COUNTRY CASE STUDY: IRELAND

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1. Setting R&D targets

1) National R&D intensity targets. Does your country have R&D intensity target(s) at the national level (e.g. gross domestic expenditure on R&D as % of GDP; business expenditure on R&D as % of GDP)? If so, please specify:

Ireland set a national target of public and private RDI investment to reach a research intensity rate of 2.5% of GNP by 2020. The target was set in “Innovation 2020: Ireland’s strategy for research and development, science and technology” (2015)¹.

2) Target changes. Have the targets changed over time? If so, please specify:

Ireland’s National R&D Action Plan (Report of the Interdepartmental Committee, Building Ireland’s Knowledge Economy, July 2004) proposed that Ireland should aim to reach 2.5% of GNP by 2010, with two-thirds of the increase coming from enterprise. The Action Plan stated that GNP is a more appropriate measure of national output for Ireland than GDP due to the transfers within multinational organisations located in Ireland. Ireland’s R&D intensity in 2004 stood at 1.4% of GNP.

Perhaps more crucially, the Action Plan represented the beginning of a more structured approach to building Ireland’s National System of Innovation, which subsequent strategies, namely the Strategy for Science, Technology and Innovation 2006-2013 and Innovation 2020, have aimed to fully realise.

As part of the “Lisbon” agenda aimed at making Europe more competitive and innovative on the world stage, the Barcelona European Council concluded that Europe as a whole should aim to reach a target of spending 3% of GDP on R&D by 2010, with two thirds of that spend to come from industry.

Under the Europe 2020 Strategy, and as committed to by the Irish Government in the National Reform Programme in 2011 with a recommitment in Innovation 2020, Ireland set its current research target to raise combined public and private investment in RDI to 2.5% of GNP by 2020.

3) Subnational targets. Does your country have R&D intensity targets at the regional, local and/or sectoral level? If so, please provide an exhaustive list specifying:

Ireland has no subnational R&D intensity targets.

4) **Target criteria.** What were the criteria used to determine the specific target(s) in your country? Please select among the options below and explain why this was the preferred option:

The target was set based on the same target as set at EU level (i.e. 3% of GDP spent on R&D).

Ireland’s R&D intensity target was set in the context of the “Lisbon” agenda and the Barcelona European Council conclusion that Europe as a whole should aim to reach a target of spending 3% of GDP by 2010.

5) **The indicator.** To what extent do you think that R&D intensity provides a good indicator of innovation activity in your country? (please specify why)

Somewhat disagree.

Ireland’s experience of variability in R&D intensity, over a period when marked increases in infrastructure, human capital and other measures of innovative capacity have clearly occurred, point to R&D intensity as a poor marker of innovation activity in Ireland, when this measure is considered in isolation.

6) **Indicator challenges.** What have you found to be the main issues of using R&D to measure business-led innovation in your country? (select among the options below and provide references to quantitative and qualitative evidence where possible)

Others.

In Ireland’s case, the issues a) and f) (related to the insufficient capture in R&D statistics of the role of innovative start-up companies and broader innovation activities) have not been the subject of significant policy concern with regard to the R&D intensity indicator.

A major factor for Ireland has been the rapid increase in GNP resulting from a strong economic recovery following the 2008 financial crash. Ireland’s GERD has increased substantially in recent years, but GNP has increased at an even faster rate as indicated by the following:

- Gross Expenditure in Research and Development (GERD), as published in the R&D Budget 2017-2018, increased significantly from €2.969bn in 2014 to €3.396bn in 2017, an increase of 14.4%.
- Business Expenditure in R&D (BERD) increased by 31.5% between 2014 and 2017 as per the CSO BERD Survey 2017-18 released in April 2019.
- Government Budget Allocations for R&D (GBARD) increased by 1.7% between 2014 and 2017 (3.4% between 2014 and 2018 based on budget estimates).
- GNP grew by 43.3% between 2014 and 2017.

The growth in GERD between 2014 (the baseline year for I2020) and 2017 is to be welcomed, of course. However, it did not keep pace with the strong GNP growth linked to Ireland’s economic recovery. As a result, Ireland’s R&D intensity rate expressed as a percentage of GNP declined from 1.81% of GNP in 2014 to 1.46% in 2017.

