RIO Country Report 2017

The R&I Observatory country report 2017 provides a brief analysis of the R&I system covering the economic context, main actors, funding trends & human resources, policies to address R&I challenges, and R&I in national and regional smart specialisation strategies. Data is from Eurostat, unless otherwise referenced and is correct as at January 2018. Data used from other international sources is also correct to that date. The report provides a state-of-play and analysis of the national level R&I system and its challenges, to support the European Semester.
Summary

Challenges for R&I policy-making in Germany

Digital economy and society: Germany ranks only in an intermediate position with regard to exploiting opportunities from digitalization. Efforts are under way to improve digital infrastructure (5G strategy), digital education as well as eGovernment with substantial potential for improvement.

Start-up ecosystem: The number of entrepreneurs in Germany continues to decline, partly due to promising career opportunities for potential entrepreneurs in established firms given the strong labour market. Recent policy changes and developments for the increased availability of venture capital, favourable tax regulations and the establishment of a dedicated stock market segment as an exit option for early stage investors hold much promise to improve entrepreneurship in Germany.

Strengthening innovation in established firms, particularly SMEs: While overall business expenditure for R&D show strong growth rates, innovation activity has become increasingly concentrated in large firms and medium-high tech manufacturing sectors, especially automotive production. Major policy initiatives have been put in place to strengthen existing R&D policies favouring SMEs. R&D investments of SMEs have improved in 2015 which may signal a trend reversal. Political discussion has returned to considering R&D tax credits which would have the potential to foster R&D investments broadly with comparatively low administrative costs.

Resource availability for excellent science system: The German science system has significantly improved its ambition for differentiation and excellence following the joint initiative of Federal and State (Länder) governments, e.g., the Initiative for Excellence. These joint initiatives have large potential but require strategic decision-making. The Excellence Strategy and the Programme for the Support of Young Scientists hold much promise. However, it remains unclear whether they are sufficient to create attractive career opportunities for excellent researchers in Germany.

Smart specialisation

Overall, Germany has made good progress in the strategic planning of the smart specialization strategies. Research and innovation are major objectives on a national and Länder-level. The officially confirmed national strategy for Germany is the High-Tech Strategy, which is being planned and implemented with the active participation of all ministries.

At a regional level, RIS3 strategies are incorporated successfully in the regional innovation strategies of the Länder (Prognos 2017). However, due to its federal constitution of 16 Länder governments, the implementation and monitoring instruments of RIS varies substantially. While most of the Länder build their RIS strategies on the definition and development of regional clusters, the thematic clusters differ. Manufacturing industries, digital and information technologies, energy and environment as well as health industries are part of the identified specialization fields in most of the Länder (Prognos 2017). However, the implementation approaches are heterogeneous. We illustrate these different perspectives and the breadth of RIS strategies in Germany by describing two regions Brandenburg and Baden-Württemberg, with different economic and geographical conditions. Both federal states build on the definition of clusters and the improvement of cluster management activities. Due to the already high level of research, innovation and technological development, Baden-Württemberg has focused more on improving cluster management efficacy, and network effects within and among clusters. In Brandenburg, in contrast, the number of clusters is lower, and the focus is more on enhancing research and innovation activities within the clusters.

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1 In the following, we will use the German “Länder” when referring to the federal states in Germany.
Foreword

The R&I Observatory country report 2017 provides a brief analysis of the R&I system covering the economic context, main actors, funding trends & human resources, policies to address R&I challenges, and R&I in national and regional smart specialisation strategies. Data is from Eurostat, unless otherwise referenced and is correct as at January 2018. Data used from other international sources is also correct to that date. The report provides a state-of-play and analysis of the national level R&I system and its challenges, to support the European Semester.

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1 Economic context for R&I

Germany is the largest country within the European Union in terms of population (81.2 million inhabitants in 2016) and gross domestic product (GDP) (€3,263b in 2017). In relative terms, 16% of the population of EU-28 live in Germany and 21% of EU-28 GDP is produced in Germany. GDP per capita in Germany (€39,500 in 2017) is significantly above the average of EU-28 of €29,200 (2016). GDP in Germany has grown by 1.9% in 2016 and 2.2% in 2017, slightly below EU28 averages of 2.0% in 2016. The economic forecast of the European Commission predicts stable, positive GDP growth rates in Germany of 2.1% in 2018 and 2.0% in 2019, mostly in line with EU28 growth forecasts (European Commission, 2017c). Labour market trends have been consistently favourable in Germany with declining unemployment rates reaching 3.8% in 2017 (EU28: 7.7%) after 4.1% in 2016 and 4.6% in 2015. Another positive trend in Germany are consistent surpluses of government budgets amounting to 0.8% in 2016 (2015: 0.7%, 2014:0.3%) and decreasing government debt levels as a percentage of GDP, i.e. 68.1% in 2016 (2015: 70.9%, 2014: 74.6%).

Labour productivity in Germany continues to grow and is 5.7% higher in 2016 than in the reference year 2010. Labour productivity grow rates in EU28 are almost identical (5.8%) during the same time period. What is more, labour productivity growth in Germany does not seem to be much affected by the economy’s structural change. A tentative, potential explanation for this might stem from the large weight of the well-performing manufacturing sectors more than offsetting any negative contributions from the service sectors.

Table 1 DE: average fixed-weight labour productivity growth rate with different base years (%), 1971-2015

<table>
<thead>
<tr>
<th>Base year</th>
<th>All industries</th>
<th>Without services</th>
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<tbody>
<tr>
<td>1970</td>
<td>2.31</td>
<td>2.48</td>
</tr>
<tr>
<td>1975</td>
<td>2.29</td>
<td>2.51</td>
</tr>
<tr>
<td>1980</td>
<td>2.27</td>
<td>2.48</td>
</tr>
<tr>
<td>1985</td>
<td>2.27</td>
<td>2.54</td>
</tr>
<tr>
<td>1990</td>
<td>2.26</td>
<td>2.54</td>
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<tr>
<td>1995</td>
<td>2.20</td>
<td>2.45</td>
</tr>
<tr>
<td>2000</td>
<td>2.25</td>
<td>2.55</td>
</tr>
<tr>
<td>2005</td>
<td>2.26</td>
<td>2.62</td>
</tr>
<tr>
<td>2010</td>
<td>2.26</td>
<td>2.58</td>
</tr>
<tr>
<td>2015</td>
<td>2.28</td>
<td>2.58</td>
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</table>

Source: Own calculations, based on EU KLEMS (www.euklems.net). The calculations exclude non-market industries (e.g., public health and education).

According to Eurostat, Gross R&D expenditures (GERD) reached 2.94% of GDP in 2016 (provisional data) after 2.92% in 2015. This increase has been shared by government and business sources with the latter contributing consistently roughly two thirds of R&D expenditures. This development implies that Germany has almost reached its goal for R&D expenditures as part of the Europe 2020 Strategy (NRP, 2017). The Expert Commission for Research and Innovation (EFI) provides the most comprehensive evaluation of R&I in Germany on an annual basis. The commission consists of six professors from universities in Germany and Switzerland. EFI suggests to set a 3.5% goal for 2025 (EFI, 2017). Progress towards the other goal expressed in the National

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2 All quantitative indicators are provided by EUROSTAT if not explicitly referenced differently.
Reform Programme, i.e., expenditures for education and research reaching 10% of GDP, have been slower with 9.1% in 2015 (NRP, 2017), unchanged from 2014 and 2013 (NRP, 2016, NRP, 2015).

Innovation and digitalization are important topics of the current political discussion in Germany, especially during the election campaign in 2017 for the Federal Government. A new Federal government will determine future R&I strategies such as the successor of the High-Tech Strategy for the next legislation period.

1.1 Structure of the economy

Manufacturing accounted for 22.9% of gross value added (GVA) in Germany in 2016 and 17.3% of employment (EU-28: 16.2% and 13.8% respectively). The share of service sectors on total value added in Germany has remained stable at 69% in 2016. The share of knowledge-intensive services on total value added, though, has slightly declined to 34.3% in 2016 (36.1% in 2013). 82% of all firms in 2013 have less than 10 employees, which is below the average of EU28 (93%). In contrast, the share of firms with 250 and more employees in Germany in 2013 (0.5%) is higher than the average of EU28 (0.2%). 7% of all firms in Germany were founded in 2015 and this share follows a negative trend line with 8.5% in 2011. The accumulated share of exports and imports amounts to 86% of German GDP which is the highest degree of trade openness of any G7 country in 2015 (BMWi, 2016a).

