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Research and Innovation Observatory Country Report 2016 Denmark

The 2016 series of the RIO Country Report analyses and assesses the development and performance of the national research and innovation system of the EU-28 Member States and related policies.

It aims at monitoring and evaluating the EU policy implementation as well as facilitating policy learning in the Member States.

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Foreword

This report offers an analysis of the R&I system in Denmark for 2016, including relevant policies and funding, with a particular focus on topics of critical importance for EU policies. The report identifies the main challenges of the Danish research and innovation system and assesses the policy responses implemented. It was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports and online publications. The quantitative data are, 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 January 2017. The analysis does not take into account the full set of CIS 2014 data that was released mid-January 2017. The factsheet in the annex include however the most recent data including one indicator from the last wave of the Community Innovation Survey.

The report contents are partly based on the RIO Country Report 2015 (Grimpe and Mitchell, 2016).

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HIGHLIGHTS

- Denmark's macro-economic situation is stable and has recovered since the economic and financial crisis, but growth rates have been modest at 1.6% and 1.1%, in 2015 and 2016.
- Productivity growth has been weak for the last decade. Achieving stronger productivity growth would be important for addressing the macroeconomic challenges related to slow growth, increasing costs from an ageing population and preserving a generous social welfare system.
- Danish R&D intensity is about 3% of GDP and Denmark is an innovation leader in the EU, but there is still a potential to increase the innovation performance in particular of SMEs.
- Budgets for publicly funded R&D will be cut by 2% each of the next four years. However, public R&D is still projected to be close to 1%.

MAIN R&I POLICY CHALLENGES

- **Coping with structural changes to the R&I system and reinforcing the links between actors towards enhanced commercialization of public research**

Despite the good performance of the R&I system, there continues to be a potential for improving the innovation performance by strengthening the interactions in the system.
- **Support innovation and commercialization capabilities among SMEs to boost productivity**

There is scope for further support to improve innovation management and execution capabilities in the business sector, in particular amongst SMEs.
- **Increase the quality and availability of human resources**

With the recovery from the economic and financial crisis, shortages of skilled labour have begun to emerge in several industries as well as outside the larger cities.
- **Invest in R&I infrastructure.**

Research and innovation can support an increase in productivity when new technologies are taken-up by the public and private sector, and when human resources are well allocated across over-average performing economic sectors. Denmark has had a weak development of private investment in the aftermath of the economic and financial crisis. There is scope for investments in R&I infrastructure.

MAIN R&I POLICY DEVELOPMENTS IN 2016

- Cuts in budgets for public research
- Industrial Ph.D. and Post-Doc programmes reinforced
- Targeted sectoral strategies
- Cluster and network strategy 2016-2018
- Review of the business support system

1. Main R&I policy developments in 2016

Cuts in budgets for public research	The public resources for public research were reduced by 2% in 2016 and will be cut also by 2% in each of the following three years. Public R&D intensity is projected to remain close to 1% of GDP, but the cuts will make it more complex for actors to improve the performance of the R&I system. Private foundations have contributed significant amounts to the public research.
Industrial Ph.D. and Post-Doc programmes	The Industrial PhD and Post-Doc programs have been reinforced.
Targeted sectoral strategies	The Government has launched a number of targeted strategies: a National Strategy for Space, for Development and Use of Drones, and for Arctic Research, Education and Innovation.
Cluster and network strategy 2016-2018	The Danish cluster and network initiative has launched an updated cluster and network strategy for the period 2016-2018, which aims at supporting Danish strong areas, new growth areas, and renewal in existing industries.
Review of the business support system	The Government has completed a review of the Danish business support system to map and evaluate the system with respect to identifying possible challenges in the effort and to possibly target the support better ¹ .

1.1 Focus on National and Regional Smart Specialisation Strategies

Description and timing: Denmark has a series of strategies, which jointly define the Danish smart specialization actions ("S3"). These strategies are notably 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, which consist of representatives from business, regions, municipalities, education and knowledge institutions and labor market organizations. Furthermore, the smart specialization strategy includes the National Innovation Strategy and National Cluster Strategy. The Danish Growth Council coordinates and promotes cooperation and development between the national growth strategy and the regional growth and development strategies.

New developments: The government has launched in 2015 a strategy: "Growth and development in the whole of Denmark", which aims at reducing regional inequalities. 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, re-allocation of state jobs from Copenhagen, and unrealized potentials in the area of tourism.

