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Chapter:

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

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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.

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".¹

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).² 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).

¹ 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>

² Including agricultural innovation. Denmark has €413m in ESI funds.

Table 1: 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 context³ 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%.

³ 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.

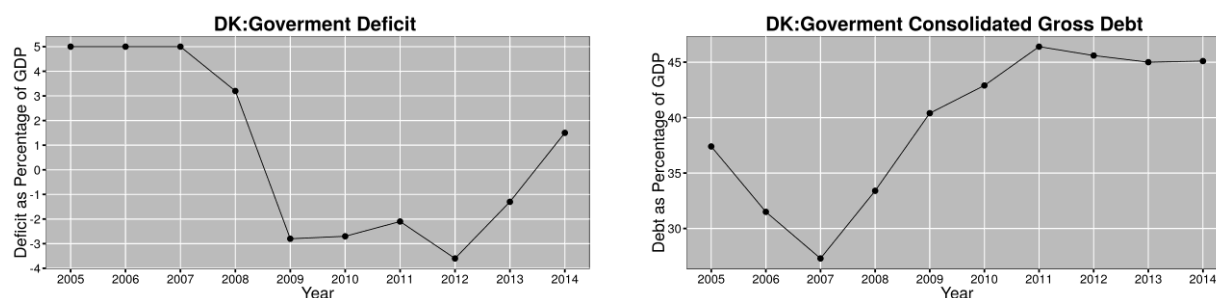


Figure 1: Government deficit and public debt
Data source: Eurostat

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 MEUR⁴). 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 2: 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 activities⁵

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.

⁴ EU funding in 2013 was 156 MEUR.

⁵ 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.

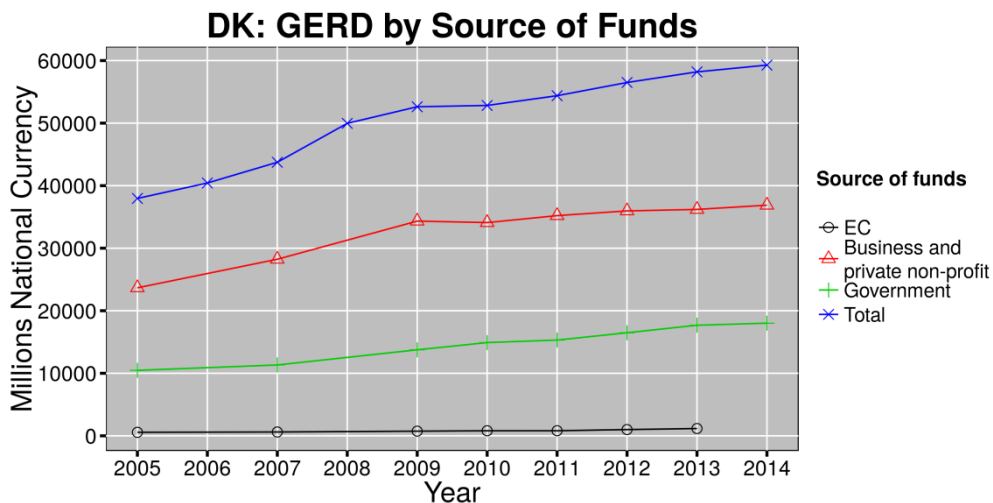


Figure 2: Development of government funding of the total GERD
Data source: Eurostat

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.