For a small economy like Ireland, the dramatic changes in GNP associated with the financial crisis and subsequent recovery, has limited the utility of the R&D Intensity measure, if considered in isolation, over the period.

But economic cycles are not the only challenge with using a measure based on GDP or GNP. Globalisation presents significant challenges in terms of measuring economic activity. While this is the case in most advanced economies, the issues are particularly acute in an Irish context, given the large multinational footprint.
GDP measures the total output of the economy in a period i.e. the value of work done by employees, companies and self-employed persons. This work generates incomes - the total income remaining with Irish residents is the GNP and it differs from GDP by the net amount of incomes sent to or received from abroad.

Gross National Income (GNI) is a very similar concept to that of GNP – the main difference between the two aggregates is that GNI adjusts domestic incomes for subsidies from and taxes paid to the EU.

Modified GNI (or GNI*) is defined as GNI less the effects of the profits of re-domiciled companies and the depreciation of intellectual property products and aircraft leasing companies.

Because the modified GNI aggregate is a better approximation of the size of the Irish economy, the Department of Finance in Ireland supplements the Government’s European budgetary requirements with debt-to-GNI* figures. Similarly, R&D expenditures as a percentage of GNI* are now calculated to provide a more reliable benchmark against other countries. This is in addition to the calculations as a percentage of GDP and GNP.

In 2018, GNI* was approximately 61% of GDP in Ireland.

See full explanatory note on GDP and GNI* from the Department of Finance in this explanatory note².

7) **Other targets.** Do your innovation strategies or other strategic documents include other quantitative targets to foster innovation? If so, please provide details on the specific targets and year of adoption, deadlines to achieve them and documents setting them.

The table below summarises the Targets included in Ireland’s National Innovation Strategy ‘Innovation 2020’ together with progress towards those targets as presented in the Mid Term Review of I2020.

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² [https://assets.gov.ie/4910/181218123252-71a2c297f26b419fa3696d7349e3e788.pdf](https://assets.gov.ie/4910/181218123252-71a2c297f26b419fa3696d7349e3e788.pdf).
<table>
<thead>
<tr>
<th>Metric</th>
<th>Baseline (2014 unless specified)</th>
<th>2020 Target</th>
<th>Latest data</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Innovation Scoreboard(^1)</td>
<td>+9%(^2) (10th place(^3))</td>
<td>+20%</td>
<td>+15.9%(^2) (9th place(^4))</td>
</tr>
<tr>
<td>Drawdown Horizon 2020</td>
<td>€620m under FP7</td>
<td>€1.25bn</td>
<td>€632.1m(^5)</td>
</tr>
<tr>
<td>Research intensity: GERD as % of GNP</td>
<td>1.82%</td>
<td>2.5%</td>
<td>1.46% (2017)(^6)</td>
</tr>
<tr>
<td>Increase private (Irish and foreign business) business funding of R&amp;D performed in Higher Education sector</td>
<td>€24m</td>
<td>€48m</td>
<td>€32m (2015)(^7)</td>
</tr>
<tr>
<td>New post-graduate enrolment (Research Masters and PhD (first year) enrolment)</td>
<td>2,235 (2013/14)</td>
<td>+500</td>
<td>2,243 (2017/18)(^8)</td>
</tr>
<tr>
<td>Increase in the proportion of innovation active enterprise</td>
<td>58%</td>
<td>73%</td>
<td>57% (2016)(^9)</td>
</tr>
<tr>
<td>Increase (+15%) in the number of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Significant enterprise R&amp;D Performers(^*)</td>
<td>1,040</td>
<td>1,200</td>
<td>918 (2017)(^10)</td>
</tr>
<tr>
<td>- Large enterprise R&amp;D Performers(^**)</td>
<td>170</td>
<td>200</td>
<td>207 (2017)(^10)</td>
</tr>
<tr>
<td>Research Personnel in enterprise</td>
<td>24,785 (2013)</td>
<td>40,000</td>
<td>27,322 (2017)(^10)</td>
</tr>
<tr>
<td>(research, technicians and support staff)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercialisation targets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Commercially relevant technologies</td>
<td>124</td>
<td>175</td>
<td>164 (2017)(^11)</td>
</tr>
<tr>
<td>- Spin-outs</td>
<td>29</td>
<td>40</td>
<td>21 (2017)(^11)</td>
</tr>
<tr>
<td>- HPSU from Spin-outs</td>
<td>11</td>
<td>16</td>
<td>15 (2017)(^11)</td>
</tr>
<tr>
<td>- Collaborative research (EI supported enterprise and Public Research Organisations)</td>
<td>878</td>
<td>920</td>
<td>1078 (2017)(^11)</td>
</tr>
</tbody>
</table>

