

Spreading Excellence & Widening Participation in Horizon 2020

Analysis of FP participation patterns and research and
innovation performance of eligible countries

Written by Jaana Puukka
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Spreading Excellence & Widening Participation in Horizon 2020 - Analysis of FP participation patterns and research and innovation performance of eligible countries

European Commission
Directorate-General for Research and Innovation
Directorate B Open Innovation and Open Science
Unit B5 Spreading excellence and Widening Participation
Contact Dionysia Lagiou
E-mail Dionysia.Lagiou@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

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Edited by independent expert Jaana Puukka

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EXECUTIVE SUMMARY AND CONCLUSIONS

The purpose of this study is to analyse the participation patterns in Horizon 2020 and the causes for the low participation of a number of EU Member States and Associated Countries, as an indirect contribution to the post-Horizon 2020 programme, updating the 2011 analysis by the Commission of the EU-13 low participation. The study is based on qualitative methods including desk research, seven country cases and eight semi-structured interviews with Widening coordinators and policy stakeholders. The seven country cases cover three Widening countries, which are performing better than average EU-13 (Cyprus, Estonia and Slovenia), two lower performing Widening countries (Bulgaria and Poland), one Widening associated country (Serbia) and one Southern European country from the EU-15 (Italy). The country case studies are available in Annex 3.

The concentration of funding in terms of participants and the geographical representation remain challenges for the Framework Programme (FP) participation. Participants from the five EU-15 countries – UK, Germany, France, Spain and Italy – receive 60% of the overall funding and represent 64.5% of the investment in R&I (GERD) in Europe. The EU-13 countries represent 8.5% of the participations in Horizon 2020 and receive 4.4% of the overall funding. The EU-13 countries have a lower success rate of applications (11.1% compared to 14.4% for the EU-15) and a much smaller share of project coordinators in signed contracts: 5.1% vs. 87.6%.

Despite their lower Horizon 2020 contributions, the EU-13 countries show a relatively good performance in Horizon 2020 in light of their R&I spending. Some EU-13 countries outperform the EU-15 average, but the differences between the best and the weakest performers remain significant. The results for the first two years of the H2020 implementation show that Cyprus, Estonia and Slovenia outperform the EU-15 averages, taking into account the size of the population, the number of researchers and national investments in R&D, while Poland, Lithuania and Bulgaria are performing below the EU-13 average. Researchers based in Cyprus and Hungary also receive more grants from the European Research Council than would be expected based on national research investment. When the national investments in R&D are taken into account, EU-13 Member States outperform on average EU-15 countries by 6.7%.

The process of bridging the EU R&I divide shows both positive and negative dynamics but the main trend in the EU-28 R&I performance is the emergence of a more nuanced divide between countries with some catching up, and others lagging behind. Most innovation leaders are improving their Summary Innovation Index Scores, but the convergence progress remains uneven. While many central and Eastern European countries are catching up on most components of innovation capacity, some countries, some of them face significant challenges in narrowing the gap in the research systems. There is also a growing divergence among the southern European countries, with Portugal improving, Spain and Italy losing ground.

For most EU regions innovation performance has improved over time, but disparities are growing in peripheral areas. The biggest gains have been made by regional Innovation Leaders, which are typically located in the most innovative countries in Western Europe and which perform best on all relevant indicators, in particular on those which measure the performance of their research system and business innovation. At the other end, performance has declined mostly in peripheral regions in the South and East of Europe, especially in Italy, Romania and Finland, but also, in Central Europe e.g. Germany. Some Widening countries feature regional pockets of excellence, usually capital regions, while in Spain, the highest performing region is the Basque Country.

The FP participation gap is not fully aligned with the innovation divide in Europe. Both Spain and Italy belong to the top-5 performers in Horizon 2020, but are Moderate Innovators according to the European Innovation Scoreboard (EIS). Nordic countries are Innovation Leaders but feature lower FP performance than could be

expected based on their R&D intensity. While the two Modest Innovators – Romania and Bulgaria – show low performance in FP, countries such as Cyprus feature high FP participation rates, but appear in EIS as Moderate Innovators.

Synergies between the FP and ESIF remain variable across the EU countries.

Some countries have successfully allocated ESIF money to R&I, which has substantially improved their R&I capabilities, whereas others continue to face challenges in utilising these funds in a sustainable way. Despite a strong EU policy mandate for maximising synergies, the tendency to work in silos continues to constrain improvements. There may also be lack of responsibility and the definition of roles and ownership at the Member States and regional level.

In order to capture the positive and negative dynamics in the process of bridging the R&I divide and building convergence, the following changes are suggested:

- Simplify the FP application, implementation and evaluation procedures.
 - In the application phase consider moving away from an application of 60-70 pages to 20 pages with focus on work packages, milestones and financial aspects;
 - Introduce greater flexibility to the implementation of the Widening programme in line with the experience from RegPot;
 - Make the evaluation phase faster in line with the European Science Foundation practice;
 - Take greater advantage of two-stage evaluations which could consist of a 'blind evaluation' of research and innovation capacity during the first stage, followed by the evaluation of the team and capacity during the second stage.
- Introduce Widening as a horizontal theme in the FP actions;
- Integrate an enhanced Synergies mechanism into the Widening programme, but avoid diluting excellence in research;
- Award extra points for the Framework Programme proposals, which make use of the infrastructure and equipment in Widening countries, developed by ESIF;
- Consider to what extent the current composite indicator identifies the countries in most need of Widening actions. Another way to identify countries could be based on a phased process of exclusion with successive indicators;
- Consider whether Widening could address the growing divergence in R&I among European regions.

In order to overcome the persisting barriers to participation in the FPs and to capture the positive and negative dynamics in the process of bridging the R&I divide and building convergence, the following suggestions are made:

- Streamline and simplify the FP application, implementation and evaluation procedures.
 - In the application phase consider moving away from an application of 60-70 pages to 20 pages with focus on work packages, milestones and financial aspects;
 - Introduce greater flexibility to the implementation of the Widening programme in line with the experience from RegPot, allowing funding for research, exchange of staff and employment of postdoctoral staff;
 - Make the evaluation phase faster in line with the European Science Foundation practice;

- Take greater advantage of two-stage evaluations, which could consist of a 'blind evaluation' of research and innovation capacity during the first stage, followed by the evaluation of the team and capacity during the second stage.
- Introduce Widening as a horizontal theme in the FP actions;
- Integrate an enhanced Synergies mechanism into the Widening programme, but avoid diluting excellence in research;
- Award extra points for the FP project proposals, which make use of the infrastructure and equipment in Widening countries, for instance developed by ESIF;
- Consider to what extent the current composite indicator identifies the countries in most need of Widening actions. Another way to identify countries could be based on a phased process of exclusion using successive indicators;
- Consider whether Widening could address the growing divergence in R&I among European regions;
- Collaborate closely with the eligible countries to monitor the implementation and impacts of reforms, including the recommendations of Policy Support Facility Reviews given the observed time lag in the implementation in some countries;
- Enhance the visibility of good practice and access to networks, e.g. encourage the participation of Teaming 2 Centres of Excellence in the European Technology Platforms and Public-private partnerships and other networks.
- Consider whether allocating support for reforms could be done on the basis of evidence of progress in the implementation;
- Encourage countries to continue their efforts to reform national R&I systems and increase investment in the public science base. For example encourage countries to introduce performance-based salary systems. Consider whether EU level action is needed to align pension systems to support research mobility;
- Address the tendency to work in silos at different levels (EU, national, regional) and introduce more flexibility from the Commission legal services to ensure better synergies between FP and ESIF.

Several countries have taken a range of measures to increase R&I performance and reduce the innovation gap, but country differences remain significant (see Annex 3). These measures include aligning the national R&I system with the EU strategies (including smart specialisation strategy) and best practice, directing EU structural funds to support R&I performance, allocating research funding through competitive means, reforming research evaluation systems, providing support and incentives for the preparation and/or implementation of FP projects (including projects which have not been funded by the FP but have been positively evaluated), building synergies with ESIF funding, and developing the national contact point systems. For example among Widening countries Estonia has developed a broad portfolio of support mechanisms, including co-financing of scientific counsellors in sector ministers to set their R&D priorities and priorities in Horizon 2020, whereas Bulgaria is still at the early stages of development. The key national measures that the EU intervention cannot substitute include the reform of the national R&I system although the EU can support this process through Horizon 2020 Policy Support Facility and ESIF.

Most factors identified in the 2011 analysis as causes for variation in country participation in the Framework Programmes remain. While some have lost their significance, others that were not specifically highlighted in 2011 have gained importance. Based on the small sample of interviews, the national research investment and the access to networks remain the most important factors causing variation in the FP

participation. In the following, we will present the causes for variation of country participation, first outlining the validity of the 2011 analysis:

- **Low national research investment remains a key cause for low performance in Framework Programmes**, however, given their national R&I spending, many Widening countries are doing relatively well. The reasons behind the correlation between Framework Programme participation and national research investment relate to the access to infrastructure and R&D personnel with skills for leading-edge research and preparation of research proposals. While Romania, Portugal and Spain have shown low R&D investment-intensity records over the past decade, countries such as Czech Republic, Bulgaria, Poland and Slovakia have stepped up their R&D investment intensity, and Czech Republic is now converging towards the EU average. In several countries the convergence has been driven by public funds, often by the increased use of ESIF for R&I activities. This points to the need for greater national efforts to ensure long term sustainability. The balance between the public and private R&D intensity varies across countries; countries with very low public investment face mounting challenges in the development of R&I capacities. A cause of concern is the bundle of long term human resources challenges that impact the access to high level skills for R&I, including ageing, outmigration, skills mismatches and low attraction of research careers. However, some of the best performing Widening countries, notably Cyprus and Estonia, register a small number of FTE researchers, who are nonetheless active in international co-publication.

- The efforts to increase national R&I expenditure should be combined with a continuing reform of the national R&I systems.
- H2020 PSF reviews should include a structured follow-up review within an agreed time span.

Further analysis could focus on:

- FP participation rates against researchers by country; FP participation rates in relation to GBAORD (Government Budget Appropriations or Outlays for Research and Development);
 - the link between research capacities and excellence;
 - the impact of the balance between public and private R&D investment; and
 - the impact of the level of funding for Higher Education R&D and the balance between basic funding and competitive funding.
- **Despite the contrasting evidence provided in the Interim Evaluation of Horizon 2020 on the growing shares of the EU-13 FP participations and the related EC funding contributions to the countries, the interviews suggest that access to existing networks and the clustering of large research-performing countries remain the Number One barrier for participation for lower performing countries, as already identified in the 2011 analysis.** The relevant networks include the Public-Private Partnerships and European Technology Platforms at EU level, which influence on the priorities for research and innovation and generate a bulk of EU project proposals. The interviews also suggest that closed networks and the related lobbying power can constitute a barrier for FP participation for newcomers not only at the international but also at the national level, for example researcher networks may be closed to younger researchers. To address these challenges, interviewees suggested that the Commission should:
- consider encouraging the participation of Teaming 2 Centres of Excellence in the European Technology Networks and other networks;
 - consider awarding additional points for projects which make use of infrastructures in the Widening country;
 - highlight the Widening country research excellence and good practice.

Further analysis could focus on:

- the access to networks, given the gap in the evidence from the EU data and the perceptions by the Widening countries.
- **Lack of articulation between the Framework Programmes and the national R&I systems continue to affect the less performing countries.** There is significant variation in the development trajectories of the national R&I systems highlighted by the Widening countries which are at different stages of aligning their R&I systems with the Framework Programmes, some performing above the EU-15 average, others lagging behind. As noted above, countries such as Estonia have systematically used the Structural Funds to reform their R&I system, which has consequently improved conditions for FP participation, whereas some have difficulties in absorbing ESIF and have not been able to use these funds successfully for reforms. Several countries continue to face challenges in the prioritisation and coordination of their R&I systems and in the implementation of reforms. Reforms in researcher training and careers are urgently needed as several countries register low efficiency in doctoral training and lack attractiveness of research careers. Implementation of innovative doctoral training, the European Charter for Researchers and Code of Conduct for Recruitment could build an enabling environment leading to a more successful performance and career development acknowledging international experience in recruitment and career progression. EU level action may also be needed to align pension systems to support research mobility.
- There is a case for closer collaboration between the Widening country and the Commission to monitor the implementation and impacts of reforms, including the recommendations of Policy Support Facility Reviews given the observed time lag in the implementation of the recommendations in some countries.
- Since the implementation of national reforms of R&I systems is critical for bridging the innovation divide and improving the FP participation, the Commission could consider an approach where support for reforms is allocated only on the basis of evidence of progress in the implementation.
- **The system learning effects through experience with Framework Programme procedures play a less significant role in Horizon 2020 than in FP7, although those countries which have accessed the FP more recently continue to face challenges.** The 2011 evaluation underlined the time that is needed for new actors to adapt to the FP as well as the culture of competing for FP funding. Successful project coordinators have often benefited from the EU programmes such as RegPot and COST as entry mechanisms to European research collaboration, but in countries with fragmented R&I systems this had not contributed to system level learning effects. Many national authorities have introduced competitive mechanisms in R&I funding allocation and evaluation procedures, but progress remains patchy across countries, and new reforms are needed to strengthen the focus on quality.
- **Differential wage levels between countries continue to affect FP participation but the impact varies across countries.** The recent changes in the Horizon 2020 remuneration policies, increasing the amount of eligible costs in low-income member states, have not adequately addressed this challenge, which affects FP participation through constraining transnational research mobility and practical problems in building an FP project budget. Interviews showed a mixed picture with very low salary levels in some public R&I systems (EUR 250 for PhD candidates in Bulgaria), while differences in salary levels were narrowing down in some countries and lower cost of living was used as an asset to attract research talents. Part of the reason for low FP participation could be the combination of low salary levels in public research system, and the availability of national competitive funding, which is easier to access and allows topping up salaries. Rather than misusing the national research funding as a salary policy, countries should be encouraged to increase investment in the public science base and introduce performance-based salary systems.