1.2 Business environment

The overall business environment in Germany is internationally competitive. The Global Competitiveness Index 2017–2018 of the World Economic Forum ranks Germany as the 5th most competitive economy.4

In terms of innovation performance, the European Innovation Scoreboard ranks Germany among the Innovation Leader countries in 2017, together with Sweden, Denmark, Finland, the Netherlands and the UK (European Commission, 2017b). Germany outperforms the average of EU28 in this composite measure by roughly 21% although its relative advantage has been slightly declining since 2010 (-3.7%). The index identifies particular strengths in Germany stemming from business R&D expenditures as well as application for Intellectual Property Rights (IPR). Relative weakness emerges from a low share of foreign doctorate students, shortages of venture capital as well as employment in fast growing enterprises. For comparison, the 2017 international Global Innovation Index ranks Germany in 9th place (2016: 10th; 2015: 12th).5


With regards to the environment for SMEs and young firms in Germany, the World Bank ranks Germany as 20th in its 2018 report for the ease of doing business, down from 17th in 2017.6 While Germany performs particularly well along the dimensions of resolving insolvency and getting electricity, it has significant disadvantages from the administrative burdens for starting a business and registering property. By comparison the SBA fact sheets of 2016 on the progress in the implementation of the Small Business Act of the European Commission welcomed the strong growth of employment in German SMEs but saw shortcomings in the areas of responsive administration and entrepreneurship.7

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5 https://www.globalinnovationindex.org/analysis-indicator (6/2017)
6 http://www.doingbusiness.org/data/exploreeconomies/germany (6/2017)
report sees untapped potentials from activating underrepresented groups (e.g., migrants), increasing the dynamic start-up markets as well as introducing digital business models.

2 Main R&I actors

R&I is a shared responsibility of the Federal Government and the 16 Länder. At the federal level, the Federal Ministry of Education and Research (BMBF) covers most of the responsibilities for research policy. The Federal Ministry of Economics and Energy (BMWi) is involved in some areas of innovation and technology policy. The Länder fund the universities in their state. Since the revision of Article 91b of the German Basic Law on 1 January 2015, the Federal Government and the Länder can cooperate on a much broader scale in the funding of science, research, and teaching. New initiatives are e.g., the Excellence Strategy and the Tenure Track Programme. Much of publicly funded research is conducted in the university system and in the non-university public research organisations which are co-funded by the Federal government and the Länder. The four major non-university research organisations are Max Planck Society (MPG), Fraunhofer Society (FhG), Helmholtz Association (HGF), and Leibniz Association (WGL). They provide a dynamic element to the German R&I system because of their ability to respond to changing research opportunities and requirements through internally competitive funding allocation mechanisms. The German Research Foundation (DFG) complements institutional funding with project funding for basic research, selecting the most promising research projects by scientists and academics at universities and non-university research institutions based on a competitive basis.

In 2015, the German Higher Education landscape counted about 400 institutions, including 110 universities and more than 230 universities of applied sciences (Autorengruppe Bildungsberichterstattung, 2016). R&D performed by German Higher Education Institutions (HEIs) represents about 0.50% of GDP and is funded through a combination of institutional funding and project funding (e.g., Initiative of Excellence, R&D thematic programmes by BMBF) and contract research conducted for industry. R&D performed by academia and funded by the German private sector amounts to 0.07% of GDP. These shares are quite stable and have not changed much over the past years. The institutional funds received by universities are for both teaching and research and are largely provided by the Länder.

The business sector contributes roughly two thirds of R&D expenditures in Germany. It increased R&D expenditures by 3% in 2016, reaching €62.8b and employing 413,000 R&D employees. The car manufacturing industry is clearly the most important contributor to German business R&D, accounting for 35% of internal R&D. Other industries within medium-high tech manufacturing, such as machinery, electric equipment, chemicals as well as pharmaceuticals, are also large R&D investors.

3 R&I policies, funding trends and human resources

<table>
<thead>
<tr>
<th>Document title, hyperlink and date of publication/announcement</th>
<th>Short description</th>
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<tbody>
<tr>
<td><strong>Excellence Strategy</strong> ('Exzellenzstrategie') starts accepting application in December</td>
<td>Successor of the Initiative for Excellence ('Exzellenzinitiative') providing competitive funding for excellent research universities and clusters.</td>
</tr>
<tr>
<td>Date</td>
<td>Event Description</td>
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<td>-----------</td>
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<td>2016</td>
<td>The new joint Federal-Länder-Initiative “Innovative Hochschule” supports third mission activities with a focus on small and mid-size universities and universities of applied sciences to enhance the collaboration with local enterprises as well as other regional stakeholders.</td>
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<td></td>
<td><strong>Announcement of the strategy for the 5th generation of mobile communication (&quot;5G-Strategie für Deutschland&quot;) in July 2017</strong></td>
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<td></td>
<td><strong>Announcement of BMBF education initiative for the digital knowledge society (&quot;Bildungsoffensive für die digitale Wissensgesellschaft&quot;) in October 2016</strong></td>
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<td></td>
<td><strong>Start of the Research Fab Microelectronics Germany (&quot;Forschungsfabrik Mikroelektronik Deutschland&quot;) in April 2017</strong></td>
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<td><strong>Start of the platform ‘Lernende Systeme – Germany’s Platform for Artificial Intelligence ‘ in September 2017</strong></td>
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<td></td>
<td><strong>Announcement of the BMBF Start-up-Concept (&quot;Mehr Chancen für Gründungen - Fünf Punkte für eine neue Gründerzeit&quot;) in September 2017</strong></td>
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<tr>
<td>New conceptual framework for the provision of region-oriented innovation support (‘Innovation &amp; Strukturwandel’) and new funding measure (‘WIR! – Wandel durch Innovation in der Region’) in 2017</td>
<td>The new framework concept ‘Innovation &amp; Strukturwandel’ aims at fostering innovation in structurally weak regions. ‘WIR! – Wandel durch Innovation in der Region’ is the first funding measure under this umbrella. It targets interdisciplinary consortia and supports the implementation of innovative strategies that are tailored to East Germany’s regions.</td>
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<td>Law for the improvement of online access (‘Onlinezugangsverbesserungsgesetz’, OZG) passed both chambers of parliament in June 2017</td>
<td>Commitment to make administrative services available online, through a central portal and based on a single user account within five years</td>
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<tr>
<td>Programme for the Support of Young Scientists (‘Programm zur Förderung des wissenschaftlichen Nachwuchses’) started in 2017</td>
<td>Creation of 1,000 additional tenure-track professor positions in Germany between 2017 and 2032</td>
</tr>
<tr>
<td>Law for copyright protection in the knowledge society (‘Urheberrechts-Wissensgesellschafts-Gesetz,’ UrhWissG) approved in June 2017</td>
<td>15% of copyrighted materials can be used free of charge for educational purposes without specific licences</td>
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**R&I funding trends**

According to Eurostat, gross R&D expenditures (GERD) in Germany have reached 2.94% of GDP in 2016. This level is significantly above the average of EU-28 of 2.03% in 2016.

**Figure 1** Trend of GERD by sources of funding

![DE: GERD by Source of Funds](image-url)

Data source: Eurostat, 2017
3.1 Public allocation of R&D and R&D expenditure

The government budget appropriations or outlays for research and development (GBAORD) amounted to €29b in 2017. The trend since 2009 is positive and increasing, since the GBAORD in 2017 is 33% higher than in 2009. The Federal Government has spent €15.7b on R&D in 2016 which is more than in 2015 (€15.0b) and significantly higher than 2010 (€12.8b; BMBF, 2017f). For 2017 this amount is planned to increase significantly (€17.2b; BMBF, 2017d). The Expert Commission for Research and Innovation suggests an even more ambitious goal for the future with total R&D expenditures reaching up to 3.5% of GDP by 2025 (EFI, 2017). R&D expenditures of the Länder are slightly lower and also not developing as dynamically. They amounted to €10.9b in 2014 which is higher than in 2013 (€10.1b; BMBF, 2017f). Among the Länder, North Rhine-Westphalia had the highest share of R&D expenditures in 2014 with 21.0%, followed by Bavaria (16.9%) and Baden-Württemberg (14%, BMBF, 2017f).