1 In 2016, when I2020 was published, this indicator was included the Innovation Union Scoreboard. To compare change in relative performance overtime, past data were re-casted
2 Performance relative to that of the EU average that year
3 The 2015 European Innovation Scoreboard uses 2014 data
4 The 2018 European Innovation Scoreboard uses 2017 data
5 DBEI October 2018
8 DBEI based on HEA enrolment data for 2017/2018
10 CSO (2019) Business Expenditure on R&D 2017-2018
11 KTI (2018) KTI Review and Annual Knowledge Transfer Survey 2017
\(^*\) Significant enterprise R&D performers invested between €100k and €2m
\(^\**\) Large enterprise R&D performers invested over €2m

- The 2018 European Innovation Scoreboard (EIS) shows that Ireland’s position in terms of innovation leadership has progressed: Ireland was in 9th position in 2017 gaining one place on the 2015 EIS (which corresponds to the 2014 baseline). Ireland remains a Strong Innovator but has not yet reached its goal to become an Innovation Leader.

- Participation in Horizon 2020 is on course to meet the EUR 1.25 billion target.

- Ireland’s research intensity rate expressed as a percentage of GNP declined from 1.81% of GNP in 2014 to 1.46% in 2017.

Targets relating to private funding for R&D performed in HEIs, human capital, enterprise R&D, and commercialisation were also included in I2020.

Regarding the target for private funding for R&D performed in HEIs:

- Over the first three years of I2020, Science Foundation Ireland (SFI) invested EUR 100 million of State (and European) funding which will be matched by EUR 53 million of enterprise funding, in 5 additional new Research Centres, bringing the total number of SFI Research Centres to 17. SFI Research Centres focus on strategically important areas of research for Ireland, linking scientists and engineers in partnerships across academia and industry.

Regarding human capital targets:

- Progress on increasing the recruitment of research talent is recent. The 2017/18 new enrolment numbers for postgraduate students (Research Masters and PhDs) show a small increase compared to the 2013/2014 baseline. Further progress is expected in 2018/19 with funding of additional PhDs students. For example, SFI committed €23.7m in funding for the period 2018-2022 for the direct recruitment of 110 postgraduates (94 PhDs and 16 MScs) with EUR 5.5 million spent in 2018. With an additional EUR 15 million allocated in 2019, SFI will commence recruitment in the new Centres for Research Training.

Regarding enterprise targets:

- The objective of increasing innovation across Ireland’s enterprise based by increasing both the number of R&D performers and the R&D research intensity for those who already innovate remains relevant.

- The ambitious target of 73% of innovation active enterprises (the highest rate of innovation active enterprise in Europe is in Germany where just over 67% of German enterprises are innovation active) is unlikely to be met by 2020.

- The number of large enterprise R&D performers exceeds the target with 217 large R&D innovators (the target was 200).

- The number of significant enterprise R&D performers decreased from 1040 to 918.

Regarding commercialisation targets:

- The number of commercially relevant technologies (Licences, options and assignments), the number of HPSU from spin-outs, and the number of collaborations by EI supported enterprise are expected to exceed targets. The number of spin-outs declined from 29 to 21 but this decline is compensated for by an increase quality of the spin-outs, as suggested by the increase in the number of spin-outs taken forward as HPSUs by EI. Also, a number
of start-ups are created independently from the Research Performing Organisations. This commercialisation record is reflected in Ireland’s strong performance in some of the EIS components (e.g. Innovation in SMEs).

The conclusion reached in the Mid Term Review of I220 is that, notwithstanding the reduction in R&D intensity, Ireland’s RDI system continues to perform strongly.

2. Implementing R&D targets and policies

8) Policy initiatives in place. What are the main policy initiatives implemented in your country with the aim of achieving the national R&D target(s)? For each policy initiative, please provide the following details:

Enterprise Policies:

A recent review concluded that the suite of RD&I supports provided to companies in Ireland is relatively comprehensive compared to similarly-sized advanced countries.3

RD&I support in Ireland is provided in the form of both agency supports and tax incentives.