¹ It should be noted that recently a new Government has taken office (November 28th). This means that the previous Government's so-called 2025-plan, which had a number of R&I-relevant policy proposals, is currently being re-considered. One consequence is the setting up of a new ministry for Public Innovation and Modernization aimed at enhancing the efficiency, digitalization and renewal of the public sector. Another new initiative is the establishment of panels of experts and stakeholders to advise the Government on policies such as entrepreneurship and digitalization.

Implementation issues: Denmark has identified the following S3 smart specialization Priorities: The maritime sector, 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 Regional Growth Fora will seek to ensure coordination and synergy between the Danish Government's growth strategy and the specific regional key strengths. The aim is to convert the government's growth plans in selected business areas into specific actions under consideration of the strengths existing within the regions.

2. Economic Context

Denmark's macro-economic situation is stable and has improved since the financial crisis. Growth rates have been modest at 1.6% and 1.1%, respectively in 2015 and 2016. The European Commission forecasts a real GDP growth of 1.5% in 2017 and 1.8% in 2018 driven mainly by private consumption, but with an increasing contribution from private investments. Although the budget deficit and the unemployment rate have decreased, the government deficit and consolidated debt are still much higher than before 2009, but with some sign of improvements. Despite very low interest rates there have been moderate investments and a weak private consumption, but recent consumer confidence surveys and investment figures indicate improvements. Inflation rates remain low despite rapidly increasing housing prices, especially in the large cities. In the medium to long term, a main concern is the continued weak productivity development of the Danish economy.

The weak productivity growth was noted as a major challenge in the 2014 and 2015 RIO reports and remains a challenge this year. Productivity can increase as a consequence of several things, one being increased private investments, although the level of investments in Denmark has been relatively low following the economic and financial crisis.

The financing of a high and sustained level of welfare in Denmark in combination with an ageing population and the need for better integration of migrants and refugees in the labour market constitute important societal and economic challenges for Denmark.

2.1 Structure of the economy

The Danish industry is well represented in what is usually classified as low-technology industries (e.g. food, furniture, textiles, and agricultural products) and low-medium technology industries. However, these industries are highly competitive as they are often extensively technology-based and automatized.

The manufacture of pharmaceuticals and medical chemicals as well as software consultancy and supply are the largest sectors in terms of research. The shares of employment in high-/medium-tech manufacturing and knowledge-intensive services sectors have remained rather stable around 4% and 47%, respectively, in the 2010-2014 period. Although Denmark is below the EU average for high-tech manufacturing, employment is significantly above the average share of knowledge-intensive services in the EU.

SMEs play an important role in Denmark with a slightly higher contribution to the economy in terms of value added than the EU average. The share of micro-firms in the firm population has been stable at around 84% in the 2010-2014-period. The number of people employed in SMEs is roughly at the EU average in 2015, at 65% compared to EU average at 67% (SBA Fact Sheet: Denmark, 2016). Firms above 100 employees make up 1.4% (2014).

2.2 Business environment

Overall, Denmark has a favourable environment for doing business. In its "Doing Business" analysis, the World Bank ranked Denmark as the third best country in the world in the last two consecutive years (2014 and 2015), which is an improvement from the 5th rank in 2013 (World Bank, 2015). The favourable business environment applies to administrative procedures and regulation, access to finance and other resources such as technological knowledge, and digital infrastructure and services. According to the European Innovation Scoreboard, performance relative to the EU has increased from 26% above the EU average in 2008 to 34% in 2015. Denmark is accordingly classified as an Innovation Leader at European level and ranked second on the Scoreboard.

2.3 Supply of human resources

The recovery after the crisis combined with an ageing labour force support the indication of an emerging under-supply of certain types of skills in the labour market (The Danish Economic Councils, 2016). For highly skilled people with a tertiary education the employment situation has generally been good. Despite the challenge of securing an adequate labour force in the long run, there is also a positive development in some key indicators of the supply of human resources. The share of new doctorate graduates per 1000 of the young population is above the EU average and has increased since 2010 as has the new graduates in STEM per 1000 population. According to Eurostat (2014), Denmark is ranked 2nd in Europe only after Finland on the number of researchers per 1000 population.

3. Main R&I actors

The eight universities are the main performers of public R&D. Other important public research performers are several of the Danish hospitals. Since 2014, the nine university colleges of higher education have been obligated to perform research activities, nevertheless these are still in their early phases.

