third countries. There is no data available on the numbers related to such grant access and portability.

The Danish Council for Independent Research as well as the precursor organisations of the Innovation Fund Denmark participate in the EUROHORCS initiative and its follow-up Science Europe, authorizing researchers moving to other countries to take the remainder of any awarded grant with them ('Money follows researchers') (Steering group on human resources and mobility, 2009).

4.4.4 Doctoral training

Doctoral training in Denmark features both the 'traditional' model of PhD education oriented towards internationally competitive education standards and a path referred to as the Industrial PhD Programme. The Industrial PhD Programme was established in Denmark in 1970 and has been a growing success ever since. It is internationally recognised for its combination of industrial experience and academic research. Since 2002, it has been part of the Danish Council for Technology and Innovation's umbrella of innovation promotion initiatives, and has been run on behalf of the council by the Danish Agency for Science, Technology and Innovation. The programme has been evaluated several times and in 2011 an impact assessment was conducted. It was found that the programme has contributed to an increased absorptive capacity in the private sector that can be expected to facilitate knowledge and technology transfer from academia to industry and hence to foster innovation in firms (DASTI, 2011b). The Industrial PhD program has since 2014 been administered by the Innovation Fund Denmark.

4.4.5 Gender equality and gender mainstreaming in research

Like all Scandinavian countries, Denmark places considerable emphasis and policy priority on gender equality. Since there is a very high degree of gender equality in Denmark which also extends into the research and innovation system, there are few concrete measures to promote gender equality. The remuneration gap between men and women in Denmark is very small compared to other countries (below 5% after 15 years of working life). The difference in the annual average salary between men and women is 6%. However, there are differences between scientific domains in terms of remuneration gaps (European Commission, 2007). The EU gender equality directives have been implemented in Danish law via the Act on Gender Equality and the Act on Equal Treatment of Men and Women.

In March 2013, the Danish Council for Independent Research held a conference on the role of gender in research and excellence. The objective of the conference was to stimulate the debate about the role of gender and how to achieve equality between the genders in all research contexts. In this context, the minister of science, innovation and higher education and the minister of gender equality discussed the introduction of special initiatives to enhance the chances of female researchers to access leading positions in research institutions. An element in this conference was to follow up on the council's initiatives for female researchers in the last decade. The conference had two concrete outputs. Firstly, the council adopted a gender equality policy. This policy addresses issues such as transparency, the composition of the council, means and evaluation, and special initiatives. Secondly, the council proposed a concrete initiative to earmark funds targeted at female research leaders to continue the work that had previously been done in that area. Moreover, in 2013, Council commissioned a study on the role of gender in research and excellence (Det Frie Forskningsråd, 2013). The report maps gender aspects and differences in the Danish R&I system. In 2011, 84% of the professorial positions in Denmark were held by men and only 16% by women. Moreover, the role of gender is analysed in the context of funding decisions.

With the 2014 Finance Act the YDUN-programme (Younger women Devoted to a UNiversity career) has been allocated about €10m. The Danish Council for Independent Research has allocated about €5m of own funds to the programme as well. YDUN is carried out in order to strengthen the utilisation of talent in Danish research by promoting a more balanced gender composition of the research environments in Denmark. The programme is operating through an exemption from the gender equality consolidation act; in case of equal qualifications between a male and female applicant, the application of the underrepresented sex is being prioritised. In 2014, the former Minister of Higher Education and Science appointed a task force on more women in science. On the basis of existing knowledge about challenges and barriers, the task force published recommendations in April 2015 about initiatives which can help promote gender equality in science. The recommendations were directed towards the Minister, the legislature, the universities, research councils and foundations etc. Furthermore, the task force identified areas where an improved knowledge base is needed in order to put new measures into practice effectively. The task force suggested issues to be included in an international analysis concerning gender balance in science which The Danish Council for Research and Innovation Policy conducted in 2015.

A study on gender equality in research commissioned by the Danish Council for Research and Innovation Policy (DFIR) concluded in 2015 that there is a gender imbalance in Danish research, particularly when researchers climb up the academic career ladder (Oxford Research, 2015b). The study analyses best practices from four European countries that have been particularly successful in increasing the share of female researchers and how these practices could be applied to the Danish context.

4.5 Optimal circulation and Open Access to scientific knowledge

4.5.1 e-Infrastructures and researchers electronic identity

Since 2012, the Danish e-Infrastructure Cooperation (DeIC) has coordinated Denmark's activities as an e-Science nation by consulting on and delivery of e-infrastructure (computers, data storage and networks) for research and teaching. DeIC's vision, goals and tasks are based on an agreement between the Danish Agency for Science, Technology and Innovation and the Danish universities. In February 2015, DeIC deployed the strategy for the years 2015-2018 which aims at improving the e-infrastructures at all Danish research environments according to international standards.

Denmark participates in many European e-infrastructure initiatives, including the GEANT network, The Partnership for Advanced Computing in Europe – PRACE, eduGAIN and eduROAM initiatives that are both aimed at easing the access to services and resources for the global research and education community. While eduGAIN enables the trustworthy exchange of information related to identity, authentication and authorisation by coordinating elements of the federations' technical infrastructure and providing a policy framework that controls this information exchange, eduROAM provides both researchers and students at registered institutions with wireless internet access at all participating institutions. The Danish eID federation WAYF joined eduGAIN in July 2013.

4.5.2 Open Access to publications and data

In 2007, the Danish Government approved the Council of the European Union's conclusions about scientific information in the digital age. As a result of this, in March 2011 an appointed Open Access Committee published its recommendations on how to implement Open Access in Denmark. In 2012, all the Danish research councils and foundations implemented their joint Open Access policy. Based on the green model of Open Access, this policy requires grant holders to seek permission to archive their research articles in institutional or subject-specific repositories no later than 6-12 months after publication. Through dialogue and collaboration with relevant stakeholders DASTI has been monitoring and analysing the implementation of Open Access across Danish research institutions. In the period from 2008-2013, 64.6% of all publications in Denmark (adjusted) were Open Access publications (total was 56.4%). This is considerably higher than the EU-28 average of 58.8% (or total of 51.3%). Of those Danish publications, 9.6% were 'Green Open Access', 9.0% were 'Gold Open Access' and 38.9% were other types of Open Access (Archambault et al., 2014). These figures, however, have been criticised as being too high and exaggerating the number of Danish scientific articles which are Open Access because of the specific methodology chosen by the authors. It is planned to introduce a Danish Open Access indicator at the beginning of 2016. A Danish Open Access indicator has been developed in the beginning of 2016 showing that approximately 18% of all Danish 2014 peer-reviewed scientific publications and conference proceedings (with ISSN) are Open Access.

The Ministry of Higher Education and Science analysed possible scenarios concerning the further implementation of Open Science in Denmark. As a result, in December 2013 a decision was taken to appoint the National Steering Group on Open Access. With representatives from all Danish universities, research councils and other relevant stakeholders the task of this group is to streamline the implementation of Open Access in Denmark based on the Danish National Strategy for Open Access which the Minister of Higher Education and Science announced in June 2014. The National Steering Group on Open Access commenced its work in 2014 and has been appointed by the minister for three years (Danish Government, 2014b). To date, 'Green Open Access' has not been mandated consistently across Danish universities and public research institutions.

Open Access to knowledge is an important issue for SMEs. In June 2011 a study was published on the levels of access to and use of research and technical information by knowledge-based SMEs in Denmark.

The study revealed 'barriers to access, access difficulties or gaps, and the costs and benefits involved in accessing research findings' (Houghton et al., 2011). The study was based on an online-survey and interviews and gave policy recommendations: '(i) addressing information literacy and improving the capacity of SMEs to navigate the information landscape; (ii) addressing accessibility and affordability of access for SMEs; and (ii) responding to the expressed concerns and wishes' of SMEs.