- The two key tax incentives programmes are the RD&I Tax Credit and the recently introduced Knowledge Development Box. These are designed to build in-company RD&I capacity and to ensure that Ireland’s tax incentive offering is competitive.

- A range of RD&I supports are provided by Enterprise Ireland to support the growth of Irish businesses, especially in world markets. There are six RD&I programmes under the remit of Enterprise Ireland, namely: Innovation Vouchers; Innovation Partnership Programme; the recently introduced Business Innovation Initiative; the High-Potential Start-up Investment Programme; Technology Centres and the agency’s RD&I Fund.

- IDA Ireland provides RD&I supports to assist in the attraction, retention, and development of foreign direct investment in Ireland. It is responsible for two key RD&I programmes: namely, the RD&I Programme and Feasibility Support and Technology Centres, which are jointly run with Enterprise Ireland.

- Science Foundation of Ireland (SFI) is responsible for four programmes, namely the Strategic Partnership Programme; SFI Research Centres; the Spokes Programme and the SFI Industry Fellowship.

- The Irish Research Council is responsible for two support programmes: namely, the Enterprise Partnership Scheme and the Employment Based Programme.

- InterTrade Ireland provides a specific RD&I initiative, the FUSION Programme, to support the promotion and development of cross-border trade and business activities.

Policies for HERD:

The policies in Innovation 2020 that focus on building capacity and excellence in the Irish RDI system in terms of research talent and research infrastructure include policies to. These actions seek to:

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- Ensure that the higher education sector drives innovation;
- Continue to develop the pipeline of talent;
- Increase the pipeline of PhDs, post-doctoral researchers and principal investigators;
- Promote “Frontier Research” across all disciplines;
- Create opportunities for world-renowned research professors;
- Develop a clear career structure for researchers involved in innovation;
- Create opportunities for improved research mobility;
- Promote gender equality in research careers;
- Further develop research infrastructure in HEIs.

Policies for GOVERD:

Policies to promote innovation in health include:

- The Department of Health has established a new Research and Development and Health Analytics Division within the Department;
- The funding and development of new health research infrastructure (the Health Innovation Hub Ireland, the Clinical Research Facilities and Clinical Research Coordination Ireland (HRB-CRCI), the national bio-banking system);
- The publication of the HRB Strategy 2016-2020 and the development and roll out of a Research Funding Evaluation Plan (2017-2020).

Actions to promote innovation in agri-food are aligned with Food Wise 2025 – the ten-year strategy for the agri-food sector. A number of milestones have been achieved:

- The launch of the Bord Bia Consumer Research and Market Insight Centre, the development of Teagasc’s Food Innovation Hub and the expansion of Teagasc’s Moorepark Technology Ltd and the launch of a new SFI-DAFM funded VistaMilk Research Centre;
- The launch of the National Policy Statement on the bioeconomy and the establishment of a High-Level Bioeconomy Implementation Group.
- The announcement of a new Marine Innovation Park (Páirc Na Mára) by Údaras na Gaeltachta to complement the national aquaculture research cluster is a key development.

Progress is being made to promote innovation in the environment and energy sectors:

- The EPA Research Strategy 2014-2020 and the Energy Research Strategy are progressing. The increase in support for Ireland’s energy/low carbon technology research & innovation sectors is substantial.
9) **Successful policies.** What policies have been most successful (currently or in the past) in driving R&D intensity? What are considered the main factors of success? (These may be a mix of policy and other contextual factors). Please provide qualitative and quantitative evidence when possible.

Policy developments since 2015 have reaffirmed the relevance of I2020’s objectives, in particular, the objective of increasing innovation across Ireland’s enterprise base by increasing both the number of R&D performers and the R&D intensity for those who already innovate.

At a high level, the success of Ireland’s policy-mix in building innovative capacity and excellence can be illustrated by successes in the following areas:

*Talent*
- A consistent objective of Ireland’s innovation policy has been to support mobility of research talent between higher education and enterprise in particular. Innovation 2020 contains a target to increase Research Personnel in Enterprise to 40,000. Progress towards this target is being made.

*Science base*
- The quality of Irish research has gone from 36th (2003) to 12th (2019) according to InCites Essential Science Indicators by Clarivate Analytics.