Gross debt has kept the downward trend of the last years and declined in 2016 to 68.1% compared to 70.9% in 2015. This may leave some room for increased public investment without breaching EU and national debt rules.

As a further option for boosting public support for research and innovation and as a means for reinvigorating the innovative strength of German SMEs, the Expert Commission on Research and Innovation (EFI) has in its 2017 report called again for the introduction of R&D tax incentives as an important complement to the direct funding instruments currently in use (EFI, 2017).

3.2 Private R&D expenditure

According to Eurostat, business expenditures on R&D (BERD) accounted for 2% of GDP in 2015 and 2016 representing 69% of total R&D expenditures. This figure is up from 1.9% in 2013. A two-third contribution of the business sector to total R&D expenditures is also part of the quantitative goals of Germany expressed in its 2017 National Reform Programme (NRP, 2017). Manufacturing accounts for more than 80% of all R&D expenditure. Business R&D expenditures are significantly above the average levels of EU-28 (2016: 1.31%). Within manufacturing, medium high-tech manufacturing sectors are predominant. The following three sectors account for almost 60% of all business R&D expenditures in 2014: a) motor vehicles and parts; b) electrical equipment, computer, electronic and optical products and c) machinery and equipment (Eurostat, 2016).

![Figure 2 Top sectors in Manufacturing](image)

(C26= computer, electronic and optical products, C28= Manufacture of machinery and equipment and C29= Manufacture of motor vehicles, trailers and semi-trailers). Top service sectors (J=information and communication, K=Financial and insurance activities, M=professional, scientific and technical activities; Data source: Eurostat, 2017)
R&D expenditures are primarily driven by the automotive industry (€21.5bn in 2015), and the contribution of service sectors to R&D has strongly increased in 2015: professional, scientific and technical activities increased from €3.13bn in 2014 to €4.69bn in 2015 (Eurostat, 2017).

The share of foreign firms on business R&D expenditures in Germany has slightly declined from 26% in 2011 to 21% in 2015. This is the first decline since record-keeping started in the mid-1990s. The negative developments stems particularly from ICT and aerospace sectors. Nevertheless, Germany remains the second largest destination country for R&D of foreign firms behind the US (Stifterverband 2017).

The share of R&D financed by private, non-profit organisations is comparatively low at 0.01% of GDP in Germany in 2015 (EU-28 in 2015: 0.03%).

The quality of entrepreneurship in Germany has improved in 2016 with regard to higher shares of new firm creation based on innovative, digital or high growth opportunities. In absolute terms, though, the number of new firms with the latter characteristics as well as entrepreneurship overall continues to decline in Germany, with 672,000 founders in 2016 after 763,000 in 2015 and 915,000 in 2014 (KfW Research, 2017). Given a healthy job market, many potential entrepreneurs can find career opportunities in established firms, which can explain parts of the negative trend.

3.3 Supply of R&I human resources

Recent trends, like digitalisation, foster the demand for highly skilled human resources. Despite this clear need, the trend in public expenditure on education (relative to the gross domestic product) has remained stable since 2009 (4.2 in 2015 compared to 4.3 in 2009), and also the public expenditure on tertiary education shows a constant trend (0.8 in 2015 versus 0.9 in 2009). The number of graduates in STEM is increasing: in 2015 the number of new graduates in STEM programmes per 1000 population is higher in 2015 with 2.46 compared to 2.33 in 2015 and 1.79 in 2010. Despite an increasing trend regarding individuals between 25 and 34 years old with completed tertiary education (30% in 2015 versus 25.7% in 2009), the share of employees with completed tertiary education is largely constant with 28.7% in 2016 compared to 27.7% in 2009.

Regarding the development of scientific personnel, the trend is flat. The number of the new doctorate graduates per 1000 individuals in the population segment of 25-34 year olds has remained stable over the last years (2.3 in 2015 as compared to 2.28 in 2014 and 2.29 in 2013). Similarly, the share of scientists and engineers in the group 25-64 years old as % of active population is relatively stable with 7.7% in 2015 (6.3% in 2010).

BMBF tries to increase the number of female students and researchers in academia. In 2014, 48% of the students with an academic degree that entitles them to enter a doctoral program were female (BMBF, 2017c). Also, BMBF is successfully fostering its efforts into increasing the number of female students for STEM programs: in 2014 31.3% of the STEM students were female as compared to 18.6% in 20088. However, the share of female researchers in 2013 was only 27.9%, and there were only 22% female, tenured professors in Germany in 20159. According to the yearly report on young academic scholars of BMBF, female young scholars in universities have significantly less often a full-time employment (54%) as compared to their male colleagues (68%, BMBF, 2017c). Overall, BMBF aims at increasing the share of highly skilled female employees, as well as the share of female researchers. In 2016, as a result of the female professor

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program which was initiated in 2008 and had an overall funding of €300m, the 500th female professor was tenured, and this positive trend is expected to be continued.\(^\text{10}\)

Considering the high immigration in 2015 and 2016 in Germany, integration, inclusion and chances for equal opportunity are very important topics for the German higher education system. BMBF is making major efforts to improve the integration of individuals with immigration background in the German education system, beginning from primary education (Authoring Group Educational Reporting (BMBF), 2017). Based on this report, the improvement of knowledge and skills of pupils with immigration background have improved, especially in secondary education. Still, disparities between native Germans and foreigners exist with respect to their final school qualification: young foreigners are more than twice as likely to leave school without acquiring the lower secondary school certificate and three times less likely to achieve a higher education entrance qualification (Authoring Group Educational Reporting (BMBF), 2017). Once they are in the higher education system, though, there are only small differences between students with and without migration backgrounds in terms of completing their first academic degrees (see also Figure 3).

Figure 3 German and foreign school-leavers by school type

Due to the high immigration in 2015 and 2016, the share of population with immigration background has reached, its highest value since the beginning of its measure by the federal statistical office with 18.6 million persons.\(^\text{11}\) The group of individuals with immigration background comprises, however, immigrants as well as individuals who have been born in Germany with at least one parent not being born as German. Within this group, immigrants have significantly less school qualifications, but more often academic degrees. This explains the efforts of BMBF to improve language skills at every educational level, and the integration of immigrants in the German educational system.

In addition, an important issue, especially considering the high number of immigrants in the last two years in Germany, is the recognition of foreign degrees. To facilitate the process and establish a unified process across all Länder, the Federal Government passed

\(^\text{10}\) https://www.bmbf.de/de/500-frau-im-professorinnenprogramm-berufen-2506.html (8/2017)

\(^\text{11}\) https://www.destatis.de/DE/PresseService/Presse/Pressemitteilungen/2017/08/PD17_261_12511.html; sessio
nid=081D7383FF2346A1FC37BE82C9C2AFBD.cae3 (8/2017)
a law on the acknowledgment of foreign qualification degrees in 2012 (BMBF, 2017b). The legislation has been implemented successfully, which is demonstrated by the increasing number of applications in the last 5 years. This legislation is also valid for immigrants, and the number of immigrants that made use of counselling talks for the acknowledgment of their degrees has increased from 20% in 2015 to 40% in 2016 (BMBF, 2017b). 80% of immigrants participating in qualification programs have an academic degree; every fifth participant aims at having an acknowledgment for a medical doctor degree and every tenth participant for an engineer’s degree. The trend of the applications is expected to increase in the next years. However, despite political efforts to facilitate the recognition of foreign academic degrees, the share of tertiary degree graduates from abroad is with 6.7% in 2015 at the same level as in 2013 and 2014.