The Danish government is also co-financing eight private, certified Advanced Technology Group's - ATG's (research and technology organizations). Their primary objective is to stimulate primarily SMEs to become more competitive and innovative.

Significant investments in research and innovation are made by private foundations in Denmark. The 12 largest foundations have spent around DKK 9.7bn (approximately €1.3bn) on research, development, and higher education in 2012-2014. The main share of these funds goes to the Danish universities.

The private sector performs about two thirds of all R&D in Denmark, and many firms are highly R&I intensive. According to Statistics Denmark, 44% of all companies in Denmark had innovation activities in 2015. 30% were engaged in product or process innovation, 27.5% in organizational innovation, and 28% in marketing innovation.

Networks and linkages for innovation are important gateways to access and transfer knowledge. In 2012, 41.4% of firms collaborated on innovation, but indications are that there is still room for improved collaboration between firms, in particular for SMEs. Importantly, relatively few companies collaborate with knowledge institutions like universities (14.9% in 2012) and with public organizations including research and technology organizations (11.1 % in 2012). Especially, the low collaborative pattern with research and technology organizations is striking as there has been a substantial focus on such collaborative ventures for more than a decade.

To stimulate more collaboration between R&I actors, the Danish government has since 2007 supported more than 20 nation-wide innovation networks. These networks are designed to facilitate interaction between universities, RTO's and firms and are typically

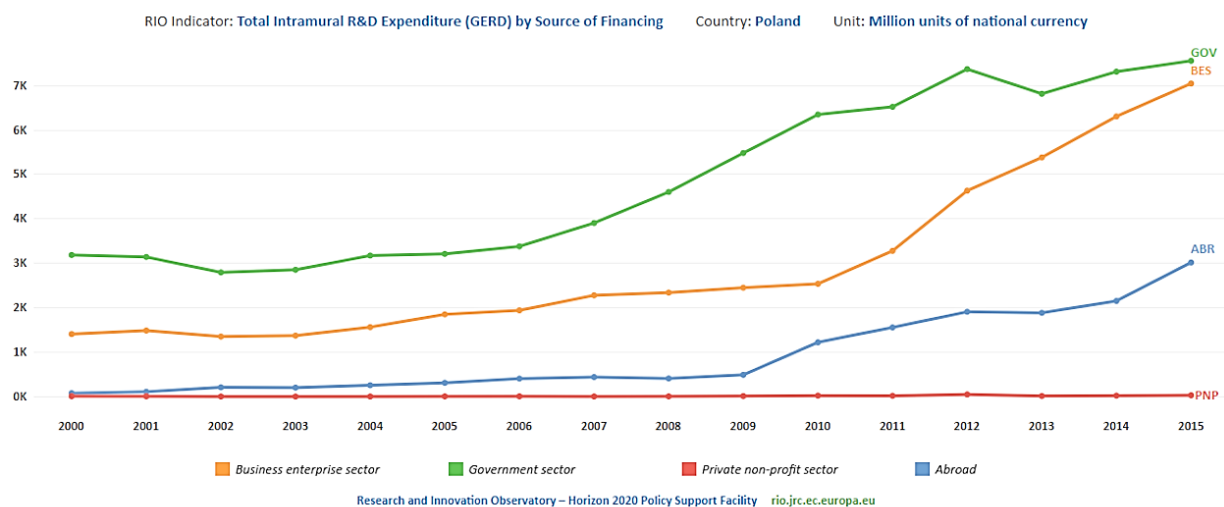
defined e.g. focusing on transport, production, energy including offshore technologies, food or service innovation. A new application round was completed in the spring of 2014 for a new four-year period (2014-2018) with a total funding of €39m supporting 22 networks. A report from the Ministry of Higher Education and Science showed that after a period of increases from 2010-2014 in the number of firms that engaged in collaborative projects as well as the companies that engaged in collaborative projects, for the first time a decrease is noted from 2014 to 2015 ("Performanceregnskab 2016"). Even though the number of companies becoming innovative based on participation in the innovation networks increased over the period from 2007 to 2015, the networks had the best performance in the years from 2011 to 2014.

In sum, the Danish research & innovation (R&I) system has undergone upgrading in all respects and, as indicated by bibliometric statistics, the quality of scientific outputs in Denmark is among the top. Nevertheless, there is still potential for improvement on the innovation output side, particularly concerning the innovation performance of SMEs, as well as the level and availability of human resources for R&I, notably in the private sector.