5. Framework conditions for R&I and Science-Business cooperation

5.1 General policy environment for business

The Danish economy is generally a very favourable environment for doing business. In its "Doing Business 2015" analysis, the World Bank ranks Denmark as the fourth best country in the world, closely followed by Norway (6th), the United Kingdom (8th), Finland (9th), Sweden (11th), Iceland (12th) and Germany (14th) and well above the OECD average (World Bank, 2014). This top-ranking position implies that Denmark has a very favourable position across all indicators used by the World Bank.

SMEs play an important role in Denmark with a slightly higher contribution to the economy than the EU average. Denmark has not adopted a specific strategy for the implementation of the Small Business Act (SBA) for Europe but in 2013 and 2014 the government presented growth plans which constitute a set of policies with topics and objectives which are comparable to those of the SBA. When looking at the SBA indicators, Denmark is found to have a very positive SBA profile, offering a favourable business environment for SMEs. Those firms benefit particularly from the innovativeness of the business enterprise sector and its competitiveness on international markets. Furthermore, Denmark offers a favourable framework for insolvency that includes short times and less costly procedures for recovering debt. The Danish Business Authority has introduced an early warning system that provides free, impartial and confidential counselling services for distressed companies in order to help them getting on a growth trajectory again (European Commission, 2014b).

5.2 Young innovative companies and start-ups

A new scheme under the Innovation Fund Denmark with so-called Entrepreneurial Pilots initiated in 2014 provides financial support and coaching for young graduates who wish to explore the possibility of creating a start-up.

In 2012, the ERAC peer review pointed to difficulties in increasing the innovation capacity and growth of SMEs (European Commission, 2012). Danish support for innovation in SMEs had been relatively underemphasized and the instruments were deemed too small. There was considered to be further need to stimulate collaboration between SMEs and larger businesses, also internationally, in order to grow into a better position in the global market place. Nevertheless, there were many support schemes available addressing market failures in the provision of private funding for innovation, particularly for SMEs. They had proved to have some positive impact (Alslev Christensen, 2011). Initiatives that target private R&D investments today include the InnoBooster program administered by the Innovation Fund, the Industrial PhD and Industrial PostDoc programmes, public-private partnerships for innovation and strategic R&D projects (see section 3.5.1), and initiatives under the Market Development Fund. The decreasing knowledge-intensity in traditional business sectors can be explained by the lack of financial incentives. The introduction of tax incentives for business R&D expenditures in 2012 provides a greater incentive for investing in R&D. Another explanation for the decreasing knowledge-intensity in traditional business sectors is the political focus on high-tech firms while policies supporting an increased innovativeness in low-tech firms might provide much greater effects.

Denmark has several science parks which provide combined office- and laboratory facilities and focus on bringing innovative firms and research institutions together. An example is the Copenhagen Bio Science Park which was significantly expanded in 2014. The aim is to increase Copenhagen's profile as a hub for biotechnology research. It is co-located with the Copenhagen Biotech Research and Innovation Centre which has been publicly financed. Another example is the NAVITAS park, opened in Aarhus in 2014, which is focused on bringing public research and private firms in the area of energy research together.

5.3 Entrepreneurship skills and STEM policy

Entrepreneurship education is widely available, for example through the Copenhagen School of Entrepreneurship (CSE) which is hosted by Copenhagen Business School (CBS), one of the eight Danish universities. CSE is the largest student incubator in Denmark, open to entrepreneurs from higher education and on a mission to help develop ideas into business. CSE prepares students for future employability, establishes commercial relationships and creates teaching methods, entrepreneurial knowledge and tools.

Moreover, the Danish Foundation for Entrepreneurship - Young Enterprise is the national knowledge centre and focal point for the development of entrepreneurship teaching at all educational levels. It works to ensure that the ability to be innovative becomes a fundamental element in all educations from primary school to PhD. The Foundation allocates funding for the development and further development of education with a focus on innovation and entrepreneurship at all levels of the education system. The Foundation also develops and publishes its own educational material, advises on the implementation of entrepreneurship in teaching, and facilitates the cooperation and networking about entrepreneurship education.

In order to improve the supply of skills for innovation and entrepreneurship, Denmark focuses on formal education by setting explicit graduation targets for young cohorts. Denmark formalised in 2009 a strategy for education and training in entrepreneurship (targeting all levels of education). More specifically, to ensure an adequate supply of advanced skills to the economy, Denmark has been investing in schemes to attract more students in science, technology, engineering and mathematics (STEM) disciplines. These include in particular financial incentives for students to increase tertiary enrolment (OECD, 2012).

5.4 Access to finance

Venture capital and business angels networks

Denmark has developed a policy focus on turning knowledge into business by supporting the commercialisation of public and private research results. Four Innovation Incubators offer early stage gap-funding for start-ups from universities and beyond. The incubators invest pre-seed and seed capital accompanied by counselling for entrepreneurs. The funding of approximately €25m annually is provided by DASTI.

The Growth Fund, a state investment fund, provides venture capital to entrepreneurial growth companies. Since 1992 the Growth Fund has, in cooperation with private investors, co-financed growth in 5,400 Danish companies with a total commitment of approx. €2b. The Growth Fund invests equity or provides loans and guarantees in collaboration with private partners and Danish financial institutions. In 2014, the companies which the Fund has co-financed represented a total turnover of approx. €9b and employed more than 41,000 people all over the country.

A recent evaluation of the Growth Fund's activities shows that the fund's investments led to short-term direct effects of €270m increase in GDP and the creation of 3,000 jobs (DAMVAD, 2013). Moreover, indirect effects materialise since the Growth Fund has been instrumental in the establishment of 18 of the 21 Danish venture capital funds, leading to an even higher increase in GDP and creation of jobs.

The taxation regime for venture capital funds is generally favourable. Denmark provides two different fund structures for private equity and venture capital investments. Both are tax-transparent and without undue restrictions. For both domestic and foreign investors, there is no incremental tax and there is no capital gains tax for non-residents. At the fund level, the maximum capital gains tax and withholding tax are 25% (EVCA, 2012).

Business Angel investment is another important way for entrepreneurs to obtain financing. In 2013, a total of €11.8m was invested by Business Angels in 102 companies.

This has translated into 539 jobs that were created through the investments which on average had a size of €115,882 per company. Within Europe, Denmark ranks on the 12th position in terms of total investments, which can be considered as high, given the size of the country (EBAN, 2014).

5.5 R&D related FDI

For a country of the size of Denmark, foreign direct investment (FDI) statistics are generally subject to considerable fluctuation. According to the UNCTAD FDI statistics, Denmark's FDI inflows were €-8,428m in 2010, €10,544m in 2011, €384m in 2012, €-682m in 2013 and €3,359m in 2014.²⁹ There is however no distinction between R&D-related and R&D-unrelated FDI.

The Danish business investment authority "Invest in Denmark" under the auspices of the Ministry of Foreign Affairs is actively promoting Denmark as a host country for FDI. In an analysis of FDI inflows to Denmark from 2012 to 2014, the business investment authority concludes that investors locate in Denmark because they would like to leverage unique local knowledge and specialized competencies. International investors moreover appreciate Denmark's skilled workforce: more than 80% of all investors surveyed answered that skilled labour had a positive influence on their investment decision. R&D-related investments are found to constitute an important share of all FDI. One third of the investors indicated that they would set up either an R&D department, a centre of excellence or a research collaboration with a Danish university. These investors are typically interested in the Danish industrial strongholds like renewable energy, pharmaceutical development, and the maritime industry (Invest in Denmark, 2015). Invest in Denmark assists about 45 investment projects in Denmark annually. The agency seeks to provide a one-stop service for foreign companies that intent to locate or expand a business in Denmark. The agency assists businesses through its in-depth understanding of regulations and potential funding sources and through providing access to a network of contacts.