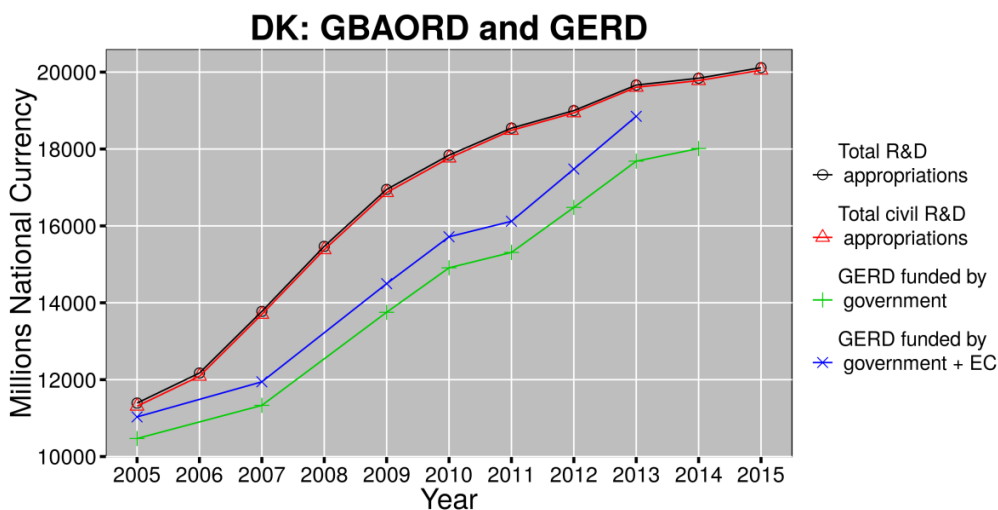


Figure 3: R&D appropriations and government funded GERD in millions of national currency
Data source: Eurostat

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 3: 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:

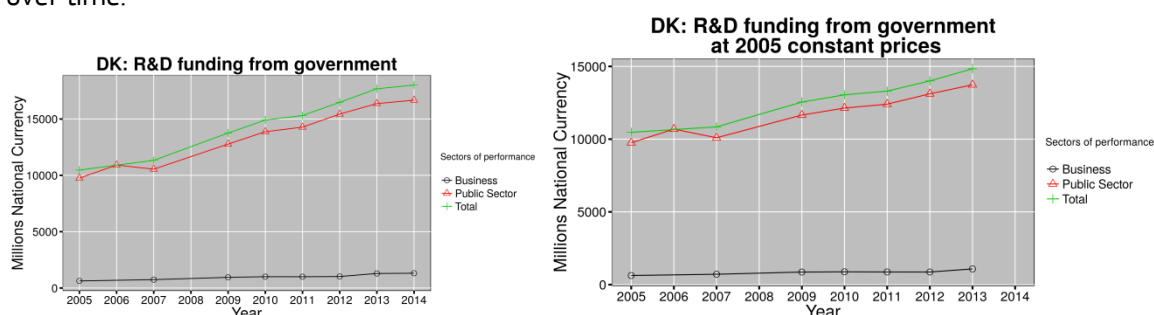


Figure 4: Government intramural expenditure by sectors of performance
Data source: Eurostat

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).

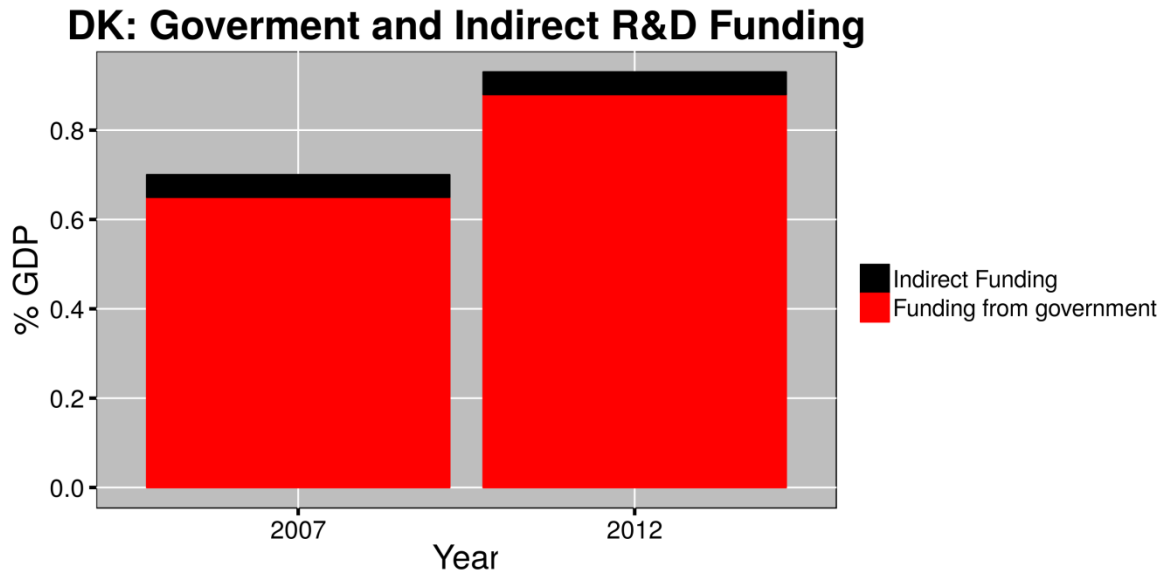
On 29 January 2014, a second amendment to the Danish R&D tax credit scheme was adopted by the Danish Parliament, as a result of which the amendments made in June 2013 now will include the income year 2014. Given that the Danish corporate income tax rate was set at 24.5% for 2014, the maximum refund to 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.⁶