4. R&I trends

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. Public research accounts for about one third and is mainly performed by the university system.

Figure 1 Development of GERD by source of funds.



4.1 Public allocation of R&D and R&D expenditure

The share of R&D performed by the higher education sector (HES) has increased in total (as % of GDP) and by funding source whether from government, the business sector, or private non-profit organizations. However, the flows from business to higher education for R&D purposes remain at a low level, despite a significant policy focus on increasing collaboration between business and universities. Private non-profit organizations account for a significantly larger proportion of the funding of R&D performed by HES compared to the investments from business. According to a recent mapping of the private funding 12 private non-profit foundations contribute around €1.3bn for research, innovation and higher education in a three-year period, 2012-2014. These funds are mainly invested in

the eight universities. Three foundations invest more than a third of their funds directly on innovation (approximately €52m) including "Industriens Fond" (The Danish Industry Foundation), which funds initiatives strengthening the competitiveness of Danish industry. The foundation funds projects based on open and thematic calls of about €15m per year. The two other foundations are Realdania and Novo Nordisk Fonden. Public funds, including the Innovation Fund Denmark, contribute around €0.3bn to innovation. These funds support the innovation networks, the ATG-institutes and the InnoBooster scheme among others.

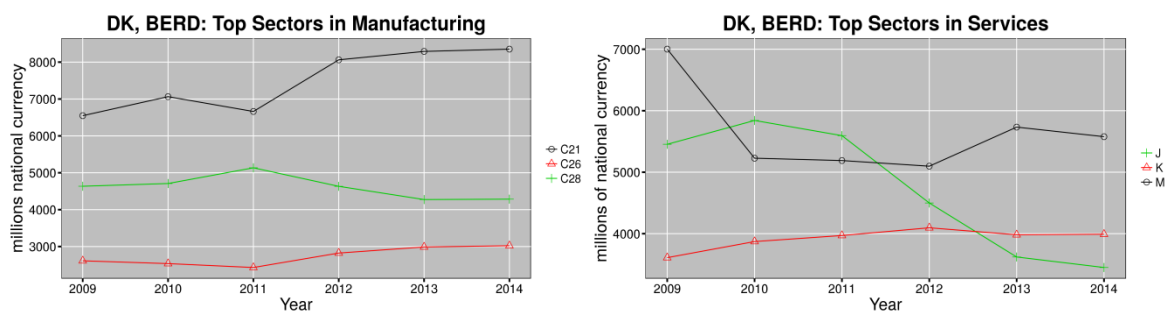
An increase in investments funded by the government in R&D in absolute terms as well as a percentage of GDP can be observed from 2010 to 2015 to about 1 % of GDP in 2015. This is well above the EU average level of 0.67% of GDP (2014). The Danish government, which came into office in June 2015, reduced the public budget allocated to research in 2016 corresponding to savings of approximately €187m. The new public expenditure level is projected still to be close to 1 % of GDP in 2016. However, this reduction may weaken Denmark's scientific and innovation capacity in the long run, in particular if the cuts result in reductions or elimination of core scientific instruments or innovation specific programs.

Public funding of R&I is also provided through international programmes. The Danish share of total EU contribution from the EU framework programmes has been stable at 2.37% from FP6 and 2.36% from FP7. However, in absolute terms, there was an increase in EU contribution to Denmark of almost 168% from €396.1m in FP6 to €1,060.6m in FP7. One year into Horizon 2020, the Danish share of total EU contribution was €152.4m, corresponding to 2.30% as of March 2015.

4.2 Private R&D expenditure

Business enterprise R&D expenditure (BERD) has been constant at 1.98% of GDP since 2011. BERD contributes about two thirds to overall GERD. The investments in R&D by the business sector are important drivers of innovative performance, and especially relevant for realizing a higher innovative performance of SMEs. The government funding of private business R&D has been slightly increasing, whereas the business sector's own funding has been slightly decreasing.

Figure 2 Top R&D sectors in manufacturing and services



Top R&D sectors: manufacturing (C21: manufacture of basic pharmaceutical products and pharmaceutical preparations; C27=manufacture of electrical equipment; C29=manufacture of motor vehicles, trailers and semi-trailers). Top sectors: service (G=wholesale and retail trade, repair of motor vehicles and motorcycles, J=information and communication, M=professional, scientific and technical activities).