Given the industrial profile of Denmark, it is – as many European countries – predominantly interested in attracting higher-value investment projects because these typically create high-paying and knowledge-intensive jobs. To measure the value of an FDI project, IBM has created an FDI Value Indicator which evaluates the added value and knowledge intensity of the jobs created during the course of an investment project. Based on this indicator, Denmark achieves a fourth rank in the world, behind Ireland, Switzerland and Sweden (IBM, 2015). This suggests that Denmark is well positioned to attract these jobs in high-value, knowledge-intensive sectors.

5.6 Knowledge markets

Over the past couple of years, several marketplaces for knowledge (or IP-protected technology) have developed that help firms find technology that they may be able to incorporate into their innovation processes. Knowledge markets, in that sense, facilitate on the one hand the acquisition of external knowledge that may be globally dispersed and on the other hand the exploitation of own technology through out-licensing or selling of IP. While knowledge acquisition may strengthen innovative capabilities, out-licensing and selling may create additional income for the company.

Many IP marketplaces today operate globally.³⁰ They are typically organised in a way that technology is displayed online in order to allow potential trading partners to do a search for IP and an initial evaluation of the fit with the company's specific needs.

²⁹ See <http://unctadstat.unctad.org/EN/>; exchange rate: 1.00 USD = 0.92 EUR

³⁰ See <https://www.ip-marketplace.org/links/>

To assist this process in Denmark, the Danish Patent and Trademark Office (DKPTO) has established an IP marketplace in 2007 which is free of charge for both buyers and sellers.³¹ The marketplace offers sellers to put patents, patent applications, utility models, designs and trademarks (i.e. intellectual property (IP) rights up for sale or out-licensing. While the IP marketplace helps with initiating the contact between two interested parties, the sale itself is not handled by the IP marketplace. The DKPTO does not offer actual counselling with respect to the trade or collaboration but has developed different tools such as standard contracts and a qualitative valuation scheme to assist firms trading with IP.³²

Surveys show that about 20% of all IP-active Danish firms engage in trading IP. Firm size plays an important role as the percentage of companies that trade IP is highest for larger firms with more than 100 employees. Trade is moreover particularly high in medical and health technologies (mostly in terms of patents) and in furniture and clothing (mostly in terms of designs and trademarks).³³ The IP marketplace has a number of cooperations with other patent offices and IP-related partners in order to create synergies and strengthen the competitiveness of SMEs.

In relative terms the patent intensity (PCT applications per million population) in Denmark is the fourth highest in Europe, though at a lower level than in the reference countries Finland and Sweden (European Commission, 2014a).

Regarding technology transfer from public research institutions, the share of patent applications being exploited (through licenses, options, assignments and spinouts) has increased in recent years, as universities have become more professional and selective in regard to patenting. A report from the Danish government shows that particularly in 2011 the number of inventions, patent applications, spinouts and licenses has increased considerably (DASTI, 2013a). International patent data suggest that Danish universities have become among the most active in Europe in utilising the EPO system. Nevertheless, the universities' income from commercialisation efforts remains relatively low compared to the GTS institutes and it has been fluctuating over the last couple of years (DASTI, 2013a). This reflects the basic division of labour between universities and the GTS system, the latter providing a wide range of R&D-related and more applied services. To avoid unfair competition with the private sector, budgetary provisions allow Danish universities only to engage in commissioned research when this is directly linked to the basic activities of the university.

Since 1990 Denmark has been a contracting state of the European Patent Convention (EPC), a multilateral treaty that established the European Patent Organisation and provided an autonomous legal system according to which patents are granted. Danish patent regulations, executed by the DKPTO therefore correspond with European patent law.

³¹ See <https://www.ip-marketplace.org/>

³² See <https://www.ip-tradeportal.com>

³³ See <http://www.ip-tradeportal.com/statistics-on-trading-ipr.aspx>

5.7 Public-private cooperation and knowledge transfer

5.7.1 Indicators

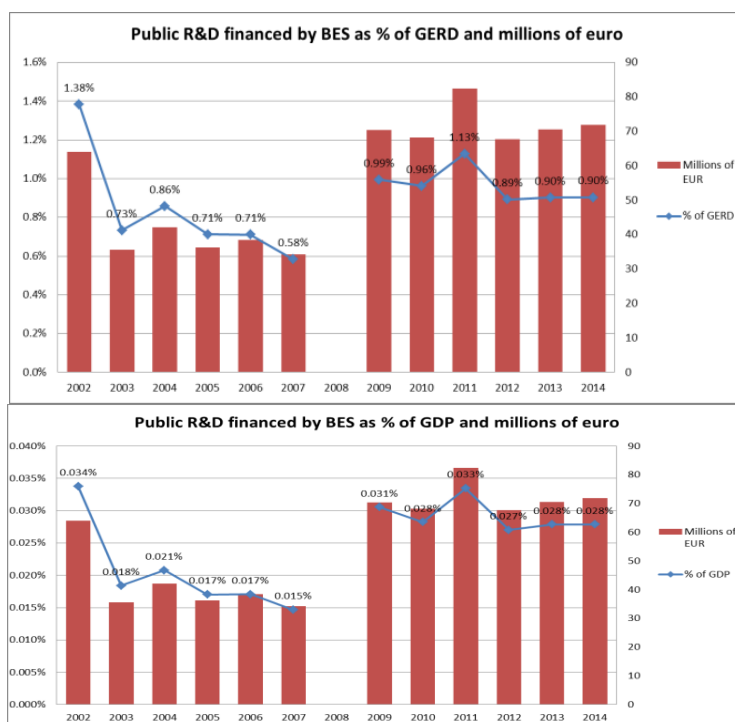


Figure 16: BES-funded public R&D as % of GERD (in €MLN) and % of GDP

Figure 16 shows the level of business enterprise (BES)-funded public R&D mostly declined between 2002-2008, albeit with a small increase in 2004 in terms of GERD, it remained fairly stable between 2012-2014 at 0.90%, these trends are broadly reflected in cash terms with peaks in 2002, 2004 and 2011 with the latter at over 80m EUR – the highest level.

As a percentage of GDP, it shows a similar trend as for GERD at 0.03% which is similar to most EU28 countries, but the stagnation in recent years is a concern in light of policy aims to improve levels of public research performed for the private sector.