**BERD**

Ireland has the highest share of R&D (75%) undertaken by the business sector in Europe, as opposed to R&D undertaken in the higher education and government sectors, suggesting significant leverage in the use of public funding in support of RD&I.

In value terms, Ireland’s BERD reached EUR 2.293 billion in 2016 which represents an almost 40 percent increase since 2009.

Although the revenue foregone as a result of the R&D tax credit is not included in the calculation of R&D intensity, the description of the policy is included here for completeness.

The R&D tax credit has become a cornerstone for stimulating RD&I activities by our enterprises and is internationally competitive. If a company spends on qualifying research and development activities, it can avail of the R&D Tax Credit. The credit is calculated at 25% of qualifying expenditure and is used to reduce a company’s Corporation Tax (CT) liability. When a company has offset current and previous years’ CT liabilities, or has no taxable profits, it may apply for a credit to be paid to them.

An Economic Evaluation of the R&D Tax Credit conducted by the Department of Finance in October 2016 indicates the tax credit achieves reasonable additional. This review estimates that of the R&D conducted by firms since 2009, 60% is additional R&D i.e. the tax credit incentivises firms to perform R&D that would not have occurred in the absence of the tax credit policy.

Analysis of the firm characteristics of the R&D tax credit show that it is mainly older, larger and non-Irish firms who derive financial benefit from the scheme, although it is typically Irish firms who benefit more from the repayable credit element of the scheme.

*Other developments point to ongoing support for Ireland’s objective to increase RD&I:*
- The Disruptive Technologies Innovation Fund (DTIF) in the National Development Plan 2018-2027 and the announcements of funding for the Regional Technology and
Innovation Clusters associated with the Technological Universities (TUs) and the Institutes of Technology (IoTs).

- The National Development Plan 2018-2027 provides for considerable indicative funding to deliver on a range of Strategic Investment Priorities over the ten-year programme which include investment in research infrastructure, a new cycle of PRTLI (the Programme for Research in Third Level Institutions), and the funding of SFI Centres for Research Training in areas of future skills need (data, digital and ICT) to address research talent and research infrastructure needs.

10) **Unsuccessful policies.** Are there any examples of policies implemented in the past in your country to drive R&D intensity that did not reach the intended objectives? (e.g. investments that did not steer as much private investment in R&D as expected) What were the factors that hindered their success? (These may be a mix of policy and other contextual factors). Please provide qualitative and quantitative evidence when possible.

Evaluations of R&D supports has been a consistent feature of Ireland’s policy process since the initiation of significant funding for RD&I in Technology Foresight Exercise and the National Development Plan, 2000 – 2006.

These evaluations have not identified particular policies that could be deemed unsuccessful. Ireland has been a late starter in terms of the development of a national innovation system and the investment of significant funding for RD&I. In this regard, Ireland has benefited from learning from other countries’ policy experiences, adopting a ‘fast follower’ approach to policy development.

This approach has been successful in enabling Ireland to significantly increase its national innovation system and innovative capacity in a relatively short period of time without major policy failures.

11) **Implementation challenges.** What have been the main challenges when implementing policies aimed at increasing R&D performance? Please provide details.

A recent national review of R&D supports in Ireland concluded that the following barriers exist for firms engaging in R&D:

- There are a range of barriers to RD&I take up impacting on firms who are currently not research active. These include financing costs, lack of RD&I culture and gaps in the RD&I absorptive capacity within the enterprises. These barriers are particularly likely to apply to small enterprises.

- A barrier which exists for firms who are not engaged in RD&I relate to a lack of knowledge on the benefits of RD&I and how their firms could engage in such activities. This may suggest a need for integrated programmes involving audits of their requirements, demonstration initiatives on the benefits of RD&I, and assistance with implementation of such activities. Without such tailored initiatives, firms may engage in very minimal research and may fail to conduct more research-intensive activities.

- For firms who are engaged in RD&I, barriers to becoming more active also relate to financing costs or risks. Personnel constraints may also hinder an expansion of RD&I for such firms.

In the Irish context, other issues may apply to medium-sized foreign firms where they do not currently have a mandate to engage in RD&I in Ireland. This may apply even though such companies operate in high technology sectors and where absorptive capacity is unlikely to be an issue.
12) **The role of policy and other factors.** To what extent was the evolution of R&D performance in your country driven by policy or by other contextual factors? Please provide details and quantitative evidence where possible, and specifying which factors particularly supported or hindered R&D investments. Please also refer to any evaluation conducted to assess the impact of policy instruments on R&D intensity.