Patents constitute an indicator of R&D output performance. Due to its small size, Denmark obtained only a very small fraction of World patents (0.6 in 2014), which is a decrease since 2010, where the level was at 0.71. If patent applications are normalized by billion GDP, the share is still decreasing from 2010 to 2015 from 7.15 to 6.24.

However, this level is still well above the EU average of 3.53. Similarly, Denmark has fared very well in scientific output if measured by bibliometric indicators.

Danish companies have a strong commitment to the internet of things (IoT). Combined with the strong infrastructure to support the adoption of IoT, Danish companies seem to be in an advantageous position compared to international counterparts. A recent study by Deloitte (2016) showed that 60% of the Danish companies have ongoing IoT activities. The Danish MADE initiative is a strategic research and innovation platform for Future Production. Since 2014, the platform has been engaged in a broad spectrum of activities from research to knowledge sharing across actors involving universities, ATG-institutes and firms.

4.3 Public sector innovation and civil society engagement

The public sector in Denmark is advanced, digitalised and well-functioning. The Danish objectives are to promote good governance, strengthen democracy and the use of digital technology. Denmark is especially developed within e-Governance and most citizens communicate with the public sector electronically. In the health sector, Denmark has embarked on a major investment programme that will amongst other things result in six completely new hospitals being ready for use in 2020 and thereafter. The aim is to have a more efficient health sector with improved hospital services. Denmark scores very well on indicators for reduction of administrative burdens and a responsive public sector in EU and World Bank comparisons. Public sector innovation in Denmark is amongst the best in Europe with successful initiatives such as MindLab, a cross-governmental innovation unit involving citizens and businesses in creating new solutions for society. The new Government which took office on the 28 November will concentrate these efforts in a separate new Ministry for Public Innovation and Modernization.

Civil society initiatives are very important in Denmark. Many civil society initiatives are not directly related to innovation, but they are often supporting local entrepreneurship and renewal – e.g. through the Local Action Groups (LAGs), which are co-financed by the EU.

The Danish Board of Technology Foundation is an important example of how to involve civil society. It is a non-profit foundation devoted to public matters that require knowledge of technology, values and widespread action in society. The Danish Board of Technology Foundation involves citizens and provides counsel to decision makers about the possibilities and consequences for citizens, the environment and society of initiatives and projects. Civil society engagement in research also takes place through 'Forskningens Døgn' (The Day of Research) where about 600 events related to research takes place all over Denmark. The overall purpose is to establish meeting places between researchers and civil society, to stimulate discussions on how research contributes to solving societal challenges, create relationships between citizens and researchers, and to provide an opportunity for citizens to contribute to research.

5. Innovation challenges

Denmark fares well in terms of science performance, but the recent Government budget cuts will make it necessary to set priorities in an effective way with a long term perspective to avoid a long term declines in scientific and innovation performance. Nevertheless, the public expenditures will still be close to the target of 1% of GDP. The main potential and the main challenges for improving the Danish innovation performance are to increase especially the innovativeness of SMEs, increasing the quality and availability of human resources, and linked to these two challenges strengthening productivity through innovation.

5.1 Challenge 1 Managing structural changes to the R&I system and reinforcing the links between actors towards enhanced commercialization of public research

Description

This challenge is related to problems at two different levels of aggregation: the overall connectivity of key actors in the innovation system and the micro-level commercialization capabilities of the firms. The former has been a policy focus for years, but recent budget cuts may make it more complex for actors to improve the linkages within the Danish R&I system. As the research system by nature is characterised by considerable inertia and long-term planning, short sighted changes may contribute to a de-coupling of links between actors and increased competition for scarce resources instead of collaboration and improved synergies for increased innovation performance of the research and innovation system. On a micro-level of aggregation, a challenge in Danish SME's is to improve their innovation capabilities by benefitting from the strong science system to improve their own innovation output.