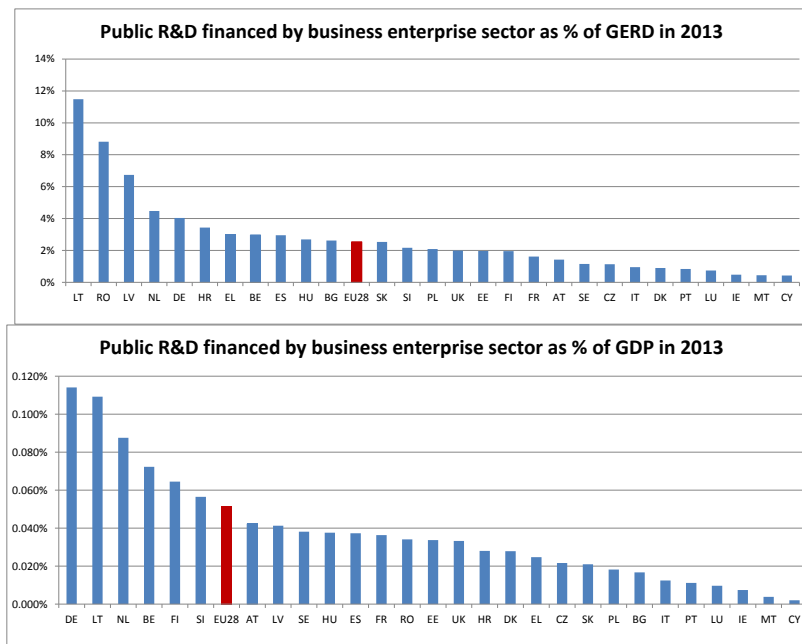


Figure 17: BES-funded public R&D as % of GERD and as % of GDP in 2013 in Member States³⁴

Figure 17 charts show the values of BES-funded public R&D in all EU28 as percentages of GERD and GDP respectively. Denmark ranks well below the EU28 as a percentage of GERD and as a percentage of GDP. In fact Denmark has a strong private non-profit R&D aspect to public research efforts - figures not included in calculations here. Were they, it would be apparent that Denmark in fact has one of the highest levels of privately-funded public R&D expenditure of the EU28. This is partly because some of the largest corporations are either owned by foundations or large foundations own important R&D companies, which have traditionally funded research through donations.

Public-private collaboration occurs mainly between firms and the eight Danish universities as well as the nine GTS institutes. While the universities are the main research performers and major collaboration partners, the GTS institutes are the main providers of commissioned R&D for the private sector and there are specific aims to service the needs of SMEs. Turning public research results into business opportunities requires more investments into research, development and innovation by larger business enterprises. This refers to both R&D in collaboration with public research and the purchase of research results from public science.³⁵ Moreover, Danish firms collaborate more with foreign universities than with Danish universities.³⁶ However, those firms (mainly larger companies and not small firms) which do cooperate with Danish universities, mainly for applied research projects, assess the cooperation as positive.³⁷

³⁴ 2011 was chosen as the latest data series providing a full comparison within EU-28.

³⁵ Draft RIO Country Report 2014.

³⁶ Danmarks Forskningspolitiske Råd, 2011. <http://ufm.dk/publikationer/2012/arsrapport-fra-danmarks-forskningspolitiske-rad-2011>

³⁷ Oxford Research, 2011

http://techtrans.dk/fileadmin/webmasterfiles/techtrans/Temah%C3%A6fter/Private_virksomheders_samarbejde_med_danske_universiteter_2011.pdf

Funding: Structural funds devoted to knowledge transfer

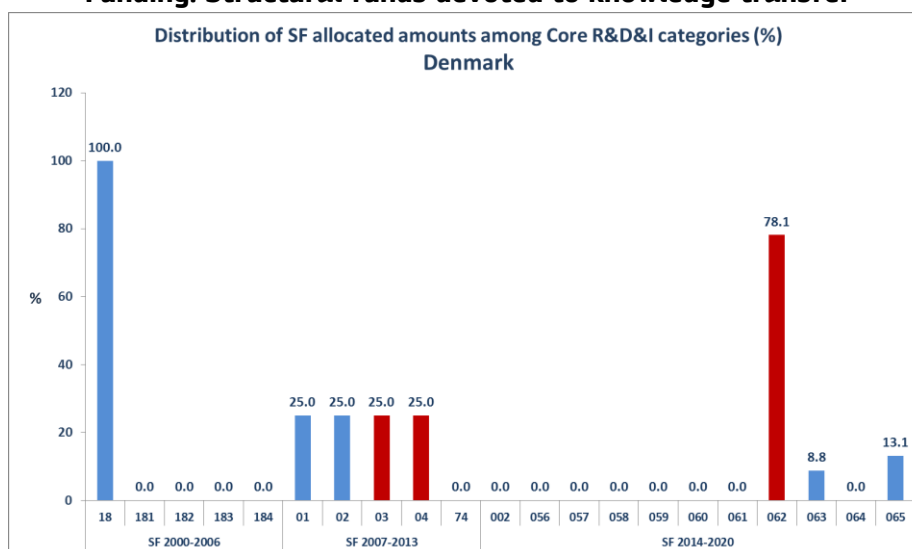


Figure 18: Structural Funds for core R&D activities 2000-2006, 2007-2013 and 2014-2020³⁸. We use the categories: 182 (2000-2006), 03 and 04 (2007-2013) and 062 (2014-2020) as proxies for KT activities.

Denmark allocated so far 78.1% of its structural funds for core R&D activities to technology transfer and university-enterprise cooperation primarily benefiting SMEs (0% for 2000-2006 and 50% 2007-2013). It was much higher than the EU average of 15.7% for the 2007-2013 period (and while well below the 26.1% 2000-2006, it was also above the 30.1% 2007-2013). It is important to note however that structural funds are less significant in Denmark compared to other countries.

Cooperation: Share of innovative companies cooperating with academia

³⁸ Figure 18 provides the Structural Funds allocated to Denmark for each of the above R&D categories. The red bars show the categories used as proxies for KT. Please note that the figures refer to EU funds and they do not include the part co-funded by the Member State.

The categories for 2000-2006 include: 18. Research, technological development and innovation (RTDI); 181. Research projects based in universities and research institutes; 182. Innovation and technology transfers, establishment of networks and partnerships between business and/or research institutes; 183. RTDI infrastructures; 184. Training for researchers.

The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.

The categories for 2014-2020 include: 002. Research and Innovation processes in large enterprises; 056. Investment in infrastructure, capacities and equipment in SMEs directly linked to Research and Innovation activities; 057. Investment in infrastructure, capacities and equipment in large companies directly linked to Research and Innovation activities; 058. Research and Innovation infrastructure (public); 059. Research and Innovation infrastructure (private, including science parks); 060. Research and Innovation activities in public research centres and centres of competence including networking; 061. Research and Innovation activities in private research centres including networking; 062. Technology transfer and university-enterprise cooperation primarily benefiting SMEs; 063. Cluster support and business networks primarily benefiting SMEs; 064. Research and Innovation processes in SMEs (including voucher schemes, process, design, service and social innovation); 065. Research and Innovation infrastructure, processes, technology transfer and cooperation of enterprises focusing on the low carbon economy and on resilience to climate change.