The recent ‘Review of RD&I Supports available to Businesses in Ireland to Maximise Business Expenditure on Research and Development’ outlined the following contextual factors relevant to Ireland’s R&D performance:

- RD&I activity is driven in the main by large foreign owned firms. The majority of expenditure on RD&I are provided by such firms.
- Among smaller firms, almost three-quarters of all RD&I expenditure is by Irish firms. This reflects the dual structure of the Irish industrial base.
- The largest single sector for RD&I in Ireland is Computer Programming, which represents 22% of all RD&I activity. The sectors that have shown the highest growth rates since 2000 are Business Services and Medical Device Manufacturing. Sectors with lower levels of RD&I include Food, Drink and Tobacco, the main indigenous sector, which is comprised mainly of SMEs.

13) **Policy lessons.** What are the main policy lessons learned during the implementation of policies for increasing R&D intensity? What would be your concrete advice to countries intending to set R&D targets and policies to achieve them for the first time? (e.g. high or low effectiveness of specific policy measures, how to take into account specific country conditions)

The Review of Innovation 2020, carried out in 2019, concluded that reaching the I2020 targets in terms of research intensity as a percentage of GNP and completing the action in terms of research talent and research infrastructure will require a substantial increase in investment.

Progress on the actions relating to investment in research talent and research infrastructure is recent and gradual. During the consultations, a consensus emerged that increased investment to further develop research talent and research infrastructure is essential if the full potential of I2020 is to be realised.

The Review of Innovation 2020 also identified the following areas to further enhance economic and/or social impact:

- Research in services and business processes including the appointment of “Star” researchers within the HEIs could be reviewed
- Interdisciplinary research could be encouraged further to deliver economic and/or societal impact (and with it, participation in European programmes)
- Coordination between research and innovation performers and policy makers could be explored further and
- Further mission-oriented funding to address societal challenges, most notably challenges associated with the pursuit of the UN Sustainable Development Goals, should be considered with some alignment of this funding with EU Research programmes.

The Review concluded that the goals of I2020 remain relevant and pertinent. It is important to ensure that public investment in R&D translates into economic and/or societal impact, including the development of research talent within HEIs and Public Research Organisations (PROs) and enterprise. This will allow for the development of Ireland’s skills base - including the skills to develop the next generation of talent.
The challenge for the successor of I2020 will be to further mobilise public and private resources to strengthen and expand research talent and research infrastructures.

3. R&D targets and innovation disparities

14) **Innovation disparities.** Which distributional aspects (i.e. social, sectoral and/or geographical disparities) has received more innovation policy attention in your country? What evidence are you using to explore the geographical and sectoral distribution of R&D performance in your country? Please provide the reference and link to that evidence where possible.

Large firms dominate aggregate RD&I expenditure as well as the value of total exports. The majority of expenditure on in-house RD&I, and a large minority of RD&I employment, is provided by such firms.

The distribution of RD&I expenditure in Ireland is also heavily influenced by firm ownership. Ireland’s RD&I performance is being driven by a large degree by a small number of foreign-owned firms. Cumulatively, 59 firms account for over half (52%) of all RD&I expenditure in Ireland, the majority of which are foreign owned.

Among smaller firms, 73% of all expenditure is by Irish firms, though this falls to 43% for medium-sized firms. Among large firms, where the majority of RD&I takes place, a large majority (90%) is conducted by foreign-owned firms, reflecting the dual-structure of the Irish industrial base.

All size classes of firms have experienced some growth in RD&I activity since 2000. Small and medium-sized firms (i.e., with up to 249 employees) grew at 4.8% per annum, compared to 4.4% for large firms.

15) **Territorial disparities.** Are territorial inequalities in innovation performance explicitly addressed by policies discussed in question 8 or other policies aimed at improving R&D performance? (e.g. measures to promote the distribution of R&D expenditures across regions; measures targeted at less innovative regions) Please explain how these policies promote inclusiveness and provide quantitative evidence of results/impacts achieved where available.

In many respects, from an R&D perspective, Ireland constitutes a region. One estimate of the spatial scope of knowledge spill-overs is 250-300 km, which broadly covers the entire landmass of Ireland, although some studies suggest smaller distances.