Further analysis could focus on:

- the impact of differential wage levels in the EU and Widening countries to research and innovation productivity, quality and FP participation.
- **The size of the project remains a barrier to FP participation, in terms of project coordination and leading a consortium.** The EU-13 countries more frequently take part in large scale FP projects, but typically coordinate and lead smaller projects. The size of the project can be a barrier as it relates to lack of appropriate research facilities and experienced support as well as the difficulty of raising matching funds. The lack of experienced support for coordination and research management is felt in the application phase (particularly for legal expertise) and in the implementation phase when administrative support is needed but not often available due to lack of human resources and skills. Here a simplification of the FP application phase could be helpful. Large projects are associated with a higher risk e.g. when national co-funding is expected. The size of projects was acknowledged as a barrier to FP participation in countries where the R&I performance is constrained by the lack of economies of scale, critical mass in research areas and access to national co-funding. Some countries such as Estonia has sought to overcome the challenge of co-funding requirement in Teaming 2 through rigorous pre-selection process and submission of one proposal instead of several proposals. Clearer guidance from the Commission would have been appreciated in the application phase.
- **Basic information, communication, advice and training have improved since 2011, but often fail to meet the more sophisticated support that the researchers are looking for.** *While the situation has improved since 2011 through shared learning (e.g. NCP Widenet) and better organisation of National Contact Point (NCP) systems, significant variation remains across EU-13 countries in terms of professionalization of the staff and resources for this work. The low take-up of the NCP services by Widening coordinators may suggest that NCPs lack capacity to broaden the scope of their services. There are also challenges in the interaction and exchange of information between the national actors – policy makers in programme committees, other representative bodies and the NCPs – in many countries. The support that is needed and typically not available includes writing grant applications and influencing the future programme calls. Some research leaders resort to foreign firms in the EU-15 countries to prepare their applications while a better system would be to include a small business from the Widening country as a team member for project management and reporting purposes.*

In addition to the seven barriers identified in 2011, the following factors have gained importance and may indirectly contribute to the uneven participation in Horizon 2020 and innovation outcomes.

- **The national R&I systems may create adverse incentives which undermine the pursuit of excellence** for example by rewarding quantity over quality in publications or participation in national research programmes rather than Framework Programmes. Several countries have developed evaluation systems which have led to a rapid growth in publication activity and 'gaming' of the system, but do not provide adequate incentives for research excellence and international collaboration. The low FP participation may also be linked to the availability of national competitive funding schemes from where funding is immeasurably easier to acquire. The rigour and transparency of the selection process in the national competitive funding schemes may raise concerns.
- **The fragmentation of national R&I systems combined with the lack of competitive universities and research organisations is an issue, despite emerging pockets of research excellence.** Many low performing countries in FP have a fragmented higher education and research system and significant difficulties in reforming the sector; this is relevant not only to the low performing Widening countries, but also to countries like Slovenia, where the reform of higher education

system has been debated for decades. While mergers and consolidation can help reach economies of scale and address the fragmentation and under-performance of the R&I system, successful mergers are costly and time-consuming and do not guarantee better performance in R&I or FP participation (although they can improve the ranking visibility). A more effective approach could be to enhance universities' institutional autonomy (over finances, estate and payroll) and accountability of higher education institutions, develop human resources and academic careers and encourage young people to publish and build international networks.

- **Language barriers may be an issue in countries which maintain high demands for local language proficiency for researchers, and also for administrative staff.** Language policies can act as a barrier to attracting international talent and prevent international staff from contributing to the institutional reforms. The difficulties faced by mobile researchers when trying to overcome language and cultural barriers is an area where governments could offer support, possibly within broader immigration policies. There is also a need to ensure that the use of national language(s) in the research evaluations does not negatively impact the quality. For example in Bulgaria, research projects submitted to the National Science Foundation are evaluated mainly by Bulgarian reviewers. For the last few years, only Bulgarian language has been used in the submission of research proposals, which has led to the lack of qualified reviewers in some scientific areas as well as conflicts of interest.
- **The regulatory and administrative burden at the national level obstruct R&I and business activities, but also FP procedures could be improved.** Only a few EU countries, including Sweden and Estonia, have launched programmes to reduce the administrative burden. In the 2016 Worldwide Governance Indicators¹, some of the less performing countries feature among the weakest in the EU in terms of the government effectiveness. In many countries public procurement policies or funding allocation systems add to the administrative burden of institutions, e.g. in some cases the Ministry of Research and Higher Education may allocate funding to universities through 20 streams each requiring detailed reporting; some institutions are also under double control by two ministries. Bureaucratic overload and accountability burden affect also mature higher education and R&I systems due to the expectations on institutions by multiple interested parties. While the administrative burden of the Horizon 2020 is perceived as low or manageable, the interviews showed that the application, implementation and evaluation phase could be streamlined.

Further analysis could focus on:

- investigating the extent of the bureaucratic overload and administrative burden of both national and FP systems in order to identify the main sources and the potential to reduce this burden.
- **The challenges in the quality of government and weak public institutions continue to hamper development in European countries and regions².** The government efficiency varies between Member States and regions as evidenced by the European Quality of Government index 2017. Furthermore, the quality of government and institutions has been identified as the main obstacle to development in regions with persistently low growth rates. In R&I and higher education, challenges in the government may manifest themselves as conflicts of interests in evaluating project proposals, as irregularities in funding distribution, as nepotism in recruitment to public positions etc. Inefficiencies in public administration, the low quality of regulations, frequent changes to the legislation and slow enforcement due to lengthy proceedings

¹ <http://info.worldbank.org/governance/wgi/#home>

² European Commission – DG Region (2018). My Region, My Europe, Our Future. 7th Report on Economic, Social and Territorial Cohesion

also weaken the effectiveness of legislation and deter R&I investment and Horizon 2020 participation.

- **Finally, the lack of a European patent code and the high costs of the intellectual property may indirectly pose a barrier to Horizon 2020 participation** as they discourage the small business to invest in R&I and academic inventors in lower income countries to engage in knowledge transfer. Compared to the United States and China and India, where patents are valid in all states and patent application costs are low, the European patent system is expensive, slow and cumbersome for small businesses and individual inventors. The European Patent Office (EPO) provides a single patent grant procedure, but not a single patent for enforcement: If an inventor wants to cover all 38 EPO members, the costs will increase to over 40, 000 euros compared to 1 000 dollars in the United States. A single patent market for the EU would enhance innovation, as entrepreneurs would have access to a single database for innovations, instead of 38 databases using 30 languages.

1 Methodology and limitations

1.1 Purpose of the study and research questions

The purpose of this study is to analyse the participation patterns in Horizon 2020 and the causes for the low participation of a number of EU Member States and Associated Countries, as an indirect contribution to the post-Horizon 2020 programme, updating the 2011 analysis by the Commission regarding the EU-13 low participation. The study sought to answer the following research questions formulated by the Commission:

- Are the facts and problems identified in the 2011 analysis of the Commission still persisting? Have they all the same weight?
- What are the existing or emerging needs, which now deserve attention?
- What are the main challenges and needs to address in non-Widening countries?
- What are the main trends in the R&I performance of EU-28?
- What are the positive and negative dynamics in the process of bridging the research and innovation divide and building convergence, and what should be pursued by the EU and national policies?
- How should the Widening programme capture dynamic evolution of performance of regions and MS? Which sources of information should be monitored?
- What correlation can be drawn between Framework Programme Participation and research and innovation performance rates as regards participation patterns and RDI performance that could maximise the impact of post-Horizon 2020 actions?
- How far is the participation gap symptomatic for the innovation divide in Europe?
- What can the EU do to overcome persisting barriers to participation in the EU's Framework Programmes through the Widening programme, the Policy Support Facility, the changes to the remuneration model?
- What kind of national measures cannot be substituted by the EU intervention? Which measures Member States are taking to increase R&I performance, to capitalise better on the excellence that exists in all Member States, to address the innovation gap?
- Could an enhanced Synergies mechanism be integrated in the post Horizon 2020 'Widening' programme?

1.2 Methodology

The study was based on qualitative methods including desk research, interviews and country case studies. The document review was undertaken to provide overview of the Horizon 2020 participation patterns, the R&I divide and the role of the Widening actions. The examined literature include European Innovation Scoreboard, European Semester reports, the Interim evaluation of Horizon 2020, the Horizon 2020 Policy Support Facility reports, the Education and Training Monitor reports, the OECD and World Bank materials, related evaluations and studies.

The primary data was collected through eight semi-structured phone/Skype interviews with the Widening coordinators and policy stakeholders during a two-week period from 9 to 19 January 2018. Interviewees were mainly identified during the Widening Days organised by the Commission on 8-9 November 2017. The group of interviewed persons comprised three Teaming 2 Centres of Excellence coordinators from Bulgaria, Slovenia and Serbia and a Project Manager for Teaming 2 centre of excellence from Cyprus, an Erasmus Chair coordinator from Poland, the Director of the NCP Widenet from Poland, and two policy stakeholders for Estonia and Slovenia each. A set of pre-identified framework themes with questions tailored to the context and situation of each person was sent prior to the interview including also checklist of barriers identified in the 2011 analysis. See Annex 1 and 2.

The interviews and the desk research provided input into seven country case studies covering three Widening countries which are outperforming the EU-15 in certain aspects (Cyprus, Estonia, Slovenia), two Widening countries which are lagging behind (Bulgaria, Poland) and one Widening Associated Country (Serbia). The case study of Italy was developed to highlight the situation in a Member State in Southern Europe. Each country case covers: (i) a summary of the Horizon 2020 performance; (ii) national policies to facilitate participation in Horizon 2020; and (iii) analysis of the research and innovation performance. See Annex 3.

1.3 Limitations of the study

The main limitations relate to the scope of the study with a small number of interviews, which cannot be fully remedied by the document review. The interviews did not cover all Widening countries and actions, and no participants from the EU-15 countries. Equally, only for two countries both the Widening coordinator and a representative of a national authority were interviewed.

2 FP participation patterns

2.1 The concentration among participants and geographical representation in Horizon 2020

The 2016 Interim evaluation of Horizon 2020 highlights the concentration of funding in terms of participants and the geographical representation as challenges. The Top 100 beneficiaries received nearly 40% of the total funding (1.7 percentage points less than in FP7). Participants from five EU-15 countries – UK, Germany, France, Spain and Italy – received 60% of the overall funding, with Germany receiving 17%, while participants from Bulgaria, Latvia, Lithuania and Malta received 0.1% each. The five top countries represent 64.5% of the investment in R&I (GERD) in Europe. While the Horizon 2020 concentration is strongest for universities and research organisations and lowest for the private sector, there are also big differences (over 18 percentage points) between the countries in terms of shares of SME participation – with Hungary, Estonia and Cyprus having the largest share of around 30% of SME participation and Sweden, Romania and Croatia all below 20%.

The EU-13 countries obtained 4.4% of the Horizon 2020 funding although their total nominal GDP amounted to about 7% of all countries taking part. The Horizon 2020

financial contributions are in line with the R&D spending as the share of GDP, which is about two times lower in the EU-13 countries than in the EU-15. In terms of European Research Council (ERC), the EU-15 countries won 85% of all ERC grants with a combined GDP of about 79%. On average the EU-13 countries won only 1.9% of the ERC grants (126 out of 6 687).

At the same time the European Structural and Investment Funds (ESIF) ensure significant money flows to the EU-13 countries. A case in point is Poland, which is a net payer in Horizon 2020, but the biggest beneficiary of the EU funding through the ESIF. In 2015, Poland's contribution to the EU budget was EUR 3 718 billion, while the total EU spending in Poland amounted to EUR 13 358 billion. Poland contributed 3.03% to the overall Horizon 2020 budget (average 2014-2015), and received 0.9% out of the Horizon 2020 grants. The balance was especially skewed with respect to the ERC as noted above, where between 2014 and 2017, Poland's 9 Polish ERC principal investigator grants represented just 0.2% of the total ERC grants.

2.2 Variation in H2020 contributions normalised per inhabitant, FTE researchers and RDI investment

Despite their overall lower Horizon 2020 contributions, some EU-13 countries are outperforming the EU-15 average. The results for the first two years of the programme implementation show that Cyprus, Estonia and Slovenia outperform the EU-15 averages, taking into account the size of the population, the number of researchers and national investments in R&D. Researchers based in Cyprus and Hungary also receive more grants from the European Research Council than would be expected based on national research investment. When the national investments in R&D are taken into account, on average, the EU-13 Member States outperform EU-15 Member States with 6.7%. On the other end of the spectrum, Poland, Lithuania and Bulgaria (except for R&D expenditure) are underperforming the EU-13 average.

The 2016 Horizon 2020 Interim evaluation report showed the large differences between the EU-15 and EU 13 countries, but also the variation across the best performing and lesser performing EU-13 countries:

- Per inhabitant, EU-15 receive EUR 44 against EUR 9 in the EU-13. While the least performing EU-13 countries reach less than 10% of the EU-15 average, the best performing EU-13 countries are above the EU-15 level: For Bulgaria and Poland the respective figures are only EUR 4 and EUR 5, compared to EUR 50 for Estonia, EUR 53 for Slovenia and EUR 70 for Cyprus.
- In terms of the number of researchers FTE, EU-15 receive EUR 11 423 compared to EUR 3 812 in EU-13. While differences in salaries and reimbursement rates partly explain this gap, it is noteworthy that the best performing EU-13 countries – Slovenia, Estonia and Cyprus all surpass the EU-15 average (EUR 13 848, EUR 15 767 and EUR 71 860 respectively), with Cyprus reaching six times higher level, while the lower achieving countries Bulgaria and Poland lag far behind (EUR 2 095 and EUR 1 908 respectively).
- Per EUR million invested from the private and public sector in R&I, the EU-13 receive EUR 67 524, 6.7% more from Horizon 2020 compared to the EU-15 (EUR 63 277). At the country level the corresponding figures for best performing EU-13 countries are as follows: Cyprus: EUR 768 657, Estonia, EUR 217 990, Slovenia EUR 128 243; and for the lower performing EU-13: Bulgaria: EUR 68 791, Poland EUR 42 743.

Some EU-13 countries such as Cyprus, Malta and Romania get a significant part of their national RTD expenditure (GERD) from the Horizon 2020 funding i.e. 25.9% for Cyprus, 10% for Malta and 5% for Romania. The EU contribution normalised by GERD shows that EU-13 countries now get relatively similar amounts as the EU-15.