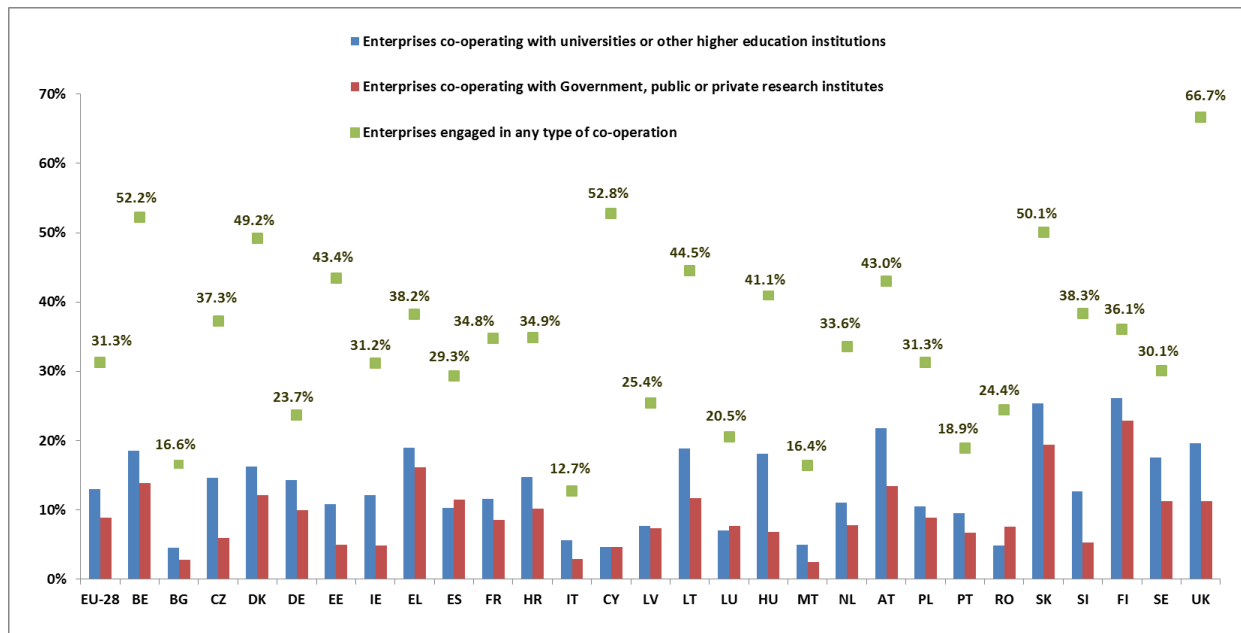


Figure 19: CIS survey 2012 – share of enterprises cooperating with academia

Denmark has a relatively high percentage of enterprises engaged in any type of cooperation (including suppliers, other companies, etc.) at 49.2%, well above the EU28 average. Some 16.2% of the total cooperation is with universities and higher education institutions. 12.2% cooperates with government or public or private research institutes. By comparison, Finland, one of the world's innovation leaders, has the highest levels of company-academia cooperation at 26% and enterprise cooperation with government, public or private research institutes accounts for 23%.

Cooperation: Technology Transfer Offices (TTOs offices), incubators and technological parks

Technology transfer offices (TTO) are in place at Danish universities, although they operate under a variety of framework conditions. This may reflect possible conflicts between universities and industry: industry players argue universities claim excessive profits. Moreover, most TTOs are subcritical in terms of the size of patent and technology portfolios to be commercialized which suggests benefits from higher collaboration between universities in this area. However, the rather low patent intensity of Danish universities, with the exception of the DTU and Aalborg University, remains a challenge if increased university patenting is the goal.

There are four innovation incubators in Denmark. Most of the innovation incubators are housed in science parks which also provide premises and laboratories in close proximity to the universities. According to available figures, there are some five science parks in Denmark.³⁹

³⁹ <http://www.unesco.org/new/en/natural-sciences/science-technology/university-industry-partnerships/science-parks-around-the-world/science-parks-in-europe/>

Cooperation: Share of public-private co-publications

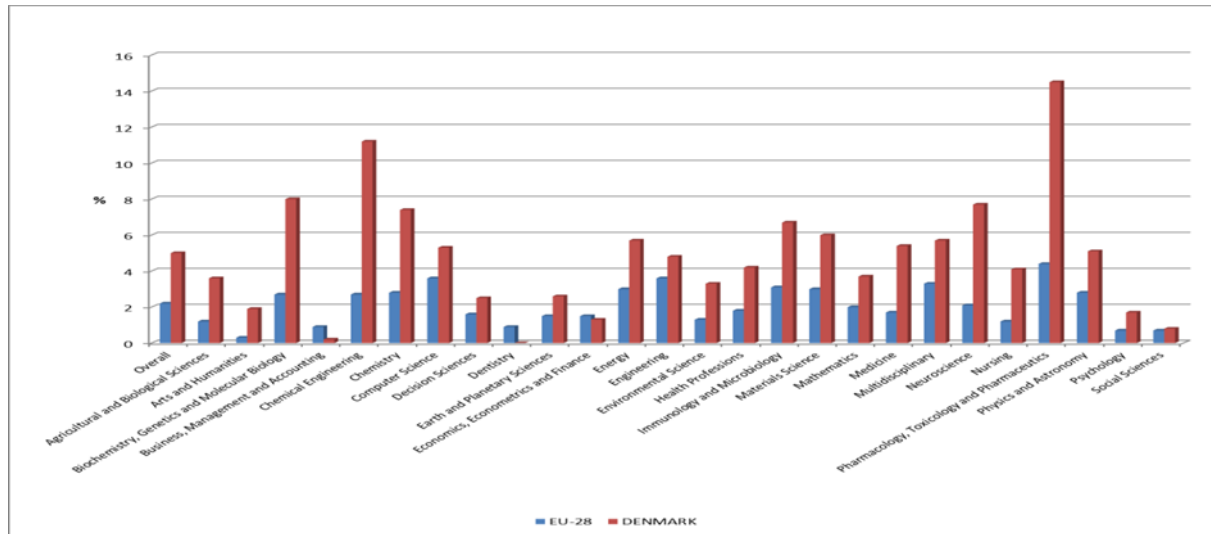


Figure 20: Co-publications by field 2003-2013. Scopus database

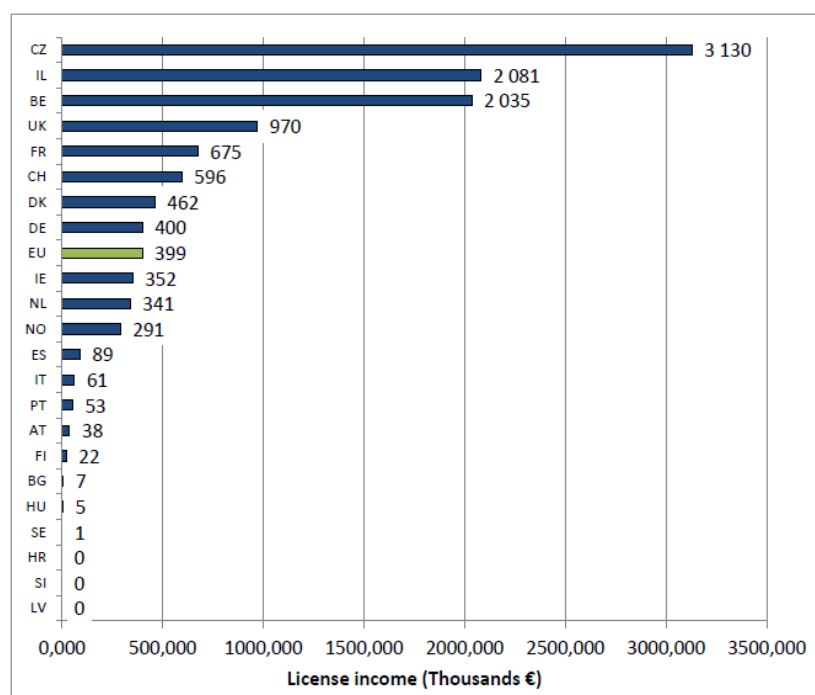
Top fields of public-private co-publications are pharmaceuticals, chemical engineering, biochemistry, genetics and molecular biology, and neuroscience, on average over the period 2003-2013. Denmark is well above the EU28 average in the majority of fields. Overall, academia-business publications accounted for 5% of publications in 2013 and the figure remained fairly stable over the ten year period. Denmark had 182.1 public-private co-publications per million of population, ranked first of the EU28 and well above the EU-28 figure of 29 (155 Finland and 57.8 Germany)⁴⁰.

⁴⁰ Source: JRC IPTS RIO elaboration on Scopus data collected by Sciencemetric in a study for the European Commission DG RTD (Campbell, 2013). The share of public-private co-publications is derived from the Scival platform and is also based on Scopus data (September 2015). SciVal[®] is a registered trademark of Elsevier Properties S.A., used under license. The data on public-private co-publications is not fully compatible with the data included in the IUS, due to differences in the methodology and the publication database adopted.