4 Policies to address innovation challenges
The Expert Commission for Research and Innovation (EFI) commends the progress that R&I in Germany had achieved through the dynamics created by the High-Tech Strategy for example by almost reaching the 3% goal for R&D expenditures as a share of GDP in its report for 2017 (EFI, 2017). The commission expresses general recommendations for how the governance of R&I in Germany should be improved as part of the successor of the High-Tech Strategy in the next legislation period, such as a clearer focus on implementation steps and goal achievement of the strategy or a stronger emphasis on evidence-based evaluations for continuous policy improvement. Apart from these general recommendations, the commission also identifies R&I challenges with particular importance for R&I in Germany:

4.1 Challenge 1: Digital economy and society
Description
The digitalization of business and society is a central challenge for R&I in Germany (Sofka and Sprutacz, 2017). On the one hand, there is strong interest in the digitalization of interconnected production processes (‘Industrie 4.0’). On the other hand, many companies, especially SMEs, are underestimating the importance of digital change. Growth in government funding for R&D in ICT has been slower than for other fields, e.g., energy (EFI, 2017) and has often times neglected growth opportunities outside of manufacturing, e.g., in healthcare or financial services (EFI, 2016). There is comparatively little emphasis on business model innovations in which the creation and capture of economic value is central (e.g., based on data), and do not necessarily focus on the control or creation of technologies per se. The Digital Economy and Society Index (DESI) ranks Germany as number 11 among all EU Member States in both 2017 and 2016 and highlights particular shortcomings from the lack of digital public services and eGovernment (European Commission, 2017a).

Policy response
Several recent policy changes tackle the digitalization challenge from different angles. From the digital infrastructure perspective, the Federal Ministry of Transport and Digital Infrastructure (‘Bundesministerium für Verkehr und digitale Infrastruktur’, BMVI) has announced a strategy for the 5th generation of mobile communication (‘5G-Strategie für Deutschland’) in July 2017 (BMVI, 2017). The strategy combines the provision of relevant frequencies, a competition establishing a 5G showcase city, €80m for 5G related R&D and continued coordination between ICT infrastructure providers and users. The strategy targets 5G coverage along all major roads by 2025.

Focusing on the digitalization of education, BMBF has published a strategy paper declaring an education initiative for the digital knowledge society (‘Bildungsoffensive für die digitale Wissensgesellschaft’) in October 2016 (BMBF, 2016a). The strategy defines central fields requiring action, i.e., digital education, effective digital infrastructure,
modernized legal frameworks, support for strategic governance of digitalization (e.g., digital competences of top decision makers in schools and higher education) as well as exploitation of internationalization potentials. The strategy bundles a range of initiatives and programmes. These include for example the BMBF top-level initiative "Professional Training 4.0" ('Berufsbildung 4.0'), a concept study for the provision of cloud-based services for schools ('Schul-Cloud'), support for the creation of up to 20 regional competence centres for digitalization, the creation of an information centre for Open Educational Resources (OER), support for the digitalization of university programmes as well as award competitions for digital education showcases ('Bundespreis Digitale Bildung'). BMBF also offers funding for internet access infrastructure in all German schools if Länder governments agree to update pedagogical concepts and teacher training.

BMBF has also launched the Research Fab Microelectronics Germany ("Forschungsfabrik Mikroelektronik Deutschland") established in April 2017. 13 application-oriented research institutes (the Fraunhofer Group for Microelectronics and two Leibniz institutes) join forces as a distributed applied research facility. They receive around €350m from the BMBF for cutting edge equipment. In a complementary second step, €50m are to be provided in 2018 for equipment upgrades at leading microelectronic labs at universities. The BMBF has also set up the platform “Lernende Systeme – Germany’s platform for artificial intelligence” in 2017 which brings together experts from science, industry and society in seven working groups discuss concrete areas of application for learning systems as well as technological, economic and social factors.

With regards to an effective digital information infrastructure, the Federal Government and the Länder are currently in negotiations on a National Research Data Infrastructure (NFDI). The NFDI aims to provide science with a basic supply of data storage capacities and generic services and provide an essential contribution to European initiatives such as the European Open Science Cloud (EOSC).

Focussing on the availability of government support for R&D in ICT, the availability of funding for this research area from the federal government has increased by 22% between 2009 and 2016 which is below the expansion of overall R&D support (32%) (EFI, 2017). The share of ICT on the overall R&D support of the federal government has increased recently slowly with 5.7% planned for 2016 (2015: 5.2%). Besides, BMBF has awarded €50m over five years for the German Internet Institute (‘Weizenbaum Institute for the Networked Society’) in Berlin in May 2017. The institute emerges from a concept competition and the winning consortium consists of five universities and two non-university research institutes located in Berlin and Brandenburg. The goal of the institute is to strengthen research on the effects of digitalization on society and the economy.

With regards to improving eGovernment in Germany, the Federal government has initiated a law for the improvement of online access ('Onlinezugangsverbesserungsgesetz', OZG) which passed both chambers of parliament in June 2017 (Deutscher Bundesrat, 2017). The law requires Federal, Länder and municipal governments to provide all administrative services online within five years, make them available through a central online portal and allow access via a single user account.

The coverage, availability and accessibility of government data for encouraging digital business models in Germany has been criticized in previous years (EFI, 2016). For addressing some of these issues, the actual Federal government has put forward changes to the availability of data through a change in the eGovernment law ('E-Government-Gesetz') which has passed both chambers of parliament in June 2016 (Deutscher Bundestag, 2017a). The law requires Federal administrations to make their data in digital form available albeit with limitations regarding confidential data. Recently, the advisory board young digital economy (‘Beirat junge digitale Wirtschaft’, bjdw) expressed their recommendations regarding digitalization for the next legislation period of the new government which will be elected in September 2017 (Beirat Junge Digitale Wirtschaft beim Bundesministerium für Wirtschaft und Energie, 2017). The advisory board focuses
mainly on the big picture, and formulates 18 recommendations regarding the improvement of general conditions and the economic environment for new start-ups in the digital economy. One important recommendation is the establishment of a new dedicated Ministry for Digitalization. Other fields comprise better education and training for digital start-up entrepreneurs, female entrepreneurship, support for start-ups in the area of artificial intelligence, improvement of the digital infrastructure.

Assessment

Recent policy initiatives demonstrate the responsiveness of policy makers for existing shortcomings in the status quo of R&I opportunities from digitalization in Germany, especially with regard to eGovernment. The increasingly leading role of the Federal government has the potential to overcome idiosyncratic or isolated eGovernment solutions from individual Länder.

EFI (2017) recommends ICT as the top priority in the next iteration of a High-Tech Strategy for the coming legislation period accompanied by more centralized governance within the Federal government, e.g., a dedicated digital ministry or innovation agency. Similarly, government support for R&D in ICT could be strengthened especially targeting start-ups and young firms (EFI, 2017).

4.2 Challenge 2: Start-up ecosystem

Description
The attractiveness of the start-up ecosystem remains a challenge for R&I in Germany. Entrepreneurship in Germany continued to decline in 2016. 672,000 individuals founded new firms in Germany in 2016 compared with 763,000 in 2015 and 915,000 in 2014 (KfW Research, 2017). Virtually all types of entrepreneurship, e.g., full-time, innovative, digital, follow the same trend, although in relative terms the share of entrepreneurs exploiting promising opportunities instead of sheer necessity has increased. Only 7.3% of firms in Germany were newly founded in 2013, down from 8.6% in 2010 (Sofka and Sprutacz, 2017). Other innovation leader Member States such as Denmark (10.3%) or the Netherlands (10.5%) have significantly higher firm birth rates. The World Bank ranks Germany 17th out of 190 economies for the administrative ease for doing business but only 114th for starting a business (World Bank, 2017). Venture capital investments amounted to 0.025% of GDP in Germany in 2015 (2014: 0.021%), significantly below other innovation leader Member States such as Denmark (0.109%) or the Netherlands (0.032%).

The challenge for entrepreneurship in Germany originates from a mix of issues including promising career opportunities for potential entrepreneurs in established companies thanks to a healthy labour market, underdeveloped venture capital markets, tax and regulatory obstacles, a lack of exit prospects for venture capital investors as well as the demographics of an aging society (EFI, 2017). Entrepreneurship education in high schools has improved but remains fragmented (EFI, 2017) while the programme EXIST promotes an entrepreneurship culture in universities (Kulicke and Seus, 2016).