2.3 Participation patterns of the EU-13 countries

The 2016 Horizon 2020 interim evaluation further showed that the level of the EU-13 participation in Horizon 2020 was broadly in line with the size of the population, the number of researchers, and the scale of R&D investment.

- Participants from the EU-13 countries represented 8.5% of the participations in Horizon 2020 and receive 4.4% of the overall funding.
- The EU-13 countries had a lower success rate of applications: 11.1% compared to 14.4% for the EU-15.
- The EU-13 countries had a much smaller share of project coordinators in signed contracts: 5.1% vs. 87.6%.
- In terms of the project size, the EU-13 countries participated more in larger projects (i.e. projects above EUR 5 million), but coordinated more often small projects (< EUR 200 000). Participation remained generally low.

2.4 Participation patterns within the Widening actions

Previous analyses of the participation patterns within the Widening actions include the 2016 Horizon 2020 interim evaluation report (covering the period December 2014 to December 2016) as well as the 2018 analysis of Widening projects running October 2017 - February 2018³. The two analyses provided different categorisations of the countries in terms of FP participation. The 2016 interim evaluation ranked the Widening countries into four groups in terms of their funding performance, while the 2018 analysis divided them into three groups based on the number of funded project per country and number of funded projects per country normalised per capita. See Table 2.1 below.

- Of all international partner countries Germany has the highest participation with highest number of partnerships, projects and different Widening country partners, followed by the UK and France.
- The Teaming action has attracted significant policy attention, given the significant funding level and the national co-funding requirement, with proposals being either coordinated or supported financially by national or regional authorities. Several countries including Poland and Estonia have used a competitive mechanism to identify the best proposals. Recipients include a research centre in Serbia (Antares).
- Countries including Poland and Czech Republic have linked the actions with their Operational Programmes in European Structural and Investment Funds.

Cost actions are funded by the Widening programme. Interviews highlighted the widespread assumption that COST should provide half of the funding to Widening countries.

³ Romijn, Francois (2018). A country-based descriptive analysis of Spreading Excellence and Widening Participation Projects. Partnerships networks, indicators of performance and smart specialisation strategies. EC DG RTD Unit B5. Policy Feedback Report.

Table 2.1. Categorisations of Widening countries based on two studies

2016 Interim Evaluation	Countries	2018 analysis on Widening projects running Oct 2017-Feb 2018	Countries
Group 1	PT, EE, CY	High performers	CY, EE, PT, LV, MT, LX
Group 2	PL	Mid-performers	HU, SI CZ, HR, RO, BG
Group 3	BG, MT, LV, RO, HU, CZ, SK, SI, HR, RS	Low performers	PL, SK, RS, LT, MD, TR
Group 4	LT, LX + associated countries apart from RS ⁴		

3 Main trends in R&I performance in EU-28⁵

- **The innovation leaders are improving their Summary Innovation Index Scores, but the convergence progress is slow and uneven among countries.** The small island states of Malta and Cyprus and several central and Eastern European countries are catching up and narrowing the gap in the quality of public research systems, while some are lagging behind⁶. At the same time, progress in key innovation outputs has been slow and a gap remains between North and South, and East and West in innovation output performance apart from the notable exceptions of Malta and Hungary. The gap between top and mid-performers has widened in recent years.
- **A persistent divide remains between northern and southern EU-15 countries.** Since the crisis the gap in public spending on R&I relative to GDP has increased, and the southern European countries have been slow in catching up. There is also a growing divergence among the southern European countries, with Portugal improving and Spain and Italy losing ground.
- **The regional disparities in innovation have increased over time as highlighted in the Regional Innovation Scoreboard 2017⁷.** For most regions, innovation performance has improved over time with biggest gains made among regional Innovation Leaders, which are typically located in the most innovative countries in Western Europe; they perform best on all indicators, especially those which measure

⁴ Albania, Armenia, Bosnia and Herzegovina, Faroe Islands, Former Yugoslav Republic of Macedonia, Georgia, Moldova, Montenegro, Serbia, Tunisia, Turkey and Ukraine

⁵ Unless otherwise informed, the data and figures on this section are based on the most recent SRIP report: EC (2018). Science, Research and Innovation Performance of the EU. Strengthening the foundations for Europe's future. https://ec.europa.eu/info/sites/info/files/rec-17-015-srip-report2018_mep-web-20180228.pdf

⁶ See also Veugelers Reinhilde (2016). The European Union's growing Innovation Divide. Bruegel Institute.

⁷ http://ec.europa.eu/growth/industry/innovation/facts-figures/regional_en

the performance of their research system and business innovation. Performance has declined mostly in geographically peripheral regions in the South and East of Europe, in particular in Finland, Italy, and Romania, but also in Central Europe, especially in Germany. The EU-13 and Widening countries feature regional pockets of excellence, usually capital regions, which divert positively from the country average⁸. While regions in southern Member states, notably Italy and Greece, have diverged substantially from the EU average, the regions in Eastern Member States are converging. At the same time competitive regions in the east generate few spill-overs and innovation remains spatially concentrated⁹. About 9% of the EU regions in seven different countries mainly in central, Eastern and Southern Europe are at high risk from globalisation and technological change¹⁰.

- **The performance gap in FP participation is not fully aligned with the innovation divide in Europe.** Spain and Italy belong to the top-5 performers in Horizon 2020, but are both only Moderate Innovators according to the European Innovation Scoreboard (EIS). Nordic countries are Innovation Leaders but feature lower FP performance than could be expected based on their R&D intensity. While the two Modest Innovators – Romania and Bulgaria – show low performance in FP, countries such as Cyprus feature high FP performance, but underperform in EIS as Moderate Innovators.

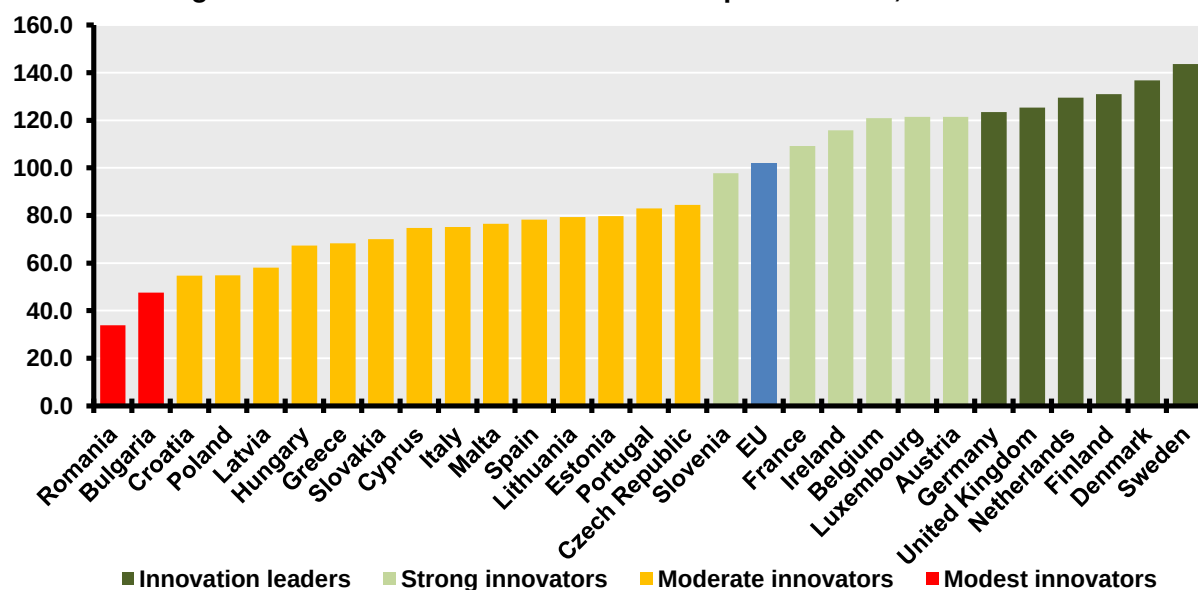
Innovation outcomes vary across EU countries, and the EU-13 countries typically score low in the European Innovation Scoreboard, and have low ranking for research outputs, including modest shares of highly-cited publications in comparison with other EU Member States. With the exception of Slovenia, which belongs to the “Strong Innovators” along with Austria, Belgium, France, Ireland, Luxembourg, most EU-13 countries – and all EU-15 countries in southern Europe – fall into the group of “Moderate Innovators”. The weakest performing group of “Modest Innovators” consists of only two countries: Bulgaria and Romania. Innovation Leaders refers to Member States where performance is more than 20% above the EU average and includes countries such as Denmark, Finland, Germany, the Netherlands, Sweden, and the United Kingdom. See Figure 3.1 below. (EIS 2017)

⁸ In Spain, however, the highest performing region is the Basque Country.

⁹ European Commission – DG Region (2017). My Region, My Europe, Our Future. 7th Report on Economic, Social and Territorial Cohesion:
http://ec.europa.eu/regional_policy/en/information/publications/communications/2017/my-region-my-europe-our-future-the-seventh-report-on-economic-social-and-territorial-cohesion

¹⁰ Ibid.

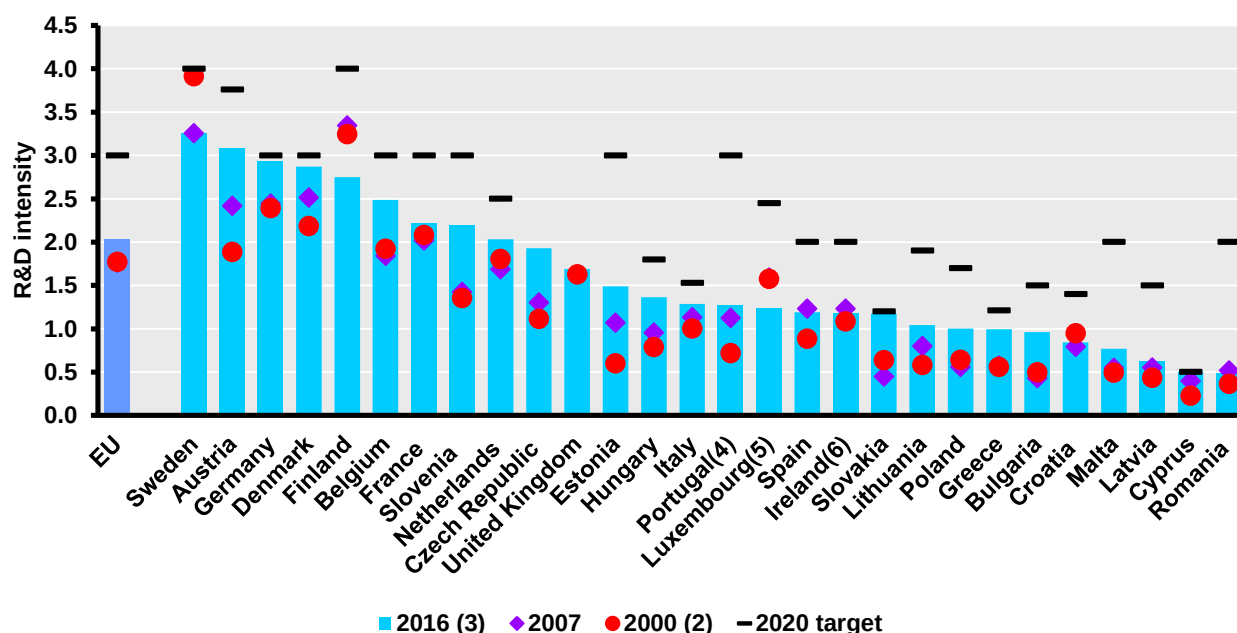
Figure 3.1. EU Member States' innovation performance, EIS 2017



Source: European Innovation Scoreboard 2017

The R&D intensities vary substantially across EU countries. Sweden, Austria, Denmark, Finland and Germany register the highest values for R&I intensities, while the best performing EU-13 countries are Slovenia and Czech Republic, above or at the EU average, respectively. The rest of the EU-13 countries fall below the EU average with several countries registering 1% or lower values, with Romania and Cyprus at the bottom end. All Southern European countries in the EU-15 group are below the EU average and feature low shares, including two of the higher performing Widening countries, Cyprus and Malta, at the bottom end of the scale, see Figure 3.2 below.

Figure 3.2. R&D intensity 2000, 2007, 2016 and 2020 target⁽¹⁾



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies

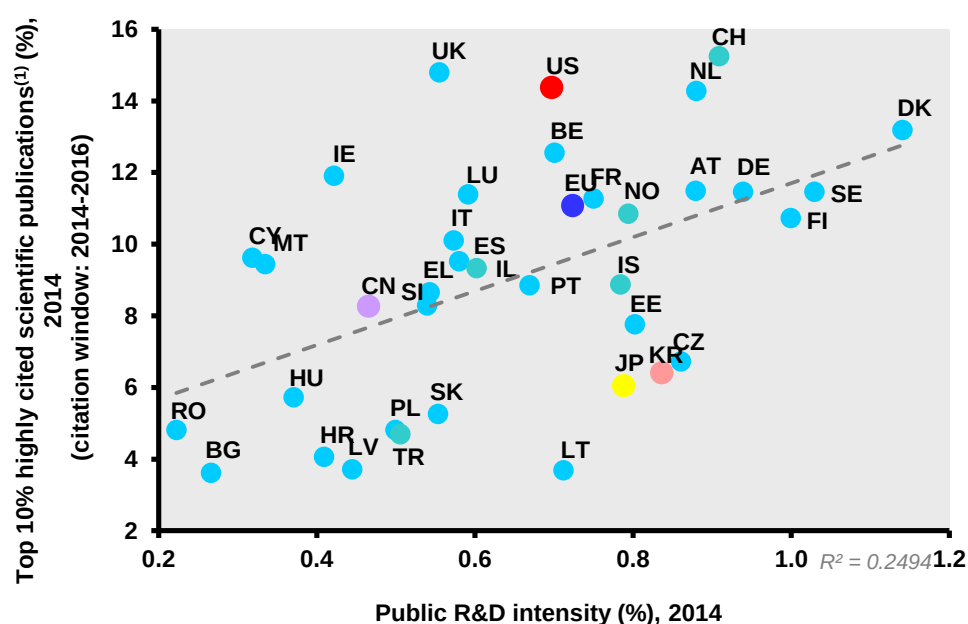
Data: Eurostat, Member States

Notes:(1) CZ, UK: R&D intensity targets are not available. (2)EL, SE: 2001; HR: 2002; MT: 2004. (3)BG, CZ, EE, FR, LV, LT, HU, PL, RO, SI, SK: 2015. (4)PT: The R&D intensity target is between 2.70% and 3.30% (3.00% was assumed). (5)LU: The R&D intensity target is between 2.30% and 2.60% (2.45% was assumed). (6)IE: The R&D intensity target is 2.5% of GNP which is estimated to be equivalent to 2.0% of GDP. (7) DK, EL, FR, LU, HU, NL, PT, RO, SI, SE, UK: Breaks in series occur between 2000 and 2016.