Cooperation: Patenting activity of public research organisations and universities together with licensing income

The charts below provide an international comparison of patent and license data. Denmark is strong in many areas, particularly license income (462/1000 research staff) and research agreements (115/1000 research staff) where it is above the EU average. However, its performance is fairly weak in patent grants - below the EU average of 4.5/1000 research staff at 2.1, and also in number of license agreements - below the 6.5/1000 research staff EU average at 3.5.

Exhibit 3-35: Thousands Euros of license income per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

Figure 21: License income per 1 000 research staff by country. EKTIS 2011-2012 survey

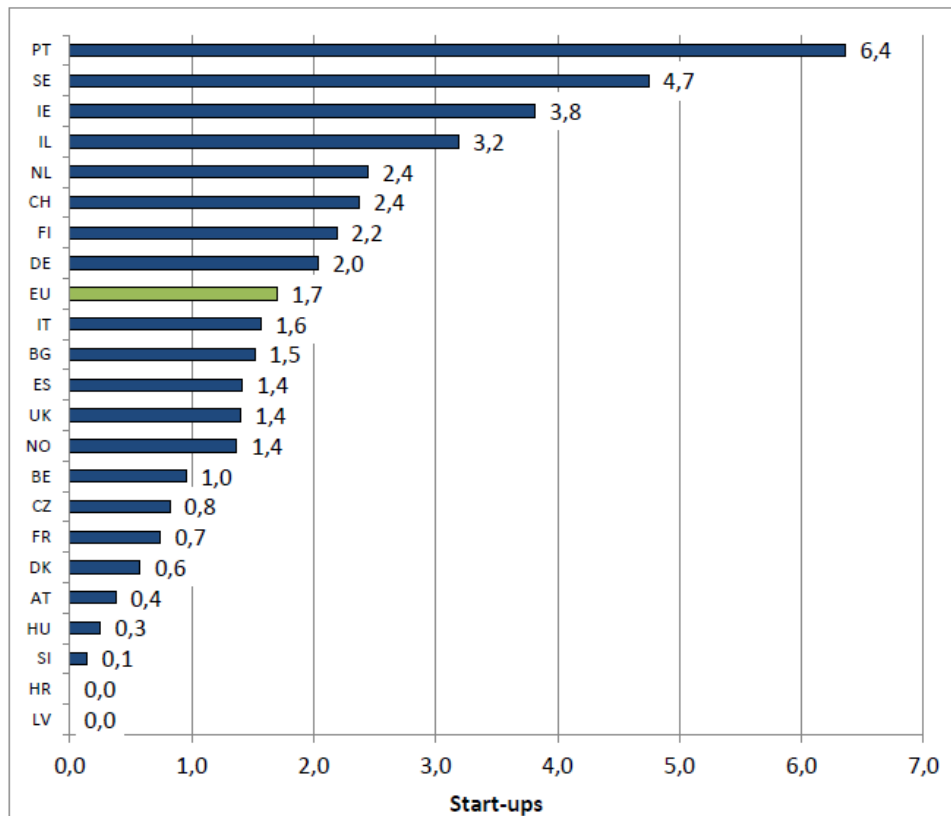
While national survey data for 2013 reveals general progress on the number of patent applications and licenses which show the highest level to date. In total, the institutions filed 198 patent applications in 2013, which is a 13 per cent increase compared to 2012. This is the highest number of applications to date. 47 patents were issued in 2013. The relatively small number compared to applications is partly due to patent rights being sold to businesses before the patent is issued. In 2013, the public research institutions signed 120 new agreements on licensing, assigning or giving options to IP compared to 108 in 2012. This is the highest number of agreements to date. Behind the national level of performance, there were major differences in the development at an institutional level⁴¹.

⁴¹ <http://ufm.dk/en/publications/2014/public-research-commercialisation-survey-denmark-2013-summary>

Cooperation: Companies

The formation of spin-off companies is rather low and only the Technical University of Denmark (DTU) has actually made significant profits from licensing.⁴² According to national data, in 2013, 15 new companies were created on the basis of licensing of IP from public research institutions. For the period 2000-2013 the development of spin-out companies has been fluctuating.⁴³ These findings are in line with the comparative data below. In terms of start-ups, Denmark had 0.6 per 1000 research staff which is below the EU average of 1.7.

Exhibit 3-33: Number of start-ups per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

Figure 22: Number of start-ups per 1 000 of research staff per country. EKTIS 2011-2012 survey

5.7.2 Policy Measures

The main framework for knowledge transfer is provided in the innovation strategy 'Denmark – Nation of solutions'⁴⁴. It contains 27 individual policy initiatives implemented since 2013 and that target knowledge transfer and open innovation activities of Danish scientific institutions and companies. Within this framework, public-private collaboration occurs mainly between firms and the eight Danish universities as well as the nine GTS institutes ('Godkendte Teknologiske Serviceinstitutter') – Advanced Technology Group. While the universities are the main research performers, the GTS institutes are the main collaboration partners of the private sector.

⁴² Idem.

⁴³ <http://ufm.dk/en/publications/2014/files-2014-1/english-summary.pdf>

⁴⁴ <http://ufm.dk/en/publications/2012/denmark-a-nation-of-solutions>

The strategy aims to foster:

- Increased co-operation between knowledge institutions, companies and other stakeholders to foster growth and employment; a higher focus on utilising research results, commercialisation and market maturation.
- Integration of innovative competences and entrepreneurship in education programmes; closer coordination of education, research and innovation policy.
- Active participation in the global knowledge and innovation network; better preparation of Danish companies and knowledge institutions for global development.
- Securing better cohesion and impact in the innovation system; alignment of the innovation system with political priorities and the needs of users.

The Denmark Act on Inventions at Public Research Institutions (2000)⁴⁵ grants title to Public Research Organizations (PRO) but allows the inventor right of first refusal. Before 2000 the rights were owned by the researcher/professor. Over recent years technology transfer has been strengthened and possible conflicts of interests have been addressed in standard agreements on IPR and in strategic collaboration agreements between universities and industry partners. Presently, innovation policy is facilitating innovation in SMEs in collaboration with GTS institutes.

A major policy initiative - the INNO+ Catalogue, 2013⁴⁶ - emerged from a political wish to improve the basis for prioritising resources for targeted innovation efforts. It is the result of an extensive process through which a wide range of stakeholders from industry and interest organisations, knowledge institutions, ministries and research councils, etc. identified the essential and most promising areas for strategic investments in innovation in Denmark. The Budget Bill for 2014 provided for funding to organisations with dedicated knowledge transfer funding lines.

Denmark also recognises that an important prerequisite for knowledge transfer is a critical supply of human resources. The shortage of human resources in science and technology and especially of engineers has been addressed by stakeholders in the private sector. The government addressed this problem via education policy and the numbers of PhD candidates in engineering doubled from 2003 to 2010. The successful Industrial PhD programme has contributed to an increased absorptive capacity in the private sector.

The main measures to support R&D collaboration between the public and the business sector are administered by the Innovation Fund Denmark, established in April 2014. These policy measures are the Industrial PhD and Industrial PostDoc programmes, InnoBooster, as well as public-private partnerships on innovation and strategic R&D projects.