Policy response
Policy responses have occurred at multiple levels. Most policies have targeted the availability of funding for entrepreneurship (Sofka and Sprutacz, 2017). Following an
overall positive evaluation of INVEST (ZEW, 2016) - a policy incentivising business angel investments in start-ups through subsidies - the programme has been extended and the tax exemption of the subsidy clarified. BMWi and EIF have increased funds for the ERP/EIF fund-of-funds ('ERP/EIF-Dachfonds') to €2.7b, €270m of which for the European Angels Fund. The Federal government has further announced its intention to create an additional Tech Growth Fund for high-tech start-ups with a volume of up to €10.b. ‘Coparion’ started in March 2016 as the follow up fund for the ERP-Startfonds. The independent governance structure is supposed to increase its flexibility in making investment decision. Coparion matches equity investments from private lead investors and has a volume of €225m. Besides, government-owned development bank KfW is increasingly becoming a visible anchor investor, signalling the quality of a start-up to other investors.

Furthermore BMBF approved a new concept for additional support to Entrepreneurship and Start-ups (‘Mehr Chancen für Gründungen – Fünf Punkte für eine neue Gründerzeit!’). The objectives of this new strategy are to support the development of a start-up culture in German science and research as well as fostering the emergence of research and technology based start-ups, especially spin-offs from research institutes and universities.

An important change affecting investments in young firms has occurred through a change in tax regulations. The Federal government has passed the law for the further development of tax deductions from business losses (‘Gesetz zur Weiterentwicklung der steuerlichen Verlustverrechnung bei Körperschaften’) in December 2016 (Deutscher Bundestag, 2016). The law preserves the opportunity for tax deductions from business losses even after changes in investors. Previously, firms lost this possibility when investors changed. Given that young firms are likely to incur losses while they develop products and markets, the possibility of losing the tax deductibility following ownership changes was seen as a disincentive for investments in young firms (EFI, 2016).

Experts were also concerned with the absence of a dedicated stock market segment as an exit option for investors in young firms (EFI, 2016). While policy can only indirectly influence financial markets, BMWi has engaged in multiple round table discussions with the German Stock Exchange (‘Deutsche Börse’). Deutsche Börse has launched a new segment named ‘Scale’ for young firms and SMEs in March 2017, trading initially 46 equities and corporate bonds.  

The Federal government and the Land Hessen have taken the initiative for a single point of contact for founders and businesses applying for permits or requiring administrative services from government (‘Einheitlicher Ansprechpartner 2.0’) as part of improved eGovernment (EFI, 2017). There is currently little information available about the progress of this initiative.

Many policy instruments targeting entrepreneurship culture in universities are part of the programme EXIST of BMWi. The programme received a positive evaluation in 2016 but the evaluation report also contends that there is much remaining potential for creating an entrepreneurial culture at universities which would require updated structures and dedicated staff (Kulicke and Seus, 2016). BMBF launched a new initiative called ‘Young Entrepreneurs in Science – YES’ in September 2017 to address some of these potentials. The initiative aims at fostering entrepreneurial spirit amongst PhD candidates.

**Assessment**

Among the ongoing assessment of the start-up ecosystem, the development bank KfW provides an annual monitoring report of entrepreneurial activity and their structure (KfW Research, 2017). The bank also provides topical reports on issues such as migrant entrepreneurship (KfW Research, 2016) or the availability of equity investments (KfW

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Research, 2015). The entrepreneurship culture aspect of EXIST has been evaluated in 2016 (Kulicke and Seus, 2016). The evaluation shows that 78% (out of 751 applications) of the initiatives that were supported by EXIST lead to successful start of new businesses. The main reason for closures of the other 22% businesses was personal reasons. Out of the successful start-ups, 84% survived the first two years. Overall, this study confirms the effectiveness of the program in supporting start-ups by improving their business start and decreasing risks for entrepreneurs in the initial phase of starting their firms.

R&I policy has made important steps towards increasing entrepreneurship in Germany. Major initiatives have been undertaken to increase funding for entrepreneurship through the provision of funds but also the elimination of barriers for private investors emerging from tax regulation. The creation of a dedicated stock exchange segment for young firms and SMEs has particular potential to attract more private venture capital investors since they have now an attractive exit option for IPOs. Entrepreneur-friendly public administration as well as entrepreneurship education has the most potential for improvement.

4.3 Challenge 3: Strengthening innovation in established firms, particularly SMEs

Description
Business R&D expenditures (BERD) have reached 2% of GDP in 2015 in Germany after 1.94% in 2014 (Eurostat, 2017). They follow a positive trend line (2009: 1.84%) and consistently comprise roughly two thirds of total R&D expenditures in Germany. Within these overall positive trends are some noteworthy challenges. First, R&D expenditures in Germany are substantially concentrated in medium-high tech manufacturing. Especially the automotive sector has been a major driver for business R&D and accounts for a third of all internal R&D in Germany in 2015 (Schasse, 2017). This concentration has the potential to pool risks from R&D trends in a single sector. Second, the expansion of innovation activities has been much more dynamic in large firms than in SMEs in Germany. The SME category has become structurally less innovative (highly innovative SMEs outgrew the segment and newly created firms are comparatively less innovative) and especially small SMEs as well as those with occasional research needs have reduced their investments (Sofka and Sprutacz, 2017). Major obstacles for innovation in SMEs emerge from a lack of access to R&D funding and skilled employees. SME R&D spending has picked up in 2015 but it remains to be seen whether this constitutes a permanent trend reversal (EFI, 2017). Third, firms headquartered in Germany have expanded their R&D expenditures both domestically and abroad between 2011 and 2013. R&D expenditures of foreign firms in Germany, though, have been largely stable or levelled off during the same period (EFI, 2017). Fourth, the pool of skilled scientists and engineers in German R&I is aging and many R&D professionals reach their retirement age. Significant efforts are required to activate potential pools of R&I employees in Germany (women, migrants, retired employees) (EFI, 2017).

Policy response
Among recent policy responses targeting innovation in SMEs, the BMBF programme “Priority for SMEs” (‘Vorfahrt für den Mittelstand’) is particularly prominent (BMBF, 2016c). It bundles a range of measures including a 30% increase in funding for R&D in SMEs to €320m annually until 2017, preferred access for SMEs in R&D programmes such as the leading edge cluster competition (‘Spitzencluster-Wettbewerb’), fostering internationalization of SMEs (‘KMU-international’), funding of regional network activities of SMEs (‘Innovationsforen Mittelstand’), support for recruiting of skilled employees as well as simplified requirement for grant applications of SMEs. In a more recent policy response, BMBF supports SMEs to fund pre-studies and feasibility studies for risky innovation projects. The funding is part of the initiative SME innovative (‘KMU-innovativ’).
and enables up to 100 SMEs to get up to EUR 50 TSD for a period of up to 6 months.\textsuperscript{13}

The main objective of this initiative is to strengthen the innovative potential and the success probability of R&D projects for SMEs (BMBF, 2017h).

Among new policies for increasing technology transfer between science and industry the programme Innovative Higher Education Institutions (‘Innovative Hochschule’) is particularly prominent. Federal and Länder governments reached an agreement for a new joint funding initiative promoting research-based ideas, knowledge and technology transfer as well as the collaboration between institutions of higher education with business and society. It has a budget of €550m between 2018 and 2027 (GWK, 2016c).

Focusing on increasing the international competitiveness of R&I in Germany, BMBF has selected 32 clusters and networks which will receive grants for their internationalization (‘Internationalisierung von Spitzenclustern, Zukunftsvorhaben und vergleichbaren Netzwerken’) in June 2017.\textsuperscript{14} The leading edge cluster competition had received positive evaluations (Rothgang et al., 2015). Experts see their internationalization as the preferable way to expand their effectiveness compared with increasing the number of leading-edge clusters (EFI, 2017).