With some exceptions, notably that of Finland and some other countries, the R&D intensities of most EU Member States grew during the period from 2007 to 2016, albeit many from a low base. Over the period 2007-2016, many, but not all, Central and Eastern European countries increasing their R&D levels in the process of upwards convergence. High R&D intensity growth rates were registered in Bulgaria, Poland and Slovakia, as well as the Czech Republic, Estonia, Greece, Malta and Hungary.

There is a positive correlation between R&D investments and research excellence in most, but not all EU countries. Measured by the share of total publications among the 10% most-cited worldwide, a positive correlation between R&D investments and scientific quality is evident for high-spending countries such as Denmark, Sweden, Germany, the Netherlands, Austria and France, while most Eastern European countries have below-EU-average investments levels matched with low levels of scientific excellence. Estonia, the Czech Republic and Lithuania could, however, expect better results given the levels of public R&D spending. Cyprus and Malta reach good results irrespective of their low investments, while the United Kingdom, Ireland and Belgium reap higher than expected returns on their R&D investments. See figure 3.3 below. These results call for greater efforts and efficiency in higher education institutions and public research organisations generating highly cited publications and efficiency in R&I systems in general.

Figure 3.3. Public R&D intensity, 2014 and the top 10% highly cited scientific publications⁽¹⁾ 2014 (citation window: 2014-2016)



Science, Research and Innovation performance of the EU 2018

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research and Innovation Policies

Data: CWTS based on Web of Science database

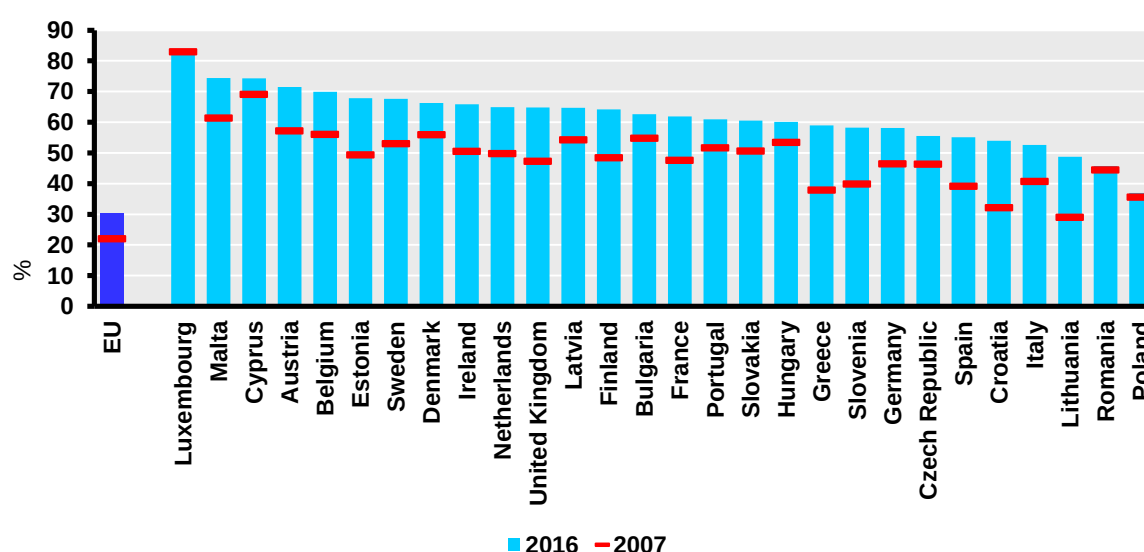
Note: (1) Scientific publications within the 10% most cited scientific publications worldwide as % of total publications of the country; fractional counting method

The Nordic countries – Finland, Denmark and Sweden – feature a high share of researchers in the total employment, above the levels of South Korea, Japan and the United States. Among the EU-13 countries Slovenia and the Czech Republic have the highest shares of researchers in total employment, while Cyprus and Romania have the lowest shares in the EU, dominated by public sector researchers. The South-Eastern European countries – Croatia, Bulgaria, Cyprus, Romania and Latvia – also show low levels, particularly for researchers in the business sector. At the same time, many Central and Eastern European countries such as Bulgaria, Hungary and Poland, and also Malta have been catching up in the past decade (2007-2015) in terms of researchers in both public and private sector. Of the EU-15 countries the lowest performing county in this measure is Italy. These results point to the need to enhance attractiveness of research careers and develop more efficient researcher training systems.

In international research collaboration, all EU countries increased their international scientific co-publication per million population during 2005-2016. Four EU-13 countries – Cyprus, Slovenia, Estonia and Portugal – climbed to the middle ranks of the EU countries while the four weakest countries – Poland, Latvia, Bulgaria and Romania – showed marginal improvement. With the exception of Slovenia and Malta, the EU-13 countries have the lowest percentages of scientific publications among the 10% most cited worldwide. Unlike countries such as Austria, Belgium, Sweden and Denmark, which actively participate in international scientific networks, Poland, Romania, Croatia and Latvia produce their scientific outputs mainly at the national level.

Three Widening countries – Luxembourg, Malta and Cyprus – lead in terms of the share of total international scientific co-publication of their total scientific publications, while Estonia ranks number 6 at the level of Denmark. Poland and Romania are the weakest performing countries in the EU in terms of international scientific publications as a percentage of total publications in the country, and have not made any progress in this measure during 2007-2016. Southern European countries such as Italy and Spain have also increased their share of international scientific publication of the total publication, See figure 3.4 below. These results point to the need to further open the national R&I systems of the low performing countries to increase their overall scientific performance and to encourage international research collaboration and mobility.

Figure 3.4. Total international scientific co-publications per country as percentage of total scientific publications per country, 2007 and 2016



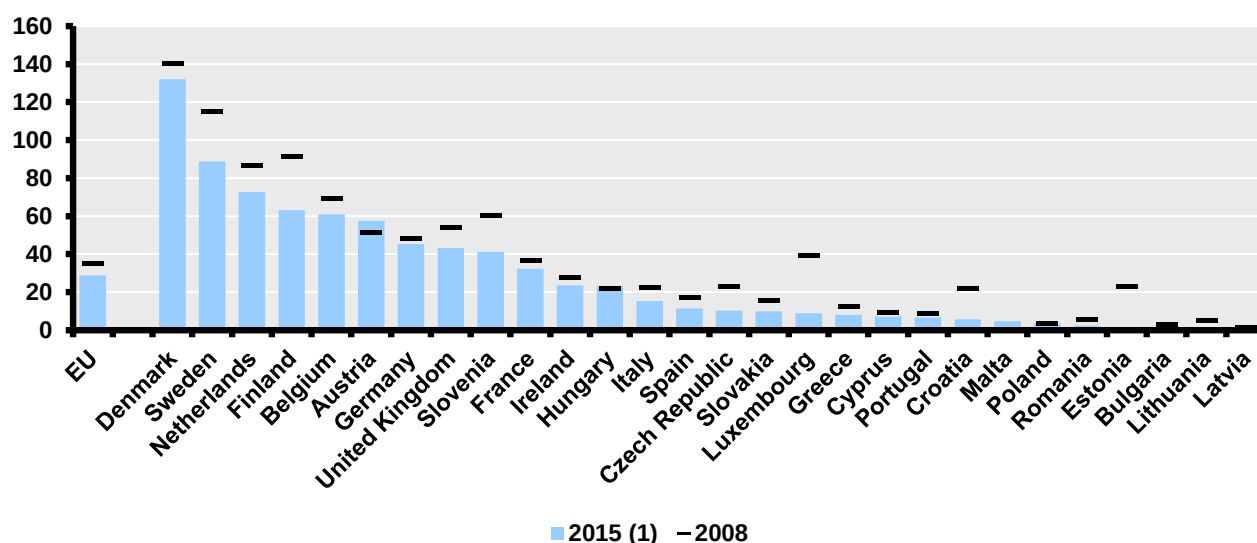
Source: DG RTD - Unit for the Analysis and Monitoring of National Research and Innovation Policies

Data: CWTS based on Web of Science database

The share of innovative enterprises have declined in many EU-countries since 2008 and 2010 with Eastern European countries lagging behind the EU average partly due to the dominance of medium- and low-technology companies in industry. Romania and Poland have the lowest shares of innovative enterprises (EIS 2017). Part of the challenge has been the limited public support for business, but this has changed in recent years with support for start-ups and science-to-business cooperation. During the period of 2007-2013 only three countries reduced the public support to business R&D, namely Spain, Italy and Finland.

Business-science linkages are unevenly developed across the EU countries. For example in Poland only 10% of innovative companies cooperate with higher education institutions. During the period 2008-2015, most EU countries reduced their results in terms of public-private scientific co-publications per million people, with Estonia registering a large reduction (See Figure 3.5 below). Central and Northern European countries perform better than the Eastern and Southern European countries: the best performing countries, which show strong science-business linkages and perform better than the United States, include Denmark (1.32) and Sweden (88.7), whereas at the other end of the spectrum Poland, Romania, Bulgaria, Lithuania and Latvia feature under-developed science-business linkages and marginal public-private co-publication. Slovenia was the best performing Widening country comparable to the UK. Southern European countries generally underperform in this measure, with Italy scoring the highest results (15.2) and Cyprus and Malta at the bottom. These results point to the need to encourage university-business cooperation particularly in lower performing countries and enhance knowledge sharing.

Figure 3.5. Public-private co-publications per million population, 2008 and 2015



Source: DG RTD. Unit for the Analysis and Monitoring of National Research and Innovation Policies.

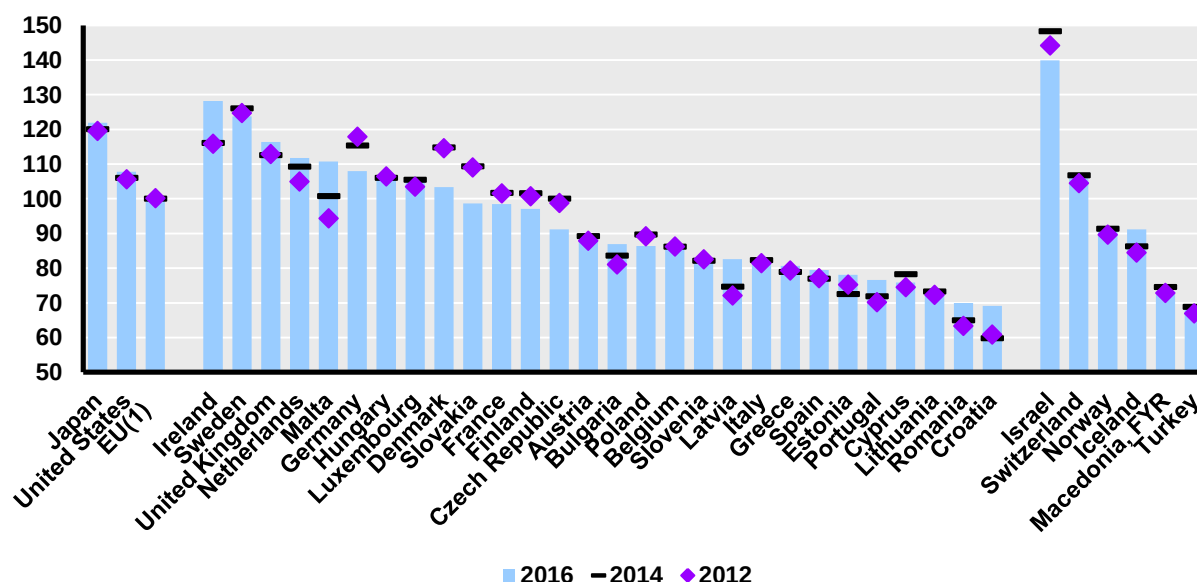
Data: EIS 2017

Progress in key innovation outputs has been slow in the EU with persistent North-South and East-West gaps, apart from Malta and Hungary. According to the Innovation Output Indicator (IOI)¹¹, Ireland is the top EU performer, followed by Sweden, the United Kingdom and the Netherlands, whereas Romania and Croatia show a low level

¹¹ IOI is based on four components (patents, employment in knowledge-intensive activities, trade in knowledge-based goods and services, innovativeness of high-growth industries) and five sub-indicators.

of innovation outputs, despite their upwards convergence together with Malta, the Netherlands and Ireland. Since 2012, innovation outputs have declined in Germany, Denmark, Slovakia, Finland and the Czech Republic, partly caused by a lower share of employment in fast-growing enterprises in innovative sectors, while performance in other indicators has been more stable. See Figure 3.6.

Figure 3.6. Innovation output indicator (EU2011 = 100), 2012, 2014 and 2016



Science, Research and Innovation performance of the EU 2018

Data: Eurostat, OECD, DG JRC

Note: (1)EU: Two sets of values are available: values for worldwide comparison and values for European comparison.

The values for worldwide comparison are shown on the graph. The value for European comparison for 2014 is 99.6

The Regional Innovation Scoreboard 2017 shows that regional differences remain pronounced across EU-28 countries. The top-30 leading regions are all in Western part of Europe and account for 36% of total R&D investment. The most innovative regions are typically in the most innovative countries in Western Europe, and almost all Regional Moderate and Modest Innovators are located in Moderate and Modest Innovator countries. The Innovation Leaders perform best on all indicators, in particular on those which measure the performance of their research system and business innovation, i.e. scientific publications and shares of innovative enterprises.