Policy response

Several policies have for decades sought to enhance collaboration between actors in the system especially focusing on innovation output by commercializing public research. Currently, this includes the Innovation Fund's InnoBooster program for SMEs, which seeks to facilitate interaction between public science, innovation partnerships for SMEs, and support for large demonstration facilities. Also the Market Development Fund, which helps enterprises bring their new products to the market faster, promotes growth, employment and export, particularly for small and medium-sized enterprises. The fund has three primary focus areas: co-funding for private enterprises' innovative solutions, market development through innovative public procurement and market development through industry partnerships. A strengthening of the RTO system (including the private "GTS – Advanced Technology Group Institutes") has also been prioritised and the ATGs has now entered performance contracts with the Ministry. Although at a relative small scale, the ministry invites applications for additional funds that are simultaneously aimed at supporting new policy initiatives like drones, space and circular resource economy and enhancing links between relevant actors. The Danish universities are currently reconfiguring their technology transfer offices aiming to improve their commercialization capabilities from a traditional linear approach towards a more collaborative and interactive model. Moreover, physical 'Innovation Hubs' are being built to provide shared facilities for researchers and businesses. Collaboration with industry and the broader society is also part of the mandatory parameters in performance contracts between the Ministry of Higher Education and Science and the universities. Funding of such activities is also the focus of private foundations².

At the regional level, the six regional growth fora have to a large extent focused on innovation in the private sector. Examples are strengthened collaboration between research institutions and SMEs and counselling focusing on growth plans in SMEs. The regional growth fora spent approximately DKK 800m (approximately €107m) on regional growth measures in 2016.

Finally, the review of the Danish business support system completed in November 2016 may further lead to changes in the use of the dedicated funds for commercialization and innovation output at the SME's, but initiatives are have not been developed, yet.

² This is for instance illustrated by AP Møller Fonden contributing €15m (50%) to a new, 6-stories high building intended to host an Innovation Hub for university-industry collaboration at Aalborg University. The Technical University of Denmark and Aarhus University are also engaged in such activities.

Policy Assessment

The independent Productivity Commission ('Produktivitetskommission'), which published its report in 2014, recommended improving linkages between actors in the R&I-system as well as strengthening the capabilities for commercialization of public research. Despite continued efforts over the last decades with some notable progress, there is still a potential for improvement of the links between the actors in the R&I system. Even stronger is the need to improve the conversion of the strong science performance into innovation output of SMEs. The Productivity Commission's attention towards larger societal partnerships including public actors as co-creators and public-private innovation efforts is new and notable. One such example is the Danish MADE initiative for production and Internet of Things aiming to improve the performance of the manufacturing sector. The audit of the Danish network and cluster initiatives showed that especially the small firms with less than 50 employees benefit from participation in the networks in terms of improving their innovative capabilities to increase their innovation output ("Performanceregnskab 2015"). The recent launch of mission-specific strategies may prove to be a viable path for enhanced R&I performance in dedicated areas.

Nevertheless, the recent cut in budgets for public research involves a risk for a set-back with negative long term consequences, also for productivity, unless priorities are set in an effective way with a view to the long-run consequences.

5.2 Challenge 2: Increase the quality and availability of human resources

Description

The Danish economy has recovered from the economic and financial crisis, and in several industries and geographical regions, there is now a lack of skilled labour, which forces firms to take in labour with less than adequate skills. Labour market issues and notably ensuring an adequate supply of skilled and highly skilled labour is a challenge for boosting the Danish innovation performance and for addressing the productivity challenge.

Furthermore, while the development in the general economic situation in Denmark remains positive with an increasing GDP per capita, the overall figures hide marked and increasing differences, not only between people in or out of the labour market, but also between geographical regions. The increasing regional inequalities are accentuated for companies outside the larger cities having problems with attracting sufficient skilled labour.

Policy response

Denmark's National Innovation Strategy has in the past included a range of initiatives to strengthen the innovation capacity through education. The political objective was that at least 25% of youth cohorts should complete a master's degree by 2020. This target has been reached, which has led the previous government to down-scale certain educational programmes at the universities. Denmark has also strengthened the Industrial PhD and Post-Doc programmes, and efforts are made to increase the supply of skilled labour including upgrading the existing work force, and the plans are to increase innovation-related and entrepreneurial skills in courses and programmes throughout the education system. The objective is to achieve a better match between the supply and demand on the labour market. The supply and quality of labour has also been stimulated through a number of labour market reforms and tax policies focusing on increasing the work incentives. It is, however, debatable to what extent the supply of labour is responsive to the improved incentives.

As a response to the challenges associated with regional inequalities, the Government launched in 2015 a strategy "Growth and development in the whole of Denmark", which

focused on competitive advantages and framework conditions for regional areas outside of the two largest cities. As part of this strategy, the government decided to move 3900 government jobs from Copenhagen to other regions in the coming four years towards 2018. A status in October 2016 showed that 1126 jobs had already been moved. The new Government announced on 28 November that a second wave of this initiative will be planned for 2018 onwards. These initiatives are focused on reducing the regional inequalities in job opportunities and stimulating the economy in the regions through the indirect effects from these jobs. Another 2016 policy initiative along these lines is the introduction of a 2-year subsidy to firms in rural areas who employ high-skilled people for innovation projects.