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: 5.9Mio. DKK per year (23,5% of 25Mio. DKK), and as of 2016: 5.5 Mio. DKK (22% of 25Mio. 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.⁷

⁶ Source: <http://www.taxand.com/taxands-take/news/danish-rd-tax-credit>

⁷ 'Measuring R&D Tax Incentives', OECD, 2013

Figure 5: 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)⁸:

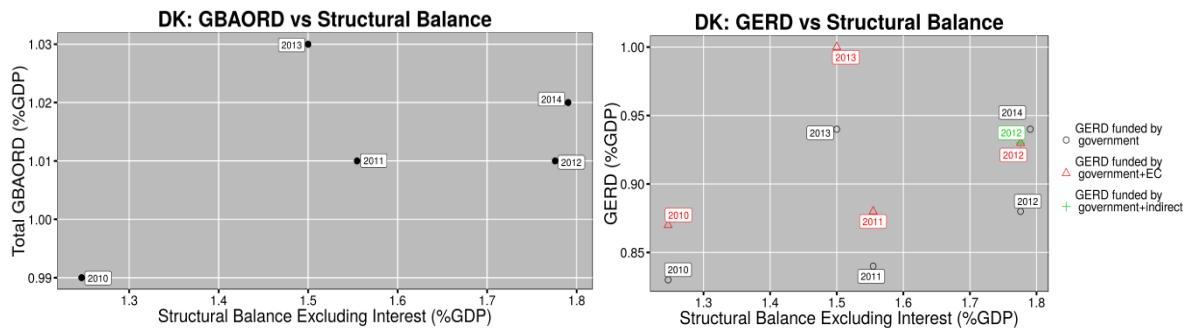


Figure 6: Fiscal consolidation and R&D

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.

⁸ 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 2014.⁹ 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).

⁹ 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.¹⁰

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

¹⁰ 2014, European Commission, DG Internal Market study:

http://ec.europa.eu/internal_market/publicprocurement/docs/modernising_rules/20141105-indicators-2012_en.pdf

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.

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)¹¹.

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 sector¹². 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 Fund¹³ (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 2010–2012.¹⁴ The Market Development Fund provides grants and guarantees to business projects which need support for market maturation. To be eligible for support these

¹¹ <https://www.evm.dk/publikationer/2013/31-10-13-strategi-for-intelligent-offentligt-indkoeb>

¹² See <http://www.nordicinnovation.org/projects/public-procurement-and-innovation-within-the-nordic-health-sector/>

¹³ http://markedsmodningsfonden.dk/in_english

¹⁴ http://ec.europa.eu/enterprise/policies/innovation/files/countryreports/denmark_en.pdf

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.