- Industrial PhD and PostDoc: Doctoral training in Denmark features both the 'traditional' model of PhD education oriented towards internationally competitive education standards and a path referred to as the Industrial PhD Programme. The Industrial PhD Programme was established in Denmark in 1970 and has been a growing success ever since. It is internationally recognised for its combination of industrial experience and academic research. The programme has been evaluated several times and in 2011 an impact assessment was conducted. It was found that the programme has contributed to an increased absorptive capacity in the private sector that can be expected to facilitate knowledge and technology transfer from academia to industry and hence to foster innovation in firms. The Industrial PostDoc programme focuses on creating career paths in the private sector for personnel who have already accomplished their doctoral degree in public research activities.

⁴⁵ <http://www.au.dk/en/about/organisation/index/6/67/6701.actoninventionsatpublicresearchinstitutions/>

⁴⁶ <http://ufm.dk/en/publications/2013/inno-catalogue>

- **InnoBooster:** Until August 2014 the knowledge pilot regulation was in effect. A grant could be given to SMEs with limited experiences in hiring highly educated employees to cover some of the salary of a new employee with a higher education and who was to execute a development or innovation project in the enterprise. The measure was to enhance the cooperation between SMEs and knowledge institutions and to increase the share of highly educated employees at SMEs. The enterprise could be given €1,333 a month for the salary of the new knowledge pilot, for a period of 6-12 months. The new Innovation Fund has taken over this measure and integrated it into a new program called InnoBooster. InnoBooster now also includes a measure that was known as innovation voucher. The measure consisted of a 40% co-funding of development projects applied for by SMEs who wished to use the funding for knowledge acquisition from a public research organisation or a member of the GTS-network. It is an objective to expand the utilisation of collaboration with knowledge organisations to a wider group of the Danish SMEs and to raise the attention of SMEs of the opportunities within utilisation of the knowledge of public research and technology institutions. The voucher could fund a maximum amount of about €14,000. With the integration into the InnoBooster instrument, the schemes were updated and further developed.
- **Public-private partnerships on innovation and strategic R&D projects:** The Innovation Fund offers support for problem-oriented strategic research projects, high-technology projects involving firms and public research institutions, and innovation partnerships within certain thematic areas (blue jobs and green solutions; intelligent, sustainable and effective plant production; Denmark as a preferred country for early clinical trials of new drugs; water-efficient industrial production; innovatorium for world-class building renovation).

The nine GTS institutes furthermore provide support through so-called innovation agents. The agents offer SMEs a free 'innovation check-up', which is meant to identify innovation opportunities and challenges, and provides specific action proposals for ways of realizing such potentials. Moreover, the program shall help firms with the establishment of contact with the right scientific institution or advisory expert, or to apply to a public pool for a grant for such innovation activities co-funded by DASTI.

Moreover, a group of 22 national Innovation Networks ('Innovationsnetværk') provides matchmaking and facilitates joint innovation projects in professional clusters of enterprises and research organisations within specific fields of technology or industrial branches. Approximately 7,000 enterprises participate in the 22 networks, of which two thirds are small enterprises with less than 50 employees. Six of the 22 networks have achieved the so called Gold Label for Cluster Excellence Management, which is given by the EU to cluster organisations that are able to document excellence on 31 quality and performance indicators. The networks are co-funded by DASTI.

Education as an enabler of knowledge transfer

An important prerequisite for knowledge transfer to happen is a critical supply of human resources. Especially engineers are perceived as being essential for a future growth of new knowledge intensive sectors (DASTI, 2014a). The Danish government has focused on this challenge for a number of years and the issue is pervasive in policy debates and documents. The shortage of human resources in STEM subjects and here especially of engineers has been addressed by stakeholders in the private sector. The government has addressed this problem especially via education policy and as a result of this policy the number of newly enrolled students increased significantly over the last years and the numbers of PhD candidates in engineering doubled from 2003 to 2010. The successful Industrial PhD programme has contributed to an increased absorptive capacity in the private sector.

The previous government has as a goal that 95% of a year group shall complete at least a youth education programme, 60% shall complete higher education and at least 25% shall complete a long-cycle higher education (Danish Government, 2012b). Job-training is accepted as a standard and successful procedure for the continuous development of skills. Life-long learning has been a policy priority for several years in the National Reform Programmes. Denmark is a country with a flexible, mobile labour force and it also has a long tradition of on-the-job training and funding schemes. In this policy context, the Quality Reform (agreed in 2007) further institutionalised the processes for upgrading of skills, qualifications and further education amongst the labour force.

Although data on purely business enterprise funding to public sector research reveals a weak collaboration system, in fact, a large part of public research funded by the private sector is funded by the foundations linked to a number of large companies. Denmark is relatively successful in science-business collaboration with a high degree of privately funded public research and enterprise collaboration with academia. It also performs well on co-patents across the board, though notably in pharmaceuticals and chemical engineering. Denmark has in place a system of technology transfer offices as well as a number of science parks, though most of Denmark's universities have a rather low patent intensity. The data shows poor performance in patent grants, number of license agreements and on start-ups although national data shows this is improving. On the other hand, license income and research agreements data for Denmark are above the EU average. A range of programmes are in place to support knowledge transfer, and a good system of evaluation supports improvements. Policies supporting strategic research topics to engage academia and business, boosting education, including the supply of engineers, and examining incentive and management systems aim towards improvements in university-business collaboration.

5.8 Regulation and innovation

Regulation can be characterised as economic, social or administrative regulation. Economic regulation seeks to improve the efficiency of markets in delivering goods and services which, as a consequence, may influence innovation. Social regulation is aimed at protecting the environment, safety and health of society which may encourage or discourage innovation. Administrative regulation concerns the practical functioning of the public and private sectors in that it is setting basic conditions for technological progress (European Commission, 2014c).

The impact of regulation on innovation and here particularly on firm innovation activities has been subject of considerable academic discussion (e.g. Blind, 2012). The growing body of empirical literature, however, has produced rather ambivalent findings regarding the impact of regulation, often depending on the type of innovation (i.e., innovation input, such as R&D, or innovation output, such as incremental or radical product or process innovations) and the way it is actually implemented in a country.

The Danish government has a strong interest in the promotion of better regulation. Despite an overall well-functioning economy, many new initiatives have been taken over the past couple of years in the areas of administrative simplification and the development of new regulation (OECD, 2009). Particularly the de-bureaucratisation initiatives of the government have been helpful in freeing up time that can be spent on innovative activities. Moreover, most regulation with an innovation impact has been implemented in the form of R&D subsidy programs, like for example the energy technology, development and demonstration program (EDDP, launched in 2008) under the Ministry of Climate, Energy and Building, or the Green Development and Demonstration Programme (GDDP) under the Ministry of Food, Agriculture and Fisheries (launched in December 2009).

The programs are meant to stimulate preventive process solutions and cooperation among technology suppliers, research institutes, consultancy firms, and users. Besides those subsidy programs, innovation regulation concerns primarily the innovation strategy 'Denmark – a nation of solutions' and other soft law which is eventually translated into strategic priorities for research and innovation funding.

5.9 Assessment of the framework conditions for business R&I

Framework conditions for innovation in Denmark are primarily influenced by the Danish innovation strategy 'Denmark – a nation of solutions'. The vision of the new innovation strategy is that Denmark should become a nation of solutions, in which innovative solutions for the grand societal challenges are converted into growth and employment (Danish Government, 2012d). The ambition of the innovation strategy is to enhance cooperation and to provide improved frameworks for innovation in firms. The strategy contains 27 policy initiatives regarding research, innovation and education. It focuses on a better knowledge exchange between companies and knowledge institutions, across borders and between the public and private sector (Danish Government, 2012d). There has been no comprehensive assessment of the strategy yet.