Policy Assessment

The skills challenge cannot be resolved within a short time period. In itself, the skills challenge is not only a matter of increasing the labour supply, but also of upgrading the existing labour supply in view of future demands for skills. In particular, several analyses (e.g. FremKom III, 2016; OECD, 2016) suggest that the future requirements of the skills profile of workers will change towards more 'soft' competences including for instance collaborative capabilities to function in increasingly networked work environments.

The skills challenge relates to both the education system and the labour market. It is accentuated by the need to improve labour market inclusion and improving the employability of disadvantaged groups. The job-integration measures agreed in the 2016 tripartite negotiations (August 2016) aimed at improving the integration of newly arrived refugees and migrants, as well as providing incentives for companies to create 10 000 new apprentice places. Ideally, an improved labour market inclusion would provide part of a response to the skills challenge.

The shortage of skilled labour is particularly felt in the outermost regions, where companies experience problems hiring the appropriately skilled labour they need. The new strategy to promote growth and development in the whole country is an attempt to alleviate the problem. There are in addition targeted labour market and tax measures in place to encourage mobility, but so far the problem of increasing regional inequalities remains.

5.3 Challenge 3 Support innovation to boost productivity

Description

Research and innovation can result in increased productivity, when new technologies are taken-up by the public and private sector, and when human resources are allocated well across performing economic sectors. Infrastructure investments can also support labour productivity improvements.

Many advanced economies including Denmark have seen a weak development in private investment in the aftermath of the economic and financial crisis. Denmark was thus only ranked 23th in productivity growth in the period 2004-2014. Likewise, the level of investment in non-R&D expenditures has followed OECD trends up until the financial crisis, but decreased significantly below OECD average after 2010 (Report on Growth and Competitiveness, 2016). There is significant scope for R&I and infrastructure investments to support improvement in the business sector in particular amongst SMEs, and this could provide a significant contribution to a stronger productivity development.

Policy response

The Productivity Commission made a comprehensive review of all sectors of the Danish economy. Its proposals aim at improving productivity both in exporting companies, in domestic business, and in the public sector. Concerning innovation, the Productivity Commission in particular recommended improving the quality of training to boost the

impact of public research and enhancing university-industry collaborations on R&D. It proposed also to give impact evaluations of R&D programmes a higher priority.

In addition to reinforcing the links between R&I actors (challenge 1) and the need to increase the quality and availability of human resources (challenge 2), Denmark has improved the funding possibilities for R&I. This is in line with the support provided by the Danish Growth Fund for on-going business development in sectors of high societal importance. Furthermore, 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 areas: Blue Denmark; Creative Industries and Design; Water, Bio and Environmental Solutions; Health and Care solutions; Energy and Climate; Food Sector; Tourism and Experience Economy, ICT and Digital Growth. The plans address specific barriers to investment and focus on areas in which new markets can be developed.

Policy Assessment

The policy response to the productivity challenge addresses relevant shortcomings in the innovation system and will expectedly contribute to a stronger productivity development. Importantly, the measures to improve funding and creating new markets complements the measures addressing the skills challenge and improving interactions between R&I actors. Still, there is room to further enhance innovation policies.

6. Focus on creating and stimulating markets

This section aims at describing and assessing national level efforts to introduce demand-side innovation policies to stimulate the uptake of innovation or act on their diffusion, including public procurement and regulations supporting innovation. It also analyses policy measures aimed at internationalisation of companies with the aim of increasing the innovativeness of the economy.

Denmark's current Innovation Strategy (2012-2020) aims to support a shift towards demand-driven innovation policy, enhancing knowledge flows, improving education, and linking the public and private innovation efforts. Demand as a driver of innovation is not only seen as a means for addressing grand societal challenges, but also as a way to make policy initiatives such as InnoBooster and smart specialization, which are more bottom-up than is often seen for innovation policy initiatives, work better.

Public procurement is a classic instrument for stimulating demand. Every year the Danish public sector spends approximately €40bn on goods and services provided by private companies. This corresponds to 15% of the Danish GDP. The local municipalities are the largest public purchasers in Denmark. Increased consideration for innovative public procurement can be noted in recent years. Several initiatives aim at using public procurement as a means of stimulating innovation ("Strategy for Intelligent Procurement", 2013) including the Market Development Fund that works to promote methods of innovative public demand.