The main areas of support are:

*Testing and adaptation: before the sales process*¹⁵

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*¹⁶

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.¹⁷ 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

¹⁵ http://markedsmodningsfonden.dk/faster_to_market

¹⁶ http://markedsmodningsfonden.dk/innovative_purchases

¹⁷ See <http://www.investindk.com/Clusters/ICT/The-worlds-best-test-market>

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 2018.¹⁸

Green public procurement: The Danish Environmental Protection Agency set aside about €0.67m¹⁹ to develop and demonstrate how PCP can work in connection with environmental technology. The effects of green public procurement²⁰ 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 Innovation²¹ 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

¹⁸ http://markedsmodningsfonden.dk/in_english

¹⁹ <http://cordis.europa.eu/fp7/ict/pcp/pcp-survey.pdf>

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

²¹ <http://www.oecd->

library.org/docserver/download/9211031ec010.pdf?expires=1397201868&id=id&accname=id24042&checksum=7BEB9FAD2857E7FA9D514813E4A80681

to BERD, with the former having a slightly higher share than the latter (i.e. ca. 0.1-0.15% of GDP).

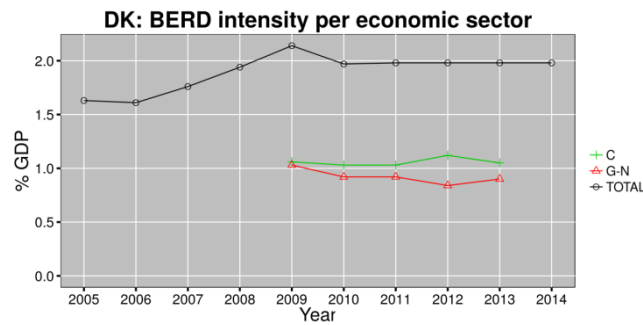


Figure 7: BERD intensity broken down by most important macro sectors (C= manufacture, G_N=services)

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 GDP²². 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%).

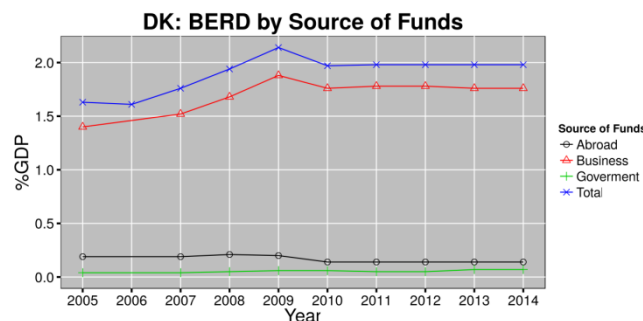


Figure 8: BERD by source of funds

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.

²² 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.

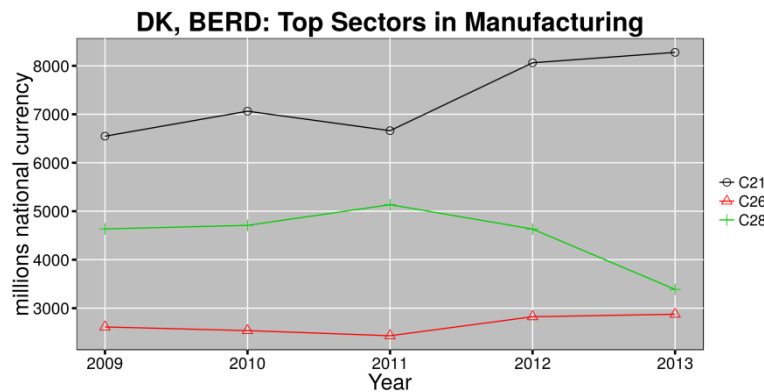


Figure 9: top sectors in manufacturing (C26= computer, electronic and optical products; C28= machinery and equipment; C21=basic pharmaceutical products and pharmaceutical preparations)

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.