The EU-13 and Widening countries feature regional pockets of excellence, usually capital regions, which divert positively from the country average, such as Praha (Prague) in the Czech Republic or Bratislavský kraj in Slovakia. Capital regions generally fair better than the rest of the country, for instance Romania's Bucuresti - Ilfov is a Modest+ Innovator, while all other regions are Modest Innovators. In Spain, however, the highest performing region is País Vasco (the Basque Country), which is the only strong innovator in the country.

Between 2011 and 2017 performance differences have increased between regions. The share of regions with increasing performance is larger than that of regions with decreasing performance, and the average rate of increase is above the average rate of decrease, 6.6% compared to 4.8%. For most regions innovation performance has improved over time with biggest gains made among regional Innovation Leaders. Performance has declined mostly in geographically peripheral regions in the South and East of Europe, in particular in Finland, Italy, and Romania, but also in Central Europe, especially in Germany. Performance has declined in all regions in Romania, and for more

than 50% of regions in Czech Republic, Hungary, Portugal and Spain but also in Denmark, Finland and Germany, which are all Innovation Leaders.

The recent Commission report on economic, social and territorial cohesion shows¹² that the regions in Eastern Member States are converging to the EU average, whereas regions in Southern Member states, notably Italy and Greece, have diverged substantially. Innovation remains spatially concentrated, and competitive regions in the eastern Member States generate few spill-overs. About 9% of the EU regions in seven different countries mainly in central, Eastern and Southern Europe are at high risk from globalisation and technological change. Important regional disparities remain in terms of GDP per head, unemployment rate (e.g. Dytiki Macedonia and Andalusia at 28.9%), total expenditure on R&D (0.06% in Sud-Est, Bulgaria, and 11.4% in Brabant Wallon), and highly educated population (11.5% in Nord-Est Bulgaria and 74.9% in Inner London).

In Italy, regional disparities between south and the centre north have further deepened during the recession. The most recent RIO report (2017) shows that between 2007 and 2014, real GDP in Southern regions fell by 1.9% on average per year, whereas the decline in the centre-north was 1.1%. R&D expenditure on regional GDP is 1.4% in the North and 0.9% in the South, and the patent activity and share of employees in high tech industries is much lower in the south¹³. Two thirds of innovating firms and three quarters of total expenditure were concentrated in five regions only (Lombardy with 25% of innovators, Veneto, Emilia Romagna, Piedmont and Lazio), whereas less than 13% of Italian firms innovating in products and processes were located in South of Italy and on the Islands. Universities in Southern regions have been hard hit by funding cuts and show weaker performance and greater reductions in student enrolment, staff and funding than elsewhere in Italy. The learning outcomes of Italian 15-year-olds in mathematics, reading and science are extremely marked in the OECD Programme for International Student Assessment (PISA) performance, with pupils from the North-Eastern regions among the top OECD performers, and pupils from the South among the worst (OECD 2016). There is also a widening north-south divide in Italy's early school leaving rate, which remains above the EU average¹⁴.

4 Causes for low participation

The 2011 analysis highlighted a range of factors as causes for variation in country participation in Framework Programmes, such as:

- national research investment and R&D personnel;
- articulation between the FP and the national research system;
- system learning through experience with FP procedures;
- wage levels;
- access to networks;
- the size of projects; and

¹² European Commission – DG Region (2018). My Region, My Europe, Our Future. 7th Report on Economic, Social and Territorial Cohesion.

¹³ Patents at the European Patent Office per million inhabitants are 106.8 in the North and 10.1 in the South, the share of employees in high tech industries is 3.7% in the North and 2% in the South (RIO 2017).

¹⁴ Education and Training Monitor 2017: Italy.
https://ec.europa.eu/education/sites/education/files/monitor2017-it_en.pdf.

- information, communication, training and the availability of advice.

In the following section we analyse to what extent these causes are still relevant and also present the following factors which remain barriers to country participation in FP and negatively impact the national R&I systems although they were not specifically highlighted in the 2011 analysis:

- adverse incentives in national R&I systems;
- fragmentation of national R&I systems;
- language barriers;
- regulatory and administrative burden and bureaucratic procedures;
- weak government and public institutions; and
- the lack of a European patent code and high costs of intellectual property.

4.1 National research investment and R&D personnel

The reasons behind the correlation between Framework Programme participation and national research investment and R&D personnel relate to the availability of better infrastructure and skills, which facilitate leading-edge research and preparation of research proposals.

The recent SRIP report (2018) shows that during the period from 2007 to 2016, the R&D investment intensities have grown in most EU Member States. The R&D intensity rates in 2016 and the improvements over the period 2007-2016 surpassed the EU averages for Belgium, Germany, France, Austria and Slovenia, however in the case of Finland the R&D intensity fell significantly. While Romania, Portugal and Spain have shown disappointing R&D investment-intensity records over the past decade, countries such as Czech Republic, Bulgaria, Poland and Slovakia have stepped up their R&D investment intensity; for the Czech Republic this has led to a strong convergence towards the EU average. In countries such as Poland much of the convergence has been driven by public funds, notably by the increased use of European Structural and Investment Funds available for R&I activities, which points to the need for greater national efforts to ensure long term sustainability.

Despite the positive improvements the R&D investment in the EU is not growing fast enough to achieve the headline target of 3% of GDP in R&D by 2020. Furthermore many Widening countries – irrespective of their performance in Horizon 2020 – continue to register low, albeit growing levels of R&D intensity. Low spending combined with fragile and/or nascent R&I systems creates barriers to developing capacity and human resources for R&I. The balance between the public and private R&D intensity also varies across EU countries, with only eight Member States where the share of R&D financed by government is below 30%: Nordic Countries (Finland, Sweden and Denmark), Germany, UK and Ireland, Bulgaria and Slovenia.

The R&I spending is important because it has an impact on the human resources for research and innovation. The numbers of researchers (FTE) vary significantly across the countries. Countries with high R&D intensity rates typically have high shares of researchers in total employment and are also innovation leaders. In line with their high R&I spending, the Nordic countries, Finland, Denmark and Sweden, have the highest share of researchers in total employment. The South-Eastern European countries – Croatia, Bulgaria, Cyprus and Romania – as well as Latvia have relatively low levels researchers in total employment, particularly in the business sector. At the same time, Central and Eastern European countries, such as Bulgaria, Hungary and Poland, as well as Malta are catching up in terms of researchers.

Although tertiary education attainment rates are growing in most EU countries, sometimes significantly above the EU average or the 2020 target, many countries are facing a range of skills challenges which impact the access to high level skills for R&I, such as ageing, outmigration, skills mismatches and issues of domestic and international attractiveness to research careers with long term impacts on research capacity. Many countries which show low FP participation have suboptimal conditions for researchers. Solid R&D spending can also help develop quality public research, competitive wages and career prospects to retain and also attract top researchers from abroad. Countries such as the UK, Sweden, Cyprus and Austria, Switzerland and Norway, report high shares of foreign-born research staff, while Hungary, Greece, Slovenia, Lithuania and Latvia have a very low share of researchers from abroad.

These results point to the need for national governments to continue their efforts to increase R&I expenditure, while implementing reforms in the national R&I systems to reduce fragmentation, improve the attractiveness of research careers, eliminate adverse incentives etc. For more detailed understanding further analysis could focus on:

- FP participation rates against researchers by country;
- FP participation rates in relation to GBAORD;
- the link between research capacities and excellence;
- the impact of the balance between public and private R&D investment; and
- the level of funding for Higher Education R&D including the balance between basic funding and competitive funding.

4.2 Articulation between Framework Programmes and national research systems

Articulation between the Framework Programmes and national research systems refers to the compatibility and complementarities between the national and EU levels or the lack of them. There is significant variation in the development trajectories of the R&I systems in European countries and in the alignment between the national R&I systems and the FPs. For example for the Widening countries some have surpassed the level of the EU-15, but most of them are less advanced.

In many countries progress has been made since the 2011 analysis in terms of articulating the FP and national research systems, but apart from notable exceptions such as Estonia, Widening countries continue to face challenges in the prioritisation and coordination of their R&I systems and especially in the implementation of reforms, with legislative reforms under planning or implementation. Estonia has pursued a widespread liberalisation and deregulation process at the fastest pace among the Widening countries. By implementing structural reforms and an enabling legal framework, Estonia has aligned its R&I strategies with the European policies and directed Structural Funds to the development of R&D infrastructure, human capital and entrepreneurship. Furthermore Slovenia, as a former part of Yugoslavia, has also benefited from a relative openness towards the West and a softer transition than many other Widening countries, but the reorganisation of the RDI sector has led to policy coordination challenges; the implementation of the reforms to develop a transparent and coordinated national R&I system in line with the Research and Innovation Strategy for 2011-2020 is in hold, and the new laws on higher education and R&D under preparation. In Poland, R&I is increasingly seen as an engine of long-term economic growth, but prioritisation and the design and implementation of policies remain a challenge. Italy's participation in the Horizon 2020 has been affected by a number of issues related to the fragmentation of strategies, with a lack of clear prioritisation and spread of many initiatives at both

national and regional levels. While Italy's National Research Programme for 2015-2020¹⁵ and its six intervention programmes have been aligned with the Cohesion policies and the Horizon 2020, the impact has been hampered by funding cuts and the delay in the approval process which left the country without a national research strategy for nearly two years. Bulgaria has made limited progress in FP participation due to under-preparedness, financial crisis, declining public funds and underutilization of European funding (PSF review report). Despite the New Vision for Development of Scientific Research in Support of Society and Economy, Bulgaria suffers from an implementation deficit, for example the recommendations of the Horizon 2020 Policy Support Facility review in 2015 have not been implemented. The new RIS3 approach and the Council for Smart Growth (CSG) are expected to revitalize Bulgaria's R&I policies and reorganize the fragmented R&I landscape, but a key challenge is the underinvestment in the public science base.

These results highlight the importance of continuing national reforms of R&I systems in order to bridge the innovation divide and improve the FP participation. There is a case for closer collaboration between the national governments and the Commission to ensure monitoring of implementation and impacts of reforms. For instance, the recommendations of the 2015 Horizon 2020 Policy Support Facility Review have not yet been implemented in Bulgaria. The Commission could also consider whether allocating support for reforms could be done on the basis of evidence of progress in the implementation.

4.3 System learning effects through experience in FP procedures

The 2011 evaluation underlined the time that is needed for new actors to adapt to the FP as well as the culture of competing for FP funding, noting that the experience gained at open competition for national funding and evaluation procedures as well as similarities in themes of work facilitate success in the FP competitions.

It is generally acknowledged that system learning effects take time but after participation in two FPs, new countries and their researchers have learnt to compete for FP funding. This 'rookie effect' was evident for countries such as Ireland and Spain, and more recently also for Portugal as well as several Widening countries. Newer Member States such as Bulgaria and Romania, which both joined the EU in 2007, and the most recent Member State Croatia, which joined in 2013 as well as accession countries appear to be still in the beginning of the learning curve.

At the individual level, research leaders from the Widening countries identified the EU programmes such as RegPot and COST as useful for capacity and network development and had accumulated strong experience in different EU programmes. COST was generally described as an effective entry mechanism to European research collaboration. There was limited evidence of the system learning effects based on individual researchers' successes, particularly in fragmented R&I systems. Equally limited was the evidence of efforts by the national authorities to facilitate this process.

Different starting points and different traditions in openness for international research collaboration contribute to varying approaches towards participation in the Framework Programmes and variation in the research evaluation systems and the use of competitive mechanisms in R&I among Member States. Countries have also adopted different approaches to the utilisation of Structural Funds, some systematically developing better framework conditions for R&I and FP competition.

Universities' role in FP participation is critical but in many cases hampered by higher education system fragmentation, lack of institutional autonomy, lack of career incentives, lack of funding opportunities for their research area and outdated career structures.

¹⁵ <http://hubmiur.pubblica.istruzione.it/web/ricerca/pnr>

While these elements are particularly present in many Widening countries, higher education institutions and their research staff in several EU-15 countries are also faced with challenges of declining funding and suboptimal framework conditions.

Other important aspects for system learning include reforms developing research capacity, including researcher training and research careers. As earlier noted, several case study countries register low level of efficiency in doctoral training, lack of attractiveness of research careers and suboptimal career systems. Implementation of innovative doctoral training, the European Charter for Researchers and the European Code of Conduct for Recruitment could help build a working environment leading to a more successful performance and career development and to ensure open, efficient and transparent recruitment practices. PSF reviews as well as the recent Mutual Learning Exercise on research mobility have also identified the failure of countries to acknowledge international experience in the career progression of researchers as a barrier for outgoing mobility¹⁶. In this case, national and/or institutional rules value international experience as a positive element in the career paths, but favour those who stay in domestic institution for most of their careers.

4.4 Differential wage levels between countries

The 2011 analysis identified variation in wages as a major reason for the differences of the level of FP funding for countries. Interviews highlighted a significant variation across the case study countries in the salary levels of PhD candidates and research staff with Bulgaria registering the lowest level for PhD candidates (250 per month). Variation in wages across countries has many negative impacts: low salary levels affect transnational mobility of researchers, driving brain drain and reducing the attractiveness of the Widening countries. Low salary levels also have a negative motivational effect on potential applicants as they can pose practical problems in building a FP project budget (as a Widening country researcher will receive a maximum of 200 000 for a 3 million euro project).

The Commission has acknowledged the problem and introduced changes to the Horizon 2020 remuneration policies, but on the basis of the interviews, these do not seem to meet the expectations. In order to reduce the salary disparities among researchers in different member states, the Horizon 2020 rules of participation have since 2013 allowed additional remuneration on top of the basic salary with an annual cap of 8 000 euros per person. As the implementation led to unintended effects in some countries, notably those benefiting from the EU Cohesion Fund (e.g. Romania and Poland), the Commission has recently (February 2017) modified the Model Grant Agreements with the aim to increase the amount of eligible costs in low-income member states¹⁷. These changes in the Horizon 2020 remuneration policies have not been considered substantial enough to address the challenge:

"The same excellence in one European country is paid much less than in another county, while the funding is coming from the same source..." (A national authority representative)

"A simple rule is equal pay for equal work. It is not only a question of salaries: Horizon 2020 grants also pay for running costs, and there is not much difference in them." (A national authority representative)

A telling example comes from Poland: As the ERC rules allow only the local average salaries to be covered but no additional payments, a Principal Investigator from Poland

¹⁶ See also IDEA CONSULT (2008), Evidence on the main factors inhibiting mobility and career development of researchers, report for DG Research.