A key element in stimulating new markets is a timely shaping of regulations. As mentioned in challenge 3 on productivity, the previous Government commissioned eight growth teams with members from industry in areas, where Danish businesses are or can be internationally competitive. 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).

Another example is the potential for innovation and market creation by relaxing the legislation to allow for Unmanned Aerial Systems (UAS or drones) to fly beyond visual line of sight (BVLOS). New legislation focusing on licenses to fly drones was adopted in September 2016, but special permits to fly BVLOS are still required.

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List of abbreviations

BERD	Business Expenditures on Research and Development
BVLOS	Beyond Visual Line of Sight (regulation for flying drones)
CEE	Central and Eastern Europe
CIS	Community Innovation Survey
CSR	Country Specific Recommendations
DESI	Digital Economy and Society Index
EC	European Commission
ERA	European Research Area
ERC	European Research Council
ESIF	European Structural and Investment Funds
EU	European Union
EU-15	The 15 Member States of the European Union from 1995 until 30.4.2004 (BE, DK, DE, EL, ES, FR, IE, IT, LU, NL, AT, PT, FI, SE, UK)
EU-28	The European Union of the current 28 Member States
FDI	Foreign Direct Investment
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditures on R&D
GOV	Government
GVA	Gross Value Added
GVC	Global Value Chain
HES	Higher Education Sector
PCP	Pre-commercial Procurement
PCT	Patent Co-operation Treaty
PPI	Public Procurement for Innovation
PRO	Public Research Organisation
R&D	Research and development
R&I	Research and innovation
S3	Smart Specialisation Strategies
SME	Small and Medium-sized Enterprise
TFP	Total Factor Productivity

Factsheet

	2009	2010	2011	2012	2013	2014	2015	2016
GDP per capita (euro per capita)	41900	43800	44500	45500	46100	47000	47800	48400
Value added of services as share of the total value added (% of total)	57.24	56.29	55.6	55.24	55.16	55.29	55.72	
Value added of manufacturing as share of the total value added (%)	12.88	12.67	12.8	13.24	13.62	13.57	14.63	
Employment in manufacturing as share of total employment (%)	11.11	10.37	10.37	10.23	10.05	10.02	10.04	
Employment in services as share of total employment (%)	54.13	55.31	54.86	54.9	55.21	55.15	54.97	
Share of Foreign controlled enterprises in the total nb of enterprises (%)	1.6	1.63	1.75	1.71	1.79			
Labour productivity (Index, 2010=100)	96.2	100	100.3	102.3	103.1	104.6	105.1	
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	1.14	1.41	1.52	1.47	2.04	2.25		
Summary Innovation Index (rank)	6	5	3	3	3	3	3	
Innovative enterprises as a share of total number of enterprises (CIS data) (%)				51.1		49.5		
Innovation output indicator (Rank, Intra-EU Comparison)			5	5	5	5		
Turnover from innovation as % of total turnover (Eurostat)		15		13.9				
Country position in Doing Business (Ease of doing business index WB)(1=most business-friendly regulations)						3	3	3
Ease of getting credit (WB GII) (Rank)						22	27	
Venture capital investment as % of GDP (seed, start-up and later stage)	0.051	0.059	0.067	0.07	0.078	0.075	0.109	
EC Digital Economy & Society Index (DESI) (Rank)						1	2	1
E-Government Development Index Rank		7				16		9
Online availability of public services – Percentage of individuals having interactions with public authorities via Internet (last 12 months)	73	78	81	83	85	84	88	88
GERD (as % of GDP)	3.07	2.94	2.97	3	3.01	3.02	3.03	
GBAORD (as % of GDP)	0.99	0.99	1.01	1.01	1.03	1.02	1.03	0.97
R&D funded by GOV (% of GDP)	0.8	0.83	0.84	0.88	0.9		0.95	
BERD (% of GDP)	2.14	1.97	1.98	1.97	1.91	1.87	1.87	
Research excellence composite indicator (Rank)				2				
Percentage of scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country		13.92	13.52	13.59	13.28			
Public-private co-publications per million population	123.2	156.47	161.67	143.89	142.08	143.48		
World Share of PCT applications	0.84	0.71	0.64	0.65	0.58	0.6		

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