With regard to strengthening the availability of skilled human resources for R&D in Germany, the Federal government had reformed the law for the support of professional training (‘Aufstiegsfortbildungsförderungsgesetz,’ AFBG) which took effect in August 2016. It resulted in an increase of financial support for professional acquiring additional qualifications by 3.2% in 2016 to €576m, reaching 162,000 individuals\textsuperscript{15}. The Federal government had taken over financing the subsistence support for school and university students (BAföG) in 2015. The number of supported students declined in 2016 by 5.5% reaching 823,000 students.\textsuperscript{16} BMBF published also the monitoring report for reform of the law for the recognition of diplomas and qualifications from abroad (‘Anerkennungsgesetz’) in June 2017 which took effect 5 years earlier (BMBF, 2017a). The report shows positive effects in terms of applications as well as economic consequences for applicants.

**Assessment**

Germany has a well-established system of support for R&D in firms and many of those programmes emphasize SMEs (‘Mittelstand’), e.g., Central Innovation Programme for SMEs (‘Zentrales Innovationsprogramm Mittelstand’, ZIM) or the German Federation of Industrial Research Associations (AiF) „Otto von Guericke“. They are accompanied by initiatives such as research in universities of applied sciences (‘Forschung an Fachhochschulen’). Recent policy responses build on established principles for strengthening firm innovation or renew efforts, e.g., “Priority for SMEs” (‘Vorfahrt für den Mittelstand’). EFI (2017) suggests that untapped potential rest in identifying overlaps between Federal and Länder support schemes.

The Centre for European Economic Research reports annually on the innovation activities of firms in Germany (ZEW, 2017). ZIM has been recently evaluated (RKW, 2017). Overall, the evaluation confirms its effectiveness into supporting the R&D activities of SMEs.

The Expert Commission for Research and Innovation has repeatedly called for the introduction of R&D tax credits, largely because of the comparatively lower entry barriers originating from administratve costs for grant applications (EFI, 2017). R&D tax credits could make R&D support available to larger groups of firms and especially SMEs with limited resources. While the commission’s suggestion has not received much political

\textsuperscript{13} https://www.bmbf.de/de/mittelstand-3133.html (9/2017)

\textsuperscript{14} https://www.bmbf.de/de/internationale-chancen-fuer-kleine-und-mittlere-unternehmen-4385.html (8/2017)

\textsuperscript{15} https://www.bmbf.de/de/bundesbildungsministerin-wanka-zur-heute-veroeffentlichten-afbg-bundesstatistik-2016-zum-4464.html (8/2018)

\textsuperscript{16} https://www.destatis.de/DE/PresseService/Presse/Pressemeldungen/2017/08/PD17_265_214.html (8/2017)
attention in recent years, the Federal government mentions R&D tax credits in its monitoring report of the New High-Tech Strategy in March 2017 and plans to assess their applicability and complementarity with existing R&D support programmes (BMBF, 2017e). R&D tax credits could be a particularly effective way for extending the base of innovative firms in Germany across industries and sizes. Hence, the development is a positive sign.

The progress towards easier recognition of qualification and diploma from a broad is another positive sign, addressing potential shortages of skilled R&I human resources. Given demographic trends, the German R&I system has untapped human resource potentials, e.g. women, migrants, retirees (EFI, 2017).

### 4.4 Challenge 4: Resource availability for excellent science system

**Description**

The German science system has undergone important changes. Part of these changes have been driven by external changes in the demand for higher education (shorter high school education and the abolishment of mandatory military service) as well as the policy changes propelling the differentiation of higher education and research in Germany, most prominently driven by the Initiative for Excellence ('Exzellenzinitiative'). Federal and Länder governments have changed the constitution in December 2014 (Art. 91b GG `Grundgesetz`) to provide the conditions for shared initiatives, which will continuously improve the quality of research in German universities as well as non-university research institutes.

Some of the most immediate challenges that the science system faces stem from insufficient basic financing ('Grundfinanzierung') and an increasing reliance of third-party funds ('Drittmittel'), involving substantial administrative costs and potentially constraining research trajectories to the ones that can attract funding. Further challenges emerge from the personnel structure of German universities. A shortage of permanent and tenure-track positions limits the career opportunities for young researchers (EFI, 2017). Germany also continues to have a mobility deficit when comparing the number of publishing researchers leaving Germany with the ones entering in 2013 (EFI, 2017). The entering researchers have, however, stronger publication records than their domestic counterparts which indicates an upgrading process.

Conversely, the German Centre for Higher Education and Science Research ('Deutsches Zentrum für Hochschul- und Wissenschaftsforschung,’ DZHW) published a study in May 2017 identifying acute shortages of qualified applicants for professorships at universities of applied sciences ('Fachhochschulen') (DZHW, 2017). The field of engineering is particularly affected since roughly half of all open positions cannot be filled following the initial round of position announcements. Considering these trends, the German science system is expected to benefit from long term, strategic decision-making.

**Policy response**

Major policy changes emerge from the continuation of important joint initiatives of Federal and Länder governments taking effect in 2016 and 2017. These include the policy programmes for the funding of non-university research organisations ('Pakt für Forschung und Innovation') as well as the Higher Education Pact ('Hochschulpakt') for universities until 2020\(^{17}\). The latter extension is designed to provide 760,000 new students (compared with 2005) with higher education. For this purpose the Federal Government has provided €9.9b and the Länder €9.4b (NRP, 2016). An important change in the Higher Education Pact is the introduction of dedicated funds for quality improvements increasing graduation rates (10% of total funds). Part of the Higher Education Pact 2020 is also that universities will see an increase of their lump-sum

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allowance for indirect project costs (‘DFG Programmpauschale’) of grants from the German Science Foundation (DFG) from 20% to 22% starting in 2016. The Länder cover the additional 2% while the Federal Government continues to fund the 20%.

Federal and Länder governments have reached an agreement in June 2016 for an Excellence Strategy (‘Exzellenzstrategie’) as successor to the Initiative for Excellence starting in 2017 (GWK, 2016d). The Excellence Strategy will be a permanent programme with a total budget of €533m co-financed by the Federal Government (75%) and the Länder in which the funded universities are located.

A further joint initiative of Federal and Länder governments is the Programme for the Support of Young Scientists (‘Programm zur Förderung des wissenschaftlichen Nachwuchses’) which aims at creating 1,000 additional tenure-track professor positions in Germany between 2017 and 2032. The Federal government funds the programme with up to €1b and universities compete for funding.

The Federal government has announced an internationalization strategy for education, science and research (‘Strategie der Bundesregierung zur Internationalisierung von Bildung, Wissenschaft und Forschung’) in February 2017 (BMBF, 2017g). The strategy aims at strengthening excellence and leveraging synergies through international collaboration. It plans to extend and strengthen networks, increase the visibility of research in Germany as well as establishing more branches and information centres of German research actors abroad.

The Federal parliament has approved the law for copyright protection in the knowledge society (‘Urheberrechts-Wissensgesellschafts-Gesetz,’ UrhWissG) in June 2017 (Deutscher Bundestag, 2017b). The law defines - among other things - a threshold of 15% for the fraction of copyrighted materials that can be used in education free of charge.

BMBF has put forward an open access strategy (‘Open Access in Deutschland’) in September 2016 (BMBF, 2016b). The strategy supports open access principles broadly and aims to establish it as the scientific standard in Germany. Meanwhile several measures have been undertaken by BMBF to implement the open access strategy (integrating open access in BMBF grants, ideas competition and Post-Grant-Fund).

Assessment
The continuation of the Pacts for Research and Innovation and the Pact for Higher Education as well as the creation of the Excellence Strategy are very positive signs for the commitments of both Federal and Länder governments to excellent science and research in Germany. It remains to be seen in what other ways Federal and Länder governments will use the new opportunities for collaboration created by the change in constitution allowing permanent partnerships.

The effectiveness of the joint initiatives Federal and Länder governments is annually assessed through monitoring reports of the Joint Science Conference (‘Gemeinsame Wissenschaftskonferenz’) (GWK, 2016a, GWK, 2016b). The Initiative for Excellence has undergone an extensive evaluation by a committee of international experts in 2016 (IEKE, 2016) and the results have been consequential for the formulation of the Excellence Strategy.

Two recent policies, the Excellence Strategy as well as the Programme for the Support of Young Scientists, explicitly acknowledge the importance of strategic decision making at the university level by making it eligible for funding. This is a promising development for strengthening university governance.