¹⁷ European Commission MEMO/17/ Spokepersons Service/Service des Porte-parole. Brussels 27 February 2017

winning an ERC grant can be paid much less than by the grant from a National Science Centre NCN, which is easier to get and allows topping up the salary. It is also difficult to use an ERC grant to pay internationally competitive salaries to post-docs. In Warsaw University, the regulations allow a monthly pay of 1 000 euros for ERC post-docs, while the average NCN post-doc receives 1 500 euro (2016) and post-docs under Marie Skłodowska – Curie Actions rules, e.g. NCN's POLONEZ, receive over 4 000 euros. While smaller institutes can find a way to go around these rules, the biggest Polish universities with inflexible salary system are unable to do this.

While a simple way to address the differential wage levels would be to implement Marie Skłodowska - Curie Actions rules (with the correction coefficient depending on the cost of living) in all Horizon 2020 programmes, including ERC grants, this would probably not encourage reforms in national R&I policies or higher national spending in R&I. As the example of Poland shows, in some countries part of the reason for low participation in Horizon 2020 is the combination of low salary levels in public research system, notably universities, and the availability of national competitive funding which is easier to access and allows topping up salaries. Consequently, the representatives of the research centres which have the autonomy to set their salary levels according to the performance were less critical of the FP funding regulations, than the systems where university/PRO staff are civil servants on fixed salaries or equivalent.

In addition to the highly critical voices, the interviews highlighted an acknowledgement among some researchers that the salary differences were narrowing, and that (some) countries were benefiting because of lower cost of living and taxation:

"The gap between salary levels is narrowing from tenth to third of the German salary level." (A research leader)

"The average salary is 2 000 euros for professors and 1 000 euros for a post doc, but the cost of living is much lower". (A research leader)

"We could attract top researchers who left their permanent positions because living costs in EU-13 are much lower than in the United States where healthcare is not covered." (A research leader)

Given the contrasting comments by some Teaming 2 coordinators, it would be useful to collect more evidence on the impact of different salary systems in the widening countries to research and innovation productivity, quality and H2020 participation.

It is noteworthy that in some systems the national research funding appears to be misused as a salary policy. For example some countries make low investment in public R&I, but allow researchers to top up their salary using national research grants. Better results could be achieved by increasing investment in the public science base and introducing a performance-based salary system in the public R&I system. The national governments, in coordination with universities and public research organisations should introduce initiatives based on individual research performance in order to adjust salary levels for research staff. Consideration could also be given to introducing an obligation to bring part of the salary from external sources: *"Nothing will change until the salary system of university professors is changed from fixed salaries to the obligation to bring part of your salary from external sources."* (A research leader)

4.5 Access to networks

Despite the evidence collected by the Commission which shows that the networks are opening to Widening countries, the access to existing networks and the clustering of large research performing countries were identified as the Number One barrier to entry for lower performing countries in Horizon 2020.

The EU internal document (see Table 4.1) based of FP Monitoring reports shows that the EU-13 share of FP participations has grown from 8.5% in 2014-2015 to 9.4% in 2016 while the share of EC FP contributions to the EU13 countries grew from 4.20% to 4.50% during the same time period¹⁸. The Horizon 2020 interim evaluation further confirmed that the EU-13 had a small share of project coordinators in terms of signed contracts compared to the EU-15 (5.1% and 87.6%, respectively) and, crucially, that the EU-13 typically coordinated smaller projects (<200 000 euros).

Table 4.1. Horizon 2020: EU13 and EU15 share of participation and share of EC contributions

Table		2014-2015	2016	2014-2015	2016
	FP7, EU13	EU13	EU13	EU15	EU15
Share of participation	7.90%	8.50%	9.40%	83.10%	81.30%
Share of EC contributions	4.20%	4.50%	4.50%	88.60%	87.10%

Source: Corda, Monitoring reports 2015 (data 2014 and 2015) and 2016

The 2016 interim evaluation of Horizon 2020 pointed to a slow progress in opening up of the networks. Intra-EU collaboration frequencies in co-publications are highest between the larger and more R&D-intensive countries, while those with smaller R&I domestic ecosystems often collaborate with each other and with at least one of the R&D intensive nations. Germany, the Netherlands and the UK have continued to collaborate with each other, and Belgium and France have also joined this trend in Horizon 2020. Spain and Italy form their own group but are also collaborating more with smaller Member States, such as Cyprus, Romania, Croatia and Greece. While the Nordics and Ireland formed their own group under FP7, in Horizon 2020 they are collaborating more with the Eastern European countries.

The slow opening up has not been appreciated by the interviewees who frequently referred to “closed networks” or “closed consortia”, which continue to apply for Horizon 2020 funding with no room to negotiate access to EU-13 members “with the excuse of lack of excellence in Widening countries”:

“Each time EU-13 country tries to argue for the need to address the uneven country participation, there are references to the lack of excellence. During the presidency it became clear that there are closed consortia.” (A national authority representative)

¹⁸ European Commission’s internal document.

"Our goal is not only participation in Spreading Excellence and Widening Participation but the entire Framework Programme. There is a need to facilitate the access of new entering countries. (A national authority representative)

"Widening and structural funds are helping to build capacity but they do not help us to become a knowledge society. The key challenge is the access to networks; but this cannot be solved by structural funds. Only research collaboration can help." (A national authority representative)

"The UK and German centres dominate because they have a long track record in Framework Programmes and they benefit from the visibility, experience and recognition. We would like our researchers to be more active in Horizon 2020 but they will need a mechanism to support this." (A national authority representative)

"Finding a consortium is difficult: sending application forms does not work, as there are closed networks which work more on the basis of a 'cousin of a rabbit'. To get access into a network the quality of the research institute is crucial." (A research leader)

The relevant networks include the Public-Private Partnerships and European Technology Platforms operating at EU level, which develop R&I roadmaps for action at EU and national level in some sectors, influence the development of priorities for research and innovation funding and subsequently generate an important number of EU project proposals. Although the networks can be accessed through a paid membership, the key players continue to lead them. In interviews, the following was suggested as a solution: *"the Commission could encourage the participation of Teaming 2 Centres of Excellence with the European Technology Platforms and Public-private partnerships and other networks."*

Closed networks and the related lobbying power can constitute a barrier for Framework Programme participation for newcomers not only at the international but also at the national level. In one of the case study countries this had involved an attempt to retrospectively influence the national selection of the smart specialisation areas after the selection of the Teaming 2 Centre of Excellence had been announced: *"As a result of lobbying, the Ministry of Economy proposed that the respective smart specialisation should be changed..."*. The national researcher networks can also be closed to young researchers due to research evaluation system, which ensures that competitive grants will go to established professors, who benefit from a point system.

Given the divergent views of the Commission and the Widening Coordinators and other interviewed stakeholders further analysis could focus on the networks and clustering of leading research actors.

4.6 Size of the projects

The 2011 analysis showed that large projects could be problematic for small countries and newer FP actors due to a variety of reasons such as the related lack of appropriate research facilities, lack of experienced support for research management, and the difficulty of raising matching funds for large projects.

The 2016 interim evaluation, however, showed that in Horizon 2020 large projects have attracted a higher share of newcomers and EU-13 participants compared to smaller projects. While majority of the EC contribution (92%) goes to projects worth over EUR 5 million, these projects also include most of the EU-13 participants, and cover 88% of the contribution they received from the EC. At the same time the EU-13 participants seem to coordinate and lead more if the projects are smaller. The fact that the EU-13 partners participate more in large scale projects but typically coordinate smaller projects implies that the size of the project still remains a barrier to FP participation, at least in terms of FP project coordination and consortium leadership.

Many countries also lack of appropriate research facilities and experienced support as well as the difficulty of raising matching funds. However, the lack of research infrastructure required for larger projects may be less of a problem for those Widening countries which have already developed R&I infrastructures with the help of the European Structural Funds. Consequently, a representative of a national authority proposed that extra points should be given for Framework Programme proposals that make use of the infrastructure and equipment in Widening countries.

The lack of experienced support for research management and coordination of larger projects was felt in the application phase (particularly in terms of legal expertise) and the implementation phase when administrative support was needed but not often available given the lack of human resources and skills (language, project management etc.). In some cases the issue was simply the small size of the administration: *"Due to the general small size of the university administration, individual researchers need to do a lot of non-research activities in Twinning. They are quite overwhelmed."* (A national authority representative)

For Widening countries coordinating large projects are associated with a higher risk, particularly when national co-funding is expected. Widening Coordinators had spent a minimum of one year in efforts trying to ensure the national co-funding, sometimes in conditions where they had to negotiate with changing ministers. In one case, the T2 coordinator did not yet know whether the national authorities would ensure the co-funding and from which funding source. Large projects are risky also for coordinators from advanced countries, who may avoid to include new less known partners. Opening the networks could help in this respect.

The size of the projects was spontaneously identified as a barrier to FP participation by Estonia, where the low efficiency of public R&D spending is caused due to the lack of economies of scale and critical mass in research areas. Estonian authorities have made efforts to address these shortcomings and ensure success in FP; for example in the case of Teaming Phase 2, the authorities had agreed that, as a small country, Estonia could sustain only one Teaming 2 Centre of Excellence, given the national co-funding requirement, and had therefore implemented a careful selection process at the country level, before submitting a single project application, in contrast to even smaller countries which had submitted several project applications. This points to a need for clearer guidance from the Commission in the application phase.

4.7 Problems with information, communication, advice and training

The 2011 identified the suboptimal information and communication system as a key challenge in some countries. The 2012 review of studies of national support structures for FP participation also showed that the interaction and exchange of information between the national actors – policy makers in programme committees, other representative bodies and the NCPs – sub-optimal in many countries¹⁹.

While the situation has improved in a number of countries through better organised NCP and shared learning through organisations such as NCP WideNet, there is high degree of variation across EU-13 and Widening countries in the NCP organisation for Horizon 2020 in terms of centralisation/decentralisation, size and professionalization of the staff and activities. The NCP organisational models range from highly decentralised systems with a large number of organisations involved (BG, FR, FI, HR, IE, BG, RO), to centralised systems with one or few institutions involved (CZ, CY, EE, NL, PL, PT, RD, SI) and a hybrid model with a central point and addition points spread across the country (AT, DK, CH). The size in staff varies equally and in many cases staff members have NCP activities

¹⁹ Åström, T., T. Jansson, G. Melin, A. Håkansson, P. Boekholt and E. Arnold (2012), On motives for participation in the Framework Programme, report for the Norwegian Ministry for Education and Research, Technopolis Group.

as additional duties. A study by the NCP Academy found no direct correlation between the efforts of the NCPs and the country's success in the Framework Programme, but concluded that the NCP structure should be adapted to the country context²⁰. The recent Mutual Learning Exercise further confirmed that the strength of the centralised and decentralised model are the weaknesses of the other and vice-versa (MLE Topic 4)²¹.

For example Estonia has developed a professionalised NCP organisation with 13 experienced staff members who are experts helping researchers (but not researchers themselves). Baltic countries also benefit from an active national representation in Brussels which is an object of envy for researchers outside the region: *"In every meeting in Brussels I feel the presence of these people."* (A research leader)

Interviews highlighted the heavy workload of many NCPs and sometimes suboptimal results. In Slovenia, most of the 21 NCPs undertake their tasks in addition to other duties with the need to "to change 4-5 hats a day". Bulgaria's 50 NCPs, scattered in different ministries institutes of the academy of sciences, universities, typically undertake their task in addition to other duties: *"Good people but overwhelmed with other tasks."* In Serbia, the NCPs, all based in the ministry, lack time and resources to take part in important meetings. Despite professionalization and concentration of most of Poland's 36 NCPs in one organisation (IPPT PAN), which also coordinates the NCP Widenet, the NCP system is "stuck on the FP5 level". While Polish higher education and research institutions with a track record in FP participation have developed in-house expertise for support, most institutions lack this capacity.

The interviews also highlighted the low take-up of the NCP services by the Widening coordinators. Reasons for this varied: while some research leaders explained that the NCPs were overloaded with other tasks, other noted that the NCPs were more geared to newcomers than experienced applicants or complicated scientific projects: *"The NCPs offer services suited for the FP5 but not Horizon 2020 or complicated scientific projects. They can talk about the project management in theory, but do not offer useful support in practice."* These comments suggest that NCPs may lack capacity to broaden the scope of their activities.

The support that is needed but often not available include writing grant applications and influencing the future programme calls. In the absence of grant-writing services, some research leaders resort to foreign firms to prepare their applications. They also advocated the Austrian practice where small firms provide this support and are part of the project team which ensures good results in the project management and reporting. A key to better FP participation by low performing countries is the access to the network and platform which is preparing the call, but the NCPs do not seem to fill this gap. Interviews showed that the researchers would be interested in taking part in the preparatory work but lack funding and time allocation for visits to Brussels.

²⁰ NCP Systems – benchmarking on micro and macro level & gathering future needs
http://www.ncpacademy.eu/wp-content/uploads/2017/08/20170531-NCP-Academy-Helsinki-Experience-Report_FINAL_sep17.pdf.

²¹ The comparative benefits of centralised NCP systems include visibility, accessibility, pooling of resources, communication and information channels, standardisation of practices, exchange of good practices, experiences and knowledge. The benefits of decentralised systems include: closeness to beneficiaries, wider reach, regional coverage, richness of the network with different actors and various NCP practices – innovative approaches.

4.8 *Adverse incentives in national R&I systems*

The national R&I systems may undermine the pursuit of excellence or create adverse incentives that boost quantity over quality or a push to focus on national rather than EU competitive calls. While Several Widening countries now use research evaluation systems, such as Poland, Slovenia, Serbia, these systems tend to overvalue quantity over quality and have led to a rapid growth in publication activity as well as 'gaming' the system. In Poland half of the public research funding is distributed on the basis of the scientific units' evaluation which is based on a complicated count of publications, weighted by the impact of scientific journals (but not on their citation impacts) as well as awarded titles. The underlying calculations are facilitated by a parametrisation system which provides inadequate incentives for research excellence and international collaboration. In some cases, the low Horizon 2020 participation may also be linked to the availability of national competitive funding schemes from where funding is immeasurably easier to acquire.