16) **Sectoral disparities.** Are sectoral disparities in innovation performance explicitly addressed by policies discussed in question 8 or other policies aimed at improving R&D performance? Please explain how these policies promote inclusiveness and provide quantitative evidence of results/impacts achieved where available.

Based on data from 2014, the largest single sector of in-house RD&I in Ireland is Computer Programming, representing 22% of all activity, followed by the sectors Chemicals, Computer, Electronic & Optical products, and Computer Consultancy with 13%, 13% and 12% of aggregate RD&I spend, respectively. The sectors showing the highest growth rates are Business Services and Medical Device Manufacturing. Traditional Manufacturing and Food, Drink & Tobacco constitute lower shares, but in these sectors RD&I has increased.

17) **Other country characteristics.** How are other specific characteristics of the country (e.g. sectoral structure, R&D strengths) taken into account when designing innovation policies aimed at improving R&D performance?

Not specified.
4. R&D targets in the digital age

18) **Policy strategies.** Do current R&D and innovation policy debates and/or policy strategies in your country address the opportunities and challenges of digital and AI-driven innovation? Please provide details regarding current debates in your country or how those have been integrated in innovation strategies.

   Not specified.

19) **Policy initiatives.** Have specific policy initiatives to foster R&D been created or adjusted in view of changes in research and innovation practices brought about by digital technologies? Please provide details of those changes, making reference to the specific policies concerned.

   In 2012, the Irish Government introduced Research Prioritisation, which aligns the majority of competitively awarded public investment in research with 14 priority areas. Innovation 2020, Ireland’s strategy for research and development, science and technology, committed to reviewing the priority areas to ensure that they are still valid and to refresh and revise them, if necessary, in the light of changed circumstances. As a result of the Refresh of Ireland’s National Research Prioritisation Exercise, the ICT priority areas have been broadened to reflect the changes in technology and now comprise:

   - Future Networks, Communications and Internet of Things
   - Data Analytics, Management, Security, Privacy, Robotics and Artificial Intelligence (including Machine Learning)
   - Digital Platforms, Content and Applications, and Augmented Reality and Virtual Reality

   ‘Future Jobs Ireland 2019’ is the first in a series of annual action plans aimed at enhancing the resilience of Ireland’s economy and ensuring that Ireland is well placed to exploit future economic opportunities. Pillar 1 embraces innovation and technological change and calls for a strategic approach to maximise the benefits from digitalisation. The deliverables are an Industry 4.0 strategy, a national Digital strategy and an AI strategy.

   In addition, the Department of Communications, Climate Action and Environment are currently working on an updated National Cyber Security strategy.

   The National Space Strategy for Enterprise acknowledges the spill over value from the Earth Observation Big Data sets available to Ireland through the development of advanced data analytics skills from research in this area. These skill sets, whilst being highly relevant to Earth Observation, also have multiple further uses in the applications of Industry 4.0 such as Data Management, Automated Processing and Artificial Intelligence.

   The Department of Business, Enterprise and Innovation (DBEI) co-funds the Irish Centre for High-End Computing (ICHEC) to the value of EUR 1.222 million per annum. ICHEC is a national body under the aegis of NUIG and is also funded by the Department of Education and Skills. ICHEC manages Kay, Ireland’s national supercomputer for academic researchers, and delivers the national High-Performance Computing (HPC) service to academia. ICHEC also provides HPC and technical computing services to industry and participates in joint R&D activities with FDI companies.

20) **New targets.** Do the abovementioned digital/AI-related innovation strategies or initiatives include quantitative targets? If so, please provide details on the specific targets and years of adoption, deadlines to achieve them and documents setting them.
Ireland’s ‘Industry 4.0 Strategy 2025: Supporting the digital transformation of the manufacturing sector and its supply chain’\(^4\) acknowledges that there are no indicators currently in use that accurately reflect Industry 4.0 adoption in the manufacturing sector and its supply chain. However, the EC has developed a framework for reporting on the digital transformation of businesses, which utilises: indicators; surveys; real-time data; and policy analysis methodologies. This ‘Digital Transformation Scoreboard’\(^5\) (and associated report) could be used as a resource for the development of key indicators. The EC annual review of ‘Progress in National initiatives on Digitalising Industry’ could also be used as an input to bench marking and tracking of international Industry 4.0 activities.

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