The INNO+ catalogue, presented in connection with the innovation strategy, represents an example of co-evolution of supply and demand-side policies and instruments (Danish Government, 2013). The catalogue is based on the involvement of a multitude of actors from the innovation system and made in arm's length to the politicians. INNO+ identifies 21 concrete focus areas for research and innovation that are geared towards finding solutions to the grand societal challenges. The thematic focus is on transportation, environment, urban development, food, bio-economy, health, production, digital solutions and energy.

Based on the assessment in chapter 5, it can be concluded that the framework conditions conducive to business investment in R&I are generally very good. Particularly Denmark's position as a country attractive for R&D-related FDI shows that it is also the domestic firms that benefit considerably from the skill base and technological sophistication of the country. Moreover, R&I funding has considerably been streamlined, covering all stages from basic research to innovation.

6. Conclusions

Meeting structural challenges

Despite the excellent performance of the Danish research and innovation system, there are several challenges to be addressed. Structural challenges can only be addressed in the long term which is why they have been rather stable over the past few years. Nevertheless, they have been a constant focus of R&I policy making and several policy actions have been developed to meet the identified structural challenges below.

Table 6: Policy measures addressing structural challenges

Challenges	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
1. Industry-science collaboration and the commercialisation of public research results	<p>Innovation strategy Innovation Fund Denmark Public-private partnerships on innovation and strategic R&D projects Environmental technology development and demonstration programme</p> <p>Strengthening of GTS system Innovation networks InnoBooster Strategic Research Centres Strategic Research Alliances</p> <p>The Danish Foundation for Entrepreneurship – Young Enterprise (FFE-YE) Expansion of the capital base for the innovation incubators Growth Fund</p> <p>Strategy for education and training in entrepreneurship Strategy for strengthening of entrepreneurial universities Entrepreneurial pilots</p>	<p>Cooperation with the GTS-system has developed very well, but collaboration of firms with Danish universities has a potential to be improved. Only a few universities succeed (DTU and Aalborg University). However, some Danish firms prefer to cooperate with foreign universities. The 2014 evaluation concludes that the legal framework for collaboration is appropriate. Barriers relate to university management, lack of economic and other incentives and cultural differences. The new policy measures address this. There is a need for a better entrepreneurial culture and education at Danish universities. A swift accreditation of new entrepreneurship education needs to be prioritised. A new accreditation system that will fulfil this has been proposed by the previous government and an agreement has been reached in parliament.</p>
2. Increase the quality and availability of human resources in R&I	<p>Innovation strategy Study Progress Reform Industrial PhD and Post-Doc programme Doubling of PhD student intake Increasing university enrolment Strategy for life-long learning</p>	<p>Denmark is en route to fulfil its ambitious goals for tertiary education levels and has doubled the number of PhD students. The industrial PhDs and Post-Docs are an effective measure and will over time probably succeed.</p>

<p>3. Support innovation to boost productivity</p>	<p>Innovation strategy R&D collaboration with GTS system InnoBooster administered by Innovation Fund Market Development Fund Growth Fund Tax incentive for business R&D</p>	<p>Decreasing knowledge-intensity in traditional business sectors is not prevented by existing policy measures – focus on high-tech firms and SMEs may be too narrow. Low-tech firms and non R&D-related innovation expenditures should be targeted; Growth Fund is an appropriate measure for supporting on-going business development in sectors of high societal importance; The Innovation Fund has been a significant step forward in terms of providing efficient and effective funding.</p>
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Abbreviations

BERD	Business Expenditures for Research and Development
CERN	European Organisation for Nuclear Research
DASTI	Danish Agency for Science, Technology and Innovation (Styrelsen for Forskning og Innovation)
DCIR	Danish Council for Independent Research (Det Frie Forskningsråd)
DCSR	Danish Council for Strategic Research (Det Strategiske Forskningsråd)
DCTI	Danish Council for Technology and Innovation (Rådet for Teknologi og Innovation)
DEFF	Denmark's Electronic Research Library (Danmarks Elektroniske Fag- og Forskningsbibliotek)
DK	Denmark
DTU	Technical University of Denmark
EDDP	Energy Technology, Development and Demonstration Programme (Energiteknologisk Udviklings- og Demonstrationsprogram)
EPO	European Patent Organisation
ERA	European Research Area
ERA-NET	European Research Area Network
ERP Fund	European Recovery Programme Fund
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
ESS	European Spallation Source
EU	European Union
EU-28	European Union including 28 Member States
FDI	Foreign Direct Investments
FP	European Framework Programme for Research and Technology Development
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDDP	Green Development and Demonstration Programme
GDP	Gross Domestic Product

GERD	Gross Domestic Expenditure on R&D
GTS	Godkendte Teknologiske Serviceinstitutter (Advanced Technology Group)
HERD	Higher Education Expenditure on R&D
HES	Higher education sector
HRST	Human resources for science and technology
IP	Intellectual Property
IPC	International Patent Classification
IPR	Intellectual Property Rights
NRP	National Reform Programme
OECD	Organisation for Economic Co-operation and Development
PRO	Public Research Organisations
R&D	Research and development
R&I	Research and Innovation
STI	Science, technology and innovation
SF	Structural Funds
SME	Small and Medium Sized Enterprise
SPIR	Strategic Platforms for Innovation and Research (Strategiske forsknings- og innovationsplatforme)
TTO	Technology transfer office
VC	Venture Capital

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Annex 1 – List of the main research performers

Table 7: Number of employed researchers (professors, associate professors and assistant professors) at Danish universities and number of publications

Rank	University	Number of researchers				Number of publications
		2010	2011	2012	2013	2014
1	Copenhagen University	2548	2564	2695	2866	7048
2	Aarhus University	2266	2324	2336	2428	5561
3	Danish Technical University	1409	1499	1570	1642	3010
4	University of Southern Denmark	909	944	1019	1146	2825
5	Aalborg University	813	912	1076	1099	3409
6	Copenhagen Business School	435	422	460	506	818
7	Roskilde University	352	348	408	434	646
8	IT University	58	65	63	77	180

Source: Ministry of Higher Education and Science (2015)

Table 8: Top 10 Danish private R&D performers

EU Rank	Company name	Industry	R&D exp. 2014 (€m)	R&D 1-year growth	R&D 3-year growth	R&D intensity %
22	NOVO NORDISK	Pharmaceuticals & Biotechnology	1,728.5	14.0	12.6	14.5
84	DANSKE BANK	Banks	325.8	15.4	-1.5	5.2
86	H LUNDBECK	Pharmaceuticals & Biotechnology	318.2	50.8	-6.6	17.6
118	NOVOZYMES	Pharmaceuticals & Biotechnology	211.9	14.0	5.8	12.6
141	DANFOSS	Industrial Engineering	179.1	-3.8	2.4	3.9
159	VESTAS WIND SYSTEMS	Alternative Energy	159.0	-34.0	-27.5	2.3
165	GRUNDFOS	Industrial Engineering	153.7	-4.4	-2.2	20.8
240	GN STORE NORD	Technology Hardware & Equipment	95.7	16.4	12.4	9.7
255	WILLIAM DEMANT	Health Care Equipment & Services	86.8	2.5	2.7	6.9
264	ARLA FOODS	Food Producers	84.0	26.9	63.1	0.8

Source: EU Industrial R&D Investment Scoreboard (2015)

Annex 2 – List of the main funding programmes

Name of the funding programme	Timeline	Budget (2014)	Target group
Danish National Research Foundation: Centres of Excellence	ongoing	€92m	public research
Danish Council for Independent Research: various instruments	ongoing	€183m	public research
Innovation Fund Denmark: various instruments	ongoing	€217m	public and private research
Danish Energy Agency: EDDP	ongoing	€31m	public and private research
Danish AgriFish Agency: GDDP	ongoing	€26m	public and private research

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