4.9 *Fragmentation of higher education and R&I systems and lack of competitive universities and research organisations*

Many low performing countries in Horizon 2020 have a fragmented higher education and research and innovation system and significant difficulties in reforming the sector. This is the case not only for the low performing Widening countries as well as better performing countries.

For example in Poland, successive governments have tried to reform the HE and science system consisting of hundreds of universities and public research organisation including research institutes and the institutes of the Polish Academy of Science, but limited progress has been made given the inertia in the academia. In 2016, the ministry embarked on large scale reforms of the HE and science system, but the progress is pending and key parts of the R&I system including the Academy of Science institutes are not part of the reform. In Bulgaria, after the implosion of the pre-transition R&I system, limited progress has been made in reforming the public R&I system which includes 50 higher education institutions including only a few with significant research activity. Slovenia, one of the best-performing Widening countries, has debated the reform of higher education system for decades, but the higher education system still consists of more than 60 institutions, dominated by one university which represents 70% of the national student enrolment. Currently the implementation of reforms to develop the national R&I system is on hold, and the new laws on higher education and R&D are under preparation.

Many EU countries are considering mergers and consolidation to reach economies of scale and to address the fragmentation and under-performance of the R&I system, often driven by the poor visibility in global university rankings²², despite the costs²³ involved and the limited analysis of the effects of mergers and impacts on higher education quality and critical mass²⁴. For instance in the UK, the 2004 University of Manchester merger improved the ranking, funding base and R&I performance: presently Manchester is the second largest university in the UK, 6th in terms of FP participation and FP income and 38th in the world by Academic Ranking of World Universities (ARWU). Smaller countries

²² The top 100 rankings (mainly US universities) capture only about 0.5% of the 18 000 higher education institutions that enrol 0.4% of the world's 200 million students. See e.g. Ellen Hazelkorn (2014). *Rankings and the Reshaping of Higher Education: The battle for world-class excellence*, second edition, Palgrave.

²³ Few countries or public institutions can afford the level of investment required to the development and maintenance of world class universities which are a 1-billion-dollar-a-year operation. See Alex Usher's 2006 article titled "Can our schools become world class?" in the *Globe and Mail*.

²⁴ HEFCE (2012), *Collaborations, alliances and mergers in higher education. Lessons learned and guidance for institutions. A good practice guide*.

where mergers have improved R&I performance include Denmark which reduced R&I system fragmentation by absorbing research institutes into universities. Currently the University of Copenhagen and Aarhus University 3 feature in the top-100 of ARWU (number 30 and 65) and are number 1 and 3 in terms of FP participations and FP income in Denmark. In Finland, the 2010 Aalto University has so far not led to ranking success (rank 401-500 in ARWU), but it is number 3 in terms of FP participations and FP income after the state technological research centre VTT and Helsinki University. The interviewed research leaders were generally sceptical about merger processes which *"do not develop stronger institutes or better performers in R&I"* and about efforts *"to reconstruct science by changing the organization"*. Instead they advocated a greater focus on encouraging young people to publish and build international networks (*"Controlling professors use PhD students as assistants so that they cannot focus on their research"*).

Alternative approaches include excellence initiatives which encourage greater differentiation among higher education and research institutions based on their relative strengths, and hence enhanced research excellence. For example the German Excellence Initiative has rewarded not only research clusters but also institutional strategies, and has allocated 4.6 billion euro over 10 years.

The general level of investment in higher education institutions (and research institutes), the funding allocation system, and the human resources policies covering both doctoral training and the academic salary systems deserve more attention. As noted above the inflexible salary structures in Polish state universities and the very low salary levels in Bulgaria are a barrier to attracting and retaining talent and the Horizon 2020 participation. In Slovenia, for university professors on 100% fixed salaries Horizon 2020 means just extra work for which there is no time allocation or compensation²⁵. Under these circumstances the FP participation could be incentivised at the national level by introducing more competitive salary levels and performance-based funding, e.g. by requiring staff to bring 30-50% of their salaries from external sources or like in some US universities by establishing 9-month positions with an obligation to bring the funding for remaining three months as competitive funds. This would require progress in enhancing institutional autonomy over university finances, payroll and estate and backing this up with appropriate accountability schemes.

The contrasting trajectories of East German and Polish university systems highlights the importance of policy reforms and sustainable funding. After the unification, East German university and research system has undergone a radical transformation process which involved closing down politically compromised institutions, remodelling the research system according to the Western German model, and transferring research institutes to Eastern Germany²⁶. It also imposed an obligation for professors to reapply for their jobs in competition with West German applicants²⁷. The transformation of the higher education and research system has underpinned with a substantial funding injection: in 2014, West Germany transferred EUR 2 trillion to Eastern Germany and hence spared the institutions from funding cuts. In Poland, however, the universities have struggled with funding difficulties and many talented researchers emigrated to Western Europe. Due to the low salaries, new university hires have taken second jobs and failed to develop their research competences. The demographic bubble in many Eastern European countries has contributed to the neglect of the research system, as the priority has been on education rather than research. This has led to significant gains in higher education

²⁵ It is noteworthy that the Serbian system where faculties and research institutes are legal entities that can set their human resources policies and salaries, allows strong research units to develop and grow which can independently develop their research, set their regulations and differential salary levels.

²⁶ For instance Max Planck Society established its headquarters in Berlin and 18 institutes in Eastern Germany.

²⁷ For example in 1997, 16% of Humboldt University's academic staff had been employed since 1989.

enrolment rates in many EU-13 countries, and in some cases also to a proliferation of higher education institutions and fragmentation of the higher education system.

4.10 Language barriers

Language barriers may play an indirect role constraining Framework Programme participation. While the language skills of the research staff are generally considered sufficient for participation in Framework Programmes, in a number of countries the administrative personnel would benefit from stronger language skills (as well as rewards for Horizon 2020 participation). This may point to the need for training for administrative staff in R&I which could be offered or funded by the European Commission.

Language barriers are an issue in countries which maintain high demands for local language proficiency for international researchers. In some cases attempts to adopt flexible approaches to language policy in science have been rejected at the national policy level by the national parliaments as has been the case in Slovenia.

National language requirements may act as a barrier to attracting international talent and mobilising this talent for the strategic development and implementation in their host institutions. Some interviewees flagged the difficulty faced by mobile researchers when trying to overcome language and cultural barriers as an area where governments can offer programmes or schemes, possibly within the larger frame of immigration policies²⁸.

Widening countries are now increasingly using English in the evaluation of national competitive research applications, but the interviews showed that countries may also use national language(s) in the research evaluations to the detriment of the quality. For example in Bulgaria, research projects submitted to the National Science Foundation are evaluated mainly by Bulgarian reviewers. For the last few years, only Bulgarian language has been used in the submission of research proposals which has led to the lack of qualified reviewers in some scientific areas as well as conflicts of interest.

4.11 Regulatory and administrative burden

The regulatory and administrative burden and bureaucratic procedures obstruct both R&I and business activities, whereas the administrative burden for Horizon 2020 is considered relatively low, at least on the basis of the small sample of interviews. Few countries in Europe notably Sweden and Estonia (for business²⁹) have launched programmes to reduce the administrative burden.

The 2017 ET 2020 Peer Learning Activity for the working group on higher education showed that bureaucratic overload and accountability burden in higher education and R&I system may also emerge from the increasing expectations on institutions by multiple interested parties, each with their own accountability requirements. At worst this can lead to a bureaucratic overload through repeated collection of the same data by different authorities. For example the 2017 Horizon 2020 Policy Support Facility Review of Poland showed that the Ministry of Research and Higher Education allocates funding to universities through 20 streams each requiring thorough reporting, some institutions are also under double control by two ministries³⁰. In Greece, several national agencies and several departments of the ministry collect data in higher education institutions. This calls for an investigation of the extent of the accountability burden that is placed on

²⁸ Fernandez-Zubieta, A. and K. Guy (2010), Developing the ERA: improving knowledge flows via researcher mobility, JRC scientific and technical reports.
<http://publications.jrc.ec.europa.eu/repository/bitstream/JRC58917/Ifna24511enn.pdf>.

²⁹ <https://www.mkm.ee/en/zero-bureaucracy>

³⁰ This allocation system is currently under revision.

institutions in order to identify and quantify the main sources and extent of burden as well as the potential to reduce it. In the United Kingdom, this type of investigations, commissioned by the Higher Education Funding Council for England (HEFCE) have led to savings and reductions in regulatory burden; the most recent investigation focusing on the Research Excellence Framework.

Against this background the administrative burden of the Horizon 2020 was generally seen modest by the interviewees. Part of the perceived burden is caused by national requirements which in the case of Widening had involved securing the national co-funding. This had required months of work from all Teaming 2 coordinators including heavy paperwork. At the time of the interviews, one Teaming coordinator was still uncertain whether the national co-funding would be available and where and when it would emerge. Despite the complications, in some countries, the benefits of the co-funding requirement had far outweighed the efforts. It had ensured that the project was considered a national effort. The process had also triggered a number of positive changes in the national R&I system and a stronger appreciation of the societal benefits of science.

Based on the experience of Horizon 2020, there were suggestions in the interviews that the Commission should simplify the application and the evaluation phase of FP. In the application phase this would mean a move from an application of 60-70 pages to 20 pages with focus on work packages, milestones and financial aspects (not full information of partners), while the evaluation phase should be made faster in line with the European Science Foundation practice where the whole process will take about three months. Research leaders and/or national authorities also suggested that the Widening programme should be more flexible, allowing funding for research, exchange of staff and employment of postdoctoral staff.

4.12 Quality of government and weak public institutions

In R&I and higher education, challenges linked to the quality of government in the eligible countries may involve the conflict of interests in the evaluation of project proposals, irregularities in the distribution of funding, nepotism and favouritism in recruitment and career progress etc. Inefficiencies in public administration, the low quality of regulations, frequent changes in ministers or key ministry personnel, and frequent changes to the legislation and slow implementation also weaken the effectiveness of legislation and may deter R&I investment.

The 2016 Worldwide Governance Indicators³¹ show that many EU-countries are faced with the challenge in terms of the quality of government and weak public institutions. Several EU countries rank low in terms of the government effectiveness.

In light of the interviews the quality of government and weak public institutions remain a challenges impacting R&I systems and Horizon 2020 participation in Widening countries. While the interviewees did not flag such undesirable approaches as a major problem in the national R&I system as a problem, there was a greater acknowledgement of the use of inappropriate lobbying power in decisions linked with funding and prestige.

4.13 Lack of a European patent code and costs of intellectual property

The high costs of the intellectual property in Europe emerged as a new, albeit indirect barrier which discourages the small business to invest in R&I and academic inventors to engage in knowledge transfer and may hamper the FP participation particularly in low income countries³².

³¹ <http://info.worldbank.org/governance/wgi/#home>

³² This barrier was identified during the ad hoc interviews in the University-Business Forum in Sofia in February 2018 and further followed up by email exchange.

In comparison to the US, the European patenting system is expensive and time consuming and in most cases out of the reach of small businesses. In the United States, a patent application costs about USD 1 000 for a patent which is valid in all states. The same applies to India, Switzerland, Australia, Russian Federation, China etc.

The European Patent Office (EPO) provides a single patent grant procedure, but does not provide a single patent for enforcement. Hence the patents granted are not European Union patents or even Europe-wide patents, but a bundle of national patents and the inventor will need to pay a fee for each country where he/she thinks to apply the patent, and pay tens of thousands for the patent:

- The inventor can apply for a patent electronically³³ using one of the three languages (EN, FR, DE) and can choose the three countries which has one of the above languages as an official language.
- In order to cover the 38 EPO members (EU + the associated members), the costs will rise over 40 000 euros.
- Additional costs include the costs for local patent experts since inventor can contact the national patent office only if he/she is the citizen of the country.
- For each country where the official language is not among the three mentioned above, there is a need for an official translation of the patent documentation.
- Each year the inventor needs to the annual taxes again independently for each country using the local patent experts as mediators.

In order for the European Union to take leadership in innovation, there is a need to provide a base for the SMEs and small businesses to develop and trade know-how. A single patent market for the EU would enhance innovation as entrepreneurs would have access to a single database for innovations, instead of 38 databases using 30 languages.

5 Integrating enhanced Synergies mechanism in FPs

The purpose of developing synergies between the the Framework Programme and the European Structural and Investment Funds (ESIF) is to maximise quantity and quality of R&I investments. This implies combining the ESIF innovation investments under the smart specialisation priorities with world class research and innovation initiatives supported by the Framework Programme. Approximately 30% of the total allocations are deployed for innovation, with the aim to mobilise the innovation potential of all EU regions.

The recent Commission's study on synergies between the FP and ESIF³⁴ found that the generation of synergies remains variable, occasional and based on chance rather than a systematic process. Despite a strong EU policy mandate for maximising synergies, there appears to be a lack of responsibility, definition of roles or ownership of this policy at the Member States and regional level³⁵. The 2017 Mutual Learning Exercise³⁶ highlighted the key challenges in implementing synergies:

³³ <https://www.epo.org/index.html>.

³⁴ Available in section 'Publications' at <http://ec.europa.eu/programmes/horizon2020/en/h2020-section/spreadingexcellence-and-widening-participation>

³⁵ Mutual learning Exercise. Widening participation and strengthening synergies. Challenge paper topic 5: enable structured/effective dialogue between ESIF Managing Authorities and the Framework Programme R&D authorities – “breaking silos”. Research and Innovation. December 2017.

³⁶ Ibid.

- Coordinating the timing of potentially linked ESIF and Horizon2020 calls;
- Addressing the remaining complexities related to State Aid regulation;
- Ensuring that similar projects funded from different sources can have the same rules;
- Reorganizing authorities at the Member States;
- Addressing silo-based implementation at the DG and Member States;
- Separating the overseeing bodies and regulations;
- Perceiving synergies seen as a concept rather than funding rules;
- Rewarding civil servants for synergies rather than punishing them for misinterpretation.