18 https://www.bmbf.de/de/dfg-programmpauschale-513.html (8/2017)
19 https://www.bmbf.de/de/wissenschaftlicher-nachwuchs-144.html (8/2017)
With regard to the expansion of permanent professor positions in Germany, the Programme for the Support of Young Scientists is a promising step but it remains unclear whether 1,000 additional tenure-track positions until 2032 will be sufficient across fields and universities. There is also some concern, that Länder governments could curtail their investments in universities following the larger commitments from the Federal government (EFI, 2017).

5 Focus on R&I in National and Regional Smart Specialisation Strategies

According to the partnership agreement between Germany and the EU in 2014, the New High-Tech strategy ("Neue Hightech-Strategie des Bundes") is the officially confirmed RIS3 strategy for Germany. The High-Tech Strategy is based on six thematic priority tasks for fostering innovative strength: (1) digital economy and society, (2) sustainable economy and energy, (3) innovative workplace, (4) healthy living, (5) intelligent mobility and (6) civil security. All ministries participate into the implementation of the High-Tech Strategy. In addition, a committee of 20 experts ("High-Tech Forum") from the private sector, science and civil society support the governance institution in implementation and further development of the High-Tech Strategy.

The implementation and monitoring activities of RIS are strongly related to those of ERDF (Prognos 2017). Germany benefits from ESIF funding of €28b during the period 2014-2020. The ERDF program provides the major part of this funding (38%). Research and Innovation is the second most important topic with more than €4b, with the majority of funding stemming from ERDF (€3.8b). In addition, Germany invests €17b of own funding, so that the total budget amounts to more than €45b. The private investment matching grant of public support for enterprises amounts €1.99b, and the matching non-grant public support amounts €782m. This high level of funding from the private sector underlines its involvement in the smart specialization activities in Germany. Out of the total national budget, €16b have been allocated, and €2.5b have been already spent. Overall, 3,343 enterprises were planned to be supported, out of which a support decision was made for 255 enterprises, and support was implemented for 33 enterprises. Through the ERDF activities, 42.694 new jobs, and the equivalent of 3,015 new researcher positions have been created so far.

Germany has a strong federal tradition and the 16 Länder governments decide upon their regional strategies, including RIS. This has led to a high heterogeneity of the RIS implementation (Prognos, 2017). While the thematic clusters differ across the Länder, manufacturing industries, digital and information technologies, energy and environment as well as health industries are part of the identified specialization fields in most of the Länder. A recent study shows that RIS3 strategies are incorporated successfully in the regional innovation strategies of the Länder. Monitoring instruments and documentation, however, show also high variation. While covering each of the 16 Länder in detail goes beyond the scope of this report, the implementation of the regional smart specialisation strategies is described by contrasting two federal states, Baden-Württemberg and Brandenburg. Both Länder have different geographical locations (Baden-Württemberg is located in South-West Germany and Brandenburg is located in East Germany) and differ substantially with respect to their R&D intensities and GDP per capita.

22 https://www.hightech-strategie.de/de/Beteiligte-Ressorts-257.php (12/2017)
24 Ideally, we would like to analyze RIS3 specific data within prioritized areas but if not available the report relies on ERDF data.
27 http://www.eubuero.de/regionen-bundeslaender.htm (12/2017)
Brandenburg has the unique feature of developing a common smart specialization strategy together with Berlin. Due to these structural diversities, different regional implementation approaches, strengths and challenges of the regional smart specialisation strategies can be illustrated. Last but not least, bearing in mind that both states are very different, any outcome is also likely to differ but also contributes to better depict potential avenues.

**Brandenburg: New policy developments**

The Land Brandenburg has joined forces with the Land Berlin to develop a common research and innovation strategy (innoBB) since 2007, becoming a case study in the smart specialisation project by the OECD Working Party on Innovation and Technology Policy (MWE Brandenburg, 2017a).

Both Brandenburg and Berlin have a higher annual GDP growth (3% for Berlin and 2.7% for Brandenburg) than the German annual growth rate of 1.7% (BMWi, 2016b). However, the region faces several challenges that relate to a lack of resources, limited private R&D activities and a fragmented economic structure (MWE Brandenburg, 2017a). For this, the joint innovation strategy focuses on finding the right policy mix of different instruments to foster innovation and support stakeholders (MWE Brandenburg, 2017b).

Brandenburg has received a total amount of EU financing from ERDF funding of €850m (the national share for the ERDF amounts to €210m).29 Research and innovation has top priority, since the major part of the EU (€.35b) and national funding (€86.5m) is allocated to research and innovation initiatives. Out of the total ERDF budget of €1b, €240m have been allocated and €57m have already been spent.30 The private investment matching public support amounts to €67m. Grant support has been allocated for 1,497 enterprises and 194 have already received the financial support. 470 of the supported enterprises are start-ups. Through the ERDF support, 1940 new jobs (full time equivalent) and 100 researcher positions (full time equivalent) were created. Another 615 researchers benefit from better infrastructure.31

Strengthening the R&D infrastructure for universities, and research institutions, as well as fostering the technology transfer to the private sector are important objectives of the smart specialization strategies in Brandenburg (innobb, 2016).

**Brandenburg: Progress on implementation**

In the course of innoBB, five “Future Fields of Excellence” were identified in joint working groups in 2007. Together with four additional clusters for Brandenburg, these nine clusters form the expanded program innoBBplus (MWE Brandenburg, 2017b). After the identification of the clusters, the governments of both Länder introduced “cross-border commitments” for joint research, technology and development financing schemes.Clusters are tasked with implementing the innoBB through master plans, which are based on sector-specific SWOT analyses (Berlin-Brandenburg, 2013.)

**Brandenburg: Monitoring mechanisms and feedback loop**

The innoBB strategy is monitored through regular evaluations (MWE Brandenburg, 2017a). Annual innovation summits build the basis for regular exchange between business, science and government. In addition, an inter-departmental steering board at the state secretary level is the main political body for developing and up-grading innoBB (Berlin-Brandenburg, 2013.)

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The most recent evaluation report of the innoBB strategy was published in 2016 (innobb, 2016). This report evaluates the economic development of the defined fields of excellence and indicates the role of the clusters in the general economic development of the region. The clusters are substantial for the economic development of the region: in 2011 there were 91,500 firms operating within these clusters, which correspond to 34.4% of the firms located in the region. By the end of 2014 the number of the companies amounted to 93,646 (34%; innobb, 2016).

During the period 2011-2016 a total of 304 new projects with a total volume of more than €834m were started within the innoBB plus strategy. Out of these projects, 156 were international, and 121 had a focus on R&D or innovation. Stakeholders from industry, science and government were involved in most of the projects.

### Brandenburg: Evidence of impact

In total, the activities within the five common clusters and the four specific clusters for Brandenburg are planned to continue in 2017 (MWE Brandenburg, 2017b). According to the conclusions of the evaluations, new projects should focus on current trends, like digitalization. In addition, the assessment suggests that the collaboration between science, governments and firms should be continued. Especially the relationship between business and science, and collaborations between start-ups and established firms is a major objective for 2017. Finally, developing a comprehensive monitoring of (cross-)cluster activities is crucial for the next years (Berlin-Brandenburg, 2013).

### Baden-Württemberg: New policy developments

Baden-Württemberg is one of the most innovative regions in the European Union. The innovation strategy of Baden-Württemberg builds on multiple players from the higher education sector, private business and government (RWB EFRE, 2015). In line with smart specialization, the innovation strategy of Baden Württemberg focuses on supporting regional innovation within four regional clusters: sustainable mobility, environmental technologies and new energies, health management, and information technologies (RWB EFRE, 2015).

Baden-Württemberg has received a total amount of EU financing from the ERDF funding of €250m (the national share for the ERDF amounts the same). Research and innovation has top priority, since the major part of the EU and national budgets (€170m respectively) are allocated to research and innovation initiatives. Out of the total ERDF budget of €490m, €240m have been allocated and €16m have already been spent.

Private investment matching public support in innovation or R&D projects amounts €160m. Grant support has been allocated for 90 enterprises and 34 have already received the financial support. Through the ERDF support, 47 full time equivalent researcher positions were created, and other 135 researchers benefitted from better infrastructure.

Overall, activities related to smart specialisation strategies in Baden-Württemberg focus on how to increase the efficacy of the cluster management.