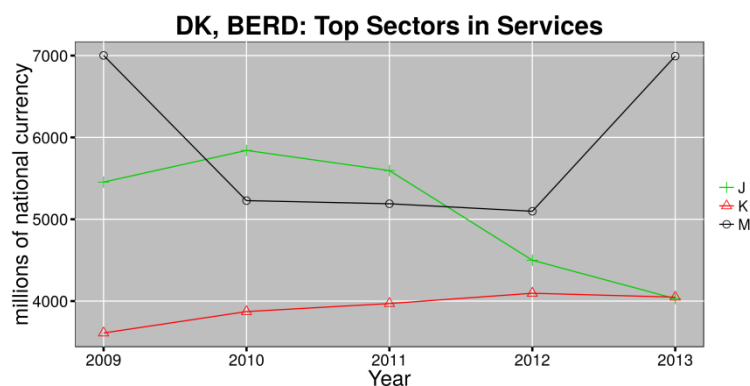


Figure 10: top service sectors (J=information and communication, M=professional, scientific and technical activities, K=Financial and insurance activities)

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.

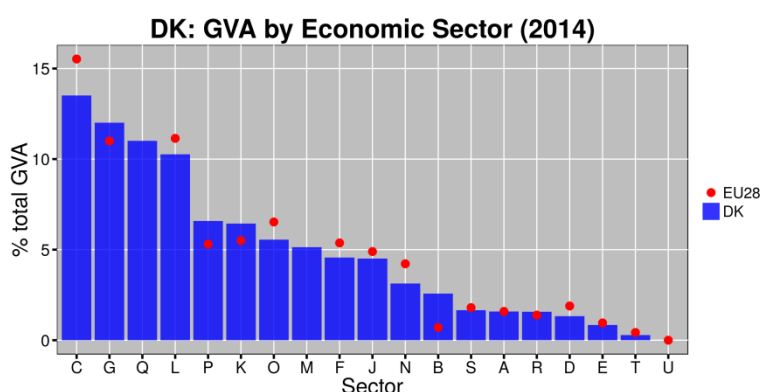


Figure 11: economic sectors as percentage of the total GVA. Top 6 sectors in decreasing order: 1) Wholesale and retail trade; repair of motor vehicles and motorcycles; 2) Human health and social work activities; 3) Manufacture; 4) Real estate activities; 5) Financial and insurance activities; 6) Public 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.

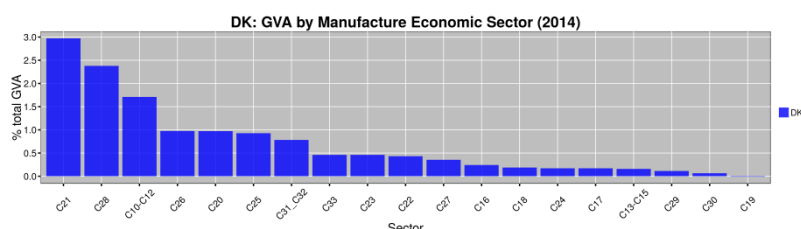


Figure 12: GVA in manufacturing. Top 6 manufacturing sectors: 1) machinery and equipment; 2) basic pharmaceutical products and pharmaceutical preparations; 3) food products; beverages and tobacco products; 4) chemicals and chemical products; 5) computer, electronic and optical products; 6) electrical 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.

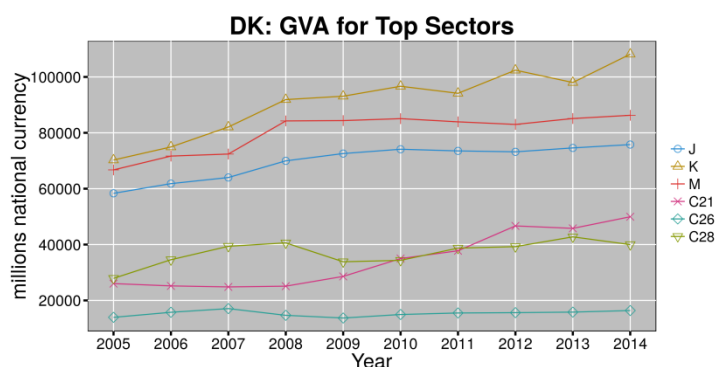


Figure 13: Value added for the leading sectors

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.