### Baden-Württemberg: Progress of the implementation

Baden-Württemberg has two main priorities within the smart specialization strategy: (1) research, technological development and innovation and (2) reduce CO2 emissions.

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Due to its economic and innovation potential, Baden-Württemberg has more than 130 cluster initiatives. Given the large number of clusters, Baden-Württemberg initiated a cluster evaluation project in 2012 in order to increase the cluster management quality based on criteria from the European Cluster Excellence Initiative (Ramboll Consulting, 2013). Within the RIS3 program, Baden-Württemberg has prioritized the following fields: sustainable mobility, photonics, biotechnology, macro- and nano-technology, logistics, creative industries, aerospace, ICT, health, and environmental technologies.\(^{35}\)

One of the major objectives of the EFRE program in Baden-Württemberg is to strengthen knowledge intensive sectors. A substantial amount of the EFRE funding (€65.4m from the total of €143.4m) is planned to be invested for projects within this sector.

Universities and research institutions are important players within the smart specialization strategy and implementation in Baden-Württemberg (RWB EFRE, 2015). These are active players in the technology and innovative knowledge transfer to the private sector. A special focus is to facilitate centres for applied research in universities of applied research. These centres should focus on interdisciplinary projects with high innovation potential especially for SMEs (Ministerium für Ländlichen Raum und Verbraucherschutz Baden-Württemberg, 2015).

**Baden-Württemberg: Monitoring mechanisms and feedback loop**

There are monitoring and evaluation instruments at different levels. Central monitoring instruments are Development Monitor 28 (‘Entwicklungsmonitor28’) as well as the innovation index (‘Innovationsindex’) Baden-Württemberg (Ministerium für Finanzen und Wirtschaft, 2013). In addition, all projects have specific milestone and roadmap systems.

The evaluation of the cluster related activities is mainly based on an input-output measurement (Ramboll Consulting, 2013). Within the first objective field of “knowledge intensive services”, 50 projects were funded through EFRE funding. The recipients of this funding were mostly private companies, but also universities, like the Karlsruhe Institute of Technology (KIT) or the Albert-Ludwigs-University in Freiburg. The majority of these projects focused on improvement of cluster management structures. The output of the projects is mainly related to soft key performance indicators, like stronger networking (Ramboll Consulting, 2013).

**Baden-Württemberg: Evidence of impact**

For the evaluation of the EFRE program for the period 2014-2020 there is a budget of €2m (Ministerium für Ländlichen Raum und Verbraucherschutz Baden-Württemberg, 2015). Stakeholders from administration, the steering committee will participate in the evaluation process. Future evaluation activities will focus their attention towards the evaluation of the implementation, the effect, and efficiency of the EFRE activities. Three priority fields have been defined which comprise a) strengthening the innovation system and the smart specialization of Baden-Württemberg; b) strengthening the energy transition and the sustainable energy sources; and finally c) technological development. The next evaluation is expected to be finalized in the first quarter of 2022 (Ministerium für Ländlichen Raum und Verbraucherschutz Baden-Württemberg, 2015).

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aussenhandel,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf (8/2016)>


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Prognos (2017), Status-Quo der Regionalen Innovationsstrategien zur „Intelligenten Spezialisierung“ (Ris3) Der Bundesländer, <link: >.


Abbreviations

AiF  Arbeitsgemeinschaft industrieller Forschungsvereinigungen "Otto von “Guericke" (German Federation of Industrial Research Associations)
BERD  Business Expenditures for Research and Development
BMBF  Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research)
BMWI  Bundesministerium für Wirtschaft und Technologie (Federal Ministry of Economics and Technology)
CHE  Centre for Higher Education
ERA  European Research Area
DG  Directorate General (of the European Commission)
DFG  Deutsche Forschungsgemeinschaft (German Research Foundation)
EC  European Commission
EFI  Expertenkommission Forschung und Innovation (Experts Commission for Research and Innovation)
ERDF  European Regional Development Fund
ESIF  European Structural and Investment Fund
ESF  European Social Fund
ESFRI  European Strategy Forum on Research Infrastructures
EU-28  European Union including 28 Member States
FhG  Fraunhofer-Gesellschaft (Fraunhofer Society)
GBAORD  Government Budget Appropriations or Outlays on R&D
GDP  Gross Domestic Product
GERD  Gross Domestic Expenditure on R&D
GWK  Gemeinsame Wissenschaftskonferenz (Joint Science Conference)
HEI  Higher education institutions
HERD  Higher Education Expenditure on R&D
HES  Higher Education Sector
HGF  Helmholtz-Gemeinschaft Deutscher Forschungszentren (Helmholtz Association)
HRK  Hochschulrektorenkonferenz (German Rectors’ Conference)
ICT  Information and Communication Technology
IU  Innovation Union
IUS  Innovation Union Scoreboard
MINT  Mathematics, Information technology, Natural sciences and Technology
MPG  Max-Planck-Gesellschaft (Max Planck Society)
NRP  National Reform Programme
OECD  Organisation for Economic Co-operation and Development
PRO  Public Research Organisations
R&D  Research and Development
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>RI</td>
<td>Research Infrastructures</td>
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<tr>
<td>RIS3</td>
<td>Regional and/or National Research and Innovation Strategies on Smart Specialisation</td>
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<td>RIS</td>
<td>Regional Innovation System</td>
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<td>R&amp;I</td>
<td>Research and Innovation</td>
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<td>SB</td>
<td>Scoreboard (of not otherwise mentioned here stands for “EU Industrial R&amp;D Investment Scoreboard”)</td>
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<tr>
<td>SME</td>
<td>Small and Medium Sized Enterprise</td>
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<tr>
<td>VC</td>
<td>Venture Capital</td>
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<td>WGL</td>
<td>Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz (Leibniz Association)</td>
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<tr>
<td>WR</td>
<td>Wissenschaftsrat (German Council of Science and Humanities)</td>
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<tr>
<td>ZIM</td>
<td>Zentrales Innovationsprogramm Mittelstand (Central Innovation Programme for SMEs)</td>
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## Factsheet

**Data sources:** various, including Eurostat, European Commission and International scoreboard data.

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<td>34300</td>
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<td>Value added of services as share of total value added (% of total)</td>
<td>71.46</td>
<td>69.12</td>
<td>68.61</td>
<td>68.51</td>
<td>68.92</td>
<td>68.79</td>
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<td>Value added of manufacturing as share of the total value added (%)</td>
<td>19.93</td>
<td>22.19</td>
<td>22.9</td>
<td>22.73</td>
<td>22.44</td>
<td>22.88</td>
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<td>Employment in manufacturing as share of total employment (%)</td>
<td>17.8</td>
<td>17.4</td>
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<td>17.64</td>
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<td>Employment in services as share of total employment (%)</td>
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<td>73.78</td>
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<td>73.79</td>
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<td>1.3</td>
<td>1.28</td>
<td>1.14</td>
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<td>Labour productivity (Index, 2010=100)</td>
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<td>102.1</td>
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<td>106.4</td>
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<td>New doctorate graduates (ISCED 6) per 1000 population aged 25-34</td>
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<td>Summary Innovation Index (rank)</td>
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<td>Innovative enterprises as a share of total number of enterprises (CIS data) (%)</td>
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<td>Innovation output indicator (Rank, Intra-EU Comparison)</td>
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<td>Turnover from innovation as % of total turnover (Eurostat)</td>
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<td>Country position in Doing Business (Ease of doing business index WB)(1=most business-friendly regulations)</td>
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<td>17</td>
<td>17</td>
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<td>Online availability of public services - Percentage of individuals having interactions with public authorities via Internet (last 12 months)</td>
<td>48</td>
<td>50</td>
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<td>GERD (as % of GDP)</td>
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<td>2.71</td>
<td>2.8</td>
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<td>GBAORD (as % of GDP)</td>
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<td>R&amp;D funded by GOV (% of GDP)</td>
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<td>0.84</td>
<td>0.84</td>
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<td>BERD (% of GDP)</td>
<td>1.94</td>
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<td>1.89</td>
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<td>Research excellence composite indicator (Rank)</td>
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<td>Percentage of scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country</td>
<td>11.51</td>
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