As noted above the EU-13 countries have developed different strategies in the utilisation of ESIF, with some countries allocating a significant part of the ESIF money to RDI, while others facing significant challenges in absorbing these funds. The 2016 report "EU Funds working together for jobs and growth"³⁷ advocates three levels of action at the strategic, programming and project level in order to secure sustainability and effective implementation. Examples of good practice in this respect include Estonia where about half of the national investment in RDI has been drawn from the ESIF funding resulting in significant improvements in the RDI policy system and the level of success of Estonian researchers. Estonia has also developed an exit strategy to ensure the sustainability of the national RDI system once the ESIF funding is reduced. At the same time, several countries have faced significant challenges in using the ESIF, to the degree that according to some sources, the east-west RDI gap has worsened by access to 'easy' funding with Structural Funds as a key part of the problem in new Member States³⁸.

At the national and regional level, main barriers to synergies centre around the quality of governance, capacity building and innovation. The 2017 mutual learning exercise on synergies highlighted the need to develop more participatory governance in regional innovation strategies (RIS3), and to address administrative, legal and technical issues and structural bottlenecks in the R&I ecosystem. The Joint Research Centre (JRC) has responded to these needs through dedicated support measures, such as the "Lagging Regions Project", which has developed participatory governance, human resources and mobility plans and long term RIS3 strategies and the "Stairway to Excellence Project" which covers training for Managing Authorities to build capacities for accessing H2020 open calls, and for collaboration. There is also dedicated support to universities through the "Higher Education for Smart Specialisation Project" which helps align higher education with regional economy and strengthens the role of education in regional innovation systems.

The interviews confirmed the highly variable outcomes of synergies and the causes for the suboptimal implementation. There was an acknowledgement of the efforts made by the Commission to enhance synergies, but these were generally perceived inadequate. While some referred to the narrow interpretations and risk aversion by the relevant National Management Authorities, more often challenges were identified in the

³⁷ Commission (2016) EU Funds working together for jobs and growth. Examples of synergies between the Framework Programmes for Research and Innovation (Horizon 2020) and the European Structural and Investment Funds (ESIF)

³⁸ For example in Croatia, only a quarter of the ESIF funding (EUR 10 billion) for the period 2014-2020 had been allocated by end 2017. Currently the World Bank Group is providing analytical services to the Government through the Reimbursable Advisory Services in the planning and implementation of interventions.

Commission, either within the narrow interpretation by the legal department or the general tendency to work in silos.

"Synergies are an old challenge due to legal, financial and administrative arrangements linked to timing, decision making etc.. There is need for more flexibility from the Commission legal services to ensure better synergies between Framework Programmes and ESIF."

"In order to create real synergies the Commission services need to come to an agreement and create a roadmap." "There is a lack of will to go ahead in the Commission. The Directorates do not cooperate." "As a first steps there is a need for a political will, and agreement to bring together the communities of Horizon 2020, ESIF and other stakeholders that offer R&I support."

"The EU regulation is not clear. If research results in technology development, the rules should allow using ESIF to take these results to the market."

Most of the interviewees supported the idea of embedding an enhanced Synergies mechanism in the post Horizon Widening programme. However some cautioned against an automatic mechanism which could lead to diluting the goal of excellence in research. Some countries see the seal of excellence a cosmetic change while the real issue is the huge oversubscription to the Horizon 2020.

6 EU action the interviews suggest for further addressing the barriers to low FP participation

- Streamline and simplify the FP application, implementation and evaluation procedures.
 - In the application phase consider moving away from an application of 60-70 pages to 20 pages with focus on work packages, milestones and financial aspects;
 - Introduce greater flexibility to the implementation of the Widening programme in line with the experience from RegPot, allowing funding for research, exchange of staff and employment of postdoctoral staff;
 - Make the evaluation phase faster in line with the European Science Foundation practice;
 - Take greater advantage of two-stage evaluations, which could consist of a 'blind evaluation' of research and innovation capacity during the first stage, followed by the evaluation of the team and capacity during the second stage.
- Introduce Widening as a horizontal theme in the FP actions;
- Integrate an enhanced Synergies mechanism into the Widening programme, but avoid diluting excellence in research;
- Award extra points for the FP project proposals, which make use of the infrastructure and equipment in Widening countries, for instance developed by ESIF;
- Consider to what extent the current composite indicator identifies the countries in most need of Widening actions. Another way to identify countries could be based on a phased process of exclusion using successive indicators;
- Consider whether Widening could address the growing divergence in R&I among European regions;

- Collaborate closely with the eligible countries to monitor the implementation and impacts of reforms, including the recommendations of Policy Support Facility Reviews given the observed time lag in the implementation in some countries;
- Enhance the visibility of good practice and access to networks, e.g. encourage the participation of Teaming 2 Centres of Excellence in the European Technology Platforms and Public-private partnerships and other networks.
- Consider whether allocating support for reforms could be done on the basis of evidence of progress in the implementation;
- Encourage countries to continue their efforts to reform national R&I systems and increase investment in the public science base. For example encourage countries to introduce performance-based salary systems. Consider whether EU level action is needed to align pension systems to support research mobility;
- Address the tendency to work in silos at different levels (EU, national, regional) and introduce more flexibility from the Commission legal services to ensure better synergies between FP and ESIF.

ANNEXES

Annex 1 Interviews

Name	Role	Country	Date
Andreja Kutnar	Coordinator T2 InnoRenew	SI	9.1.2018
Peter Volasko	H2020 National coordinator, Science Directorate, Ministry of Education Science and Sport	SI	11.1.2018
Andreja Umek Venturini	NCP for ICT and ERC		
Tsanko Gechev	Coordinator T2 PLANTASYST	BG	11.1.2018
Vesna Crnojevic- Bengin	Coordinator T2 ANTARES	RS	15.1.2018
Wieslaw Oleszek	Coordinator Erasmus Chair	PL	15.1.2018
Katarzyna Walczyk- Matuszyk	Director NCP Widenet	PL	17.1.2018
Kalina Georgiades	Project Manager T2 KIOS	CY	19.1.2018
Maria Reinfeldt	Adviser, Research Policy Department, Ministry of Education and Research	EE	19.1.2018
Rein Kaarli	Ministry of Education and Research		

Annex 2 Interview themes and questions

Your personal/your research centre's/your country's experience in the H2020/SEWP:

- Brief description of the role.
- What helped you/your centre/your country to get involved? Describe the development trajectory.
- What has worked well? What could be improved?
- What have been the challenges and what has been done to overcome them?

National/regional RDI and other related policies (e.g. higher education); reforms and their effects; Synergies with national funding, ESIF, smart specialisation, National co-funding for Teaming:

- What national/regional policies and reforms are in place to improve the participation in H2020/SEWP and narrowing the innovation gap? Are there any adverse impacts?
- What are the strengths and weaknesses of the national R&D system in relation to the participation in the Horizon 2020 and SEWP?
- To what extent are synergies with national funding, ESIF and smart specialisation pursued/achieved? Is your centre (of excellence) aligned with national/regional smart specialisation and if yes how was this done in practice?
- What are your experiences of securing the national co-funding for Teaming?
- What are your views about the National Contact Point system? Have you used the NCP services?

Possible barriers to H2020 participation:

Please evaluate to what extent items the following barriers are relevant in your country. Please provide examples of the barriers or how they have been overcome.

- Heavy administration, bureaucracy (EU, national, institutional)
- Insufficient R&D investment in your country
- Low focus on R&D in policy and business in your country
- Lack of synergies between national research system and the EU research programmes
- Lagging system learning effects
- Lack of incentives or presence of adverse incentives in your country
- Lack of professional contacts and research networks; access to existing networks
- Little experience in cross-country collaboration

- Differential wage levels between countries
- Insufficient and ineffective information, communication, advice and training
- Language barriers
- Lack of strong universities and research organisations
- Corruption
- Anything else, what?

Ideas and recommendations for improvements:

- What could be done at the EU level?
- What could be done at the national level?
- What could be done at the institutional level (university/research organisation)?
- How should the Widening programme capture dynamic performances of regions and MS?
- Could an enhanced SYNERGIES mechanism be integrated in the post Horizon 2020 'Widening' programme?

Annex 3 Country case studies

1 Cyprus

1.1 Cyprus' Horizon 2020 performance

With a population of 865 878 Cyprus is one of the least-populous member states of the European Union (0.2% of the total) but among the most successful Widening countries in Horizon 2020. The Horizon 2020 Interim report (2016) shows that Cyprus is among the highest performing EU-13 countries in terms of Horizon 2020 contribution normalised per inhabitant, FTE researchers and RDI investments. Cyprus received 73 euros per inhabitant from Horizon 2020, the sixth highest among all EU countries and the second highest among the Widening countries after Luxembourg, compared to the average of 9 euros for EU-13 or 44 for EU-15. For each full time researcher, Cyprus received EUR 71 860, the third highest amount among the Widening countries after Luxembourg and Malta, and the fourth highest among the EU-28, almost 20 times more than the EU-13 average (EUR 3 812) and over six times more than the EU-15 average (EUR 11 423). For each million euro invested in R&I, Cyprus received EUR 768 657 from the Horizon 2020, the highest amount in the EU-28 area, and eleven to twelve times more than the EU-13 and EU-15 averages (EUR 67 524 and EUR 63 277, respectively).

By October 2017, Cyprus had 325 Horizon 2020 participants who had received 88.18 million euros from the programme, including 6 ERC principal investigators (EUR 2.45 million) and 48 Marie Skłodowska-Curie Fellows (EUR 10.93 million) and 96 SME participants (EUR 27.08 million)³⁹. The University of Cyprus was the biggest beneficiary receiving about 30% of the total sum (EUR 26.90 million for 59 participations) (Ibid). Cyprus had a relatively low success rate at 11.8% compared to 13.5% for EU-28, reflecting the high application rate (2 178 applicants or 0.63 of the total): it was number 20 among EU-28 countries in terms of number of signed contracts and the budget share (Ibid). In addition to overall strong performance in Horizon 2020, Cyprus has a strong track record in Widening actions: it is the only country with two Teaming 2 Centre of Excellence Projects.

1.2 Policies to facilitate participation in Horizon 2020 in Cyprus

Cyprus offers a growing level of national support to facilitate the participation in Horizon 2020 and to narrow the innovation gap, including:

- The R&I framework programme for the programming period 2014-2020 was launched in 2016 under the name "RESTART 2016-2020 Programmes". The programme implements the smart specialisation strategy, and forms part of the Structural Funds Operational Programme "Competitiveness and Sustainable Development".
- The Research Promotion Foundation is planning the establishment of a Central Technology Transfer Office (CTTO) to support academic and research institutions.
- National Policy Statement for the Enhancement of the Entrepreneurial Ecosystem in Cyprus.
- The government commitment to provide national co-funding to each of the 11 Teaming phase 2 centre of excellence candidates.

³⁹ Horizon 2020 country profile updated 24 October 2017:
http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=cyprus

- Services by the Cyprus Research Promotion Foundation, such as funding from Structural Funds to research and innovation; enterprise network; funding to support people to go to brokerage events.
- The Government's EU programme directorate encourages EU-funded programmes (dedicated section for R&I).
- The NCP focuses on awareness raising: recently a H2020 event of 550 people: high participation in Cyprus. NCP also provides help in application process. They helped in the Teaming application by clarifying what type of networks are in play.

The strong performance of Cyprus in Horizon 2020 can be explained by the system learning effects based the cumulative success of Cypriot applicants as well as knowledge circulation with a presence of research talents who have returned to Cyprus and capitalise on their multidisciplinary research and links abroad. The University of Cyprus was established 1989 and set out to attract the Cypriot diaspora back to Cyprus. One of the outcomes of the returning research talent is the multidisciplinary research centre KIOS, one of the two Teaming Centres of Excellence in Cyprus. KIOS now boasts a long experience in FP programmes including 57 research projects, the first ERC grant in Cyprus, the first Cypriot coordinator of ESF COST network and a coordinator in ICT in FP5. This cumulative success has created a domino effect which has also mobilised government support for RDI and a system which is open to change. The implementation of the RDI/smart specialisation strategy may be facilitated by the young age of the R&I system, which implies few institutional rigidities (RIO 2016⁴⁰).

The other Teaming 2 initiative – the Centre of Excellence on Interactive Media, Smart Systems & Emerging Technologies (RISE) – aims to empower knowledge and technology transfer in the region. RISE is coordinated by the Municipality of Nicosia, and is a joint venture between the three public universities of Cyprus (University of Cyprus, Cyprus University of Technology, Open University), and two advanced partners, the Max Planck Institute for Informatics (Germany) and University College London (UK).

1.3 Research and Innovation performance in Cyprus

Cyprus is a Moderate Innovator at 75% of the European average (European Innovation Scoreboard 2017). Since 2012, performance has declined by 12.7% relative to that of the EU in 2010. Relative strengths of the Cypriot innovation system are: Attractive research systems, Human resources, and Intellectual assets. Relative weaknesses include: Linkages, Finance and support, and Firm investments. Cyprus has a small share of foreign controlled enterprise and a low number of R&D spending enterprises which spend limited sums in R&D.

Cyprus has made progress towards its national R&D intensity target of 0.5%, but stagnated since 2011⁴¹. In 2015, total R&D intensity was 0.46% of GDP, with public R&D intensity accounting for 0.31% of the GDP. Investment in R&D by the private sector was the lowest across the EU area, only 0.08% compared to EU average of 1.30% (Ibid). Cyprus plans to increase the annual expenditure on RDI until 2020 (target 0.5%), and to focus on the quality of spending. The current low values reflect the nascent R&D system in Cyprus, which is constrained by a remote location, small market size, service-oriented economy and a lack of high tech industry and skills as well as lengthy procedures in public support programmes. The low levels of R&D hinder Cyprus' ability to diversify its economic structure and boost productivity. (European Commission: European Semester Report 2017). A number of instruments have been put in place or are planned

⁴⁰ Theocharous, A, Gampfer, R, Robledo Böttcher, N (2016) RIO Country Report 2016: Cyprus Research and Innovation Observatory country reports series. JRC Science for Policy Report.

⁴¹ http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=cyprus [updated: 03 January 2018].

to support SME investment in R&D. The Action Plan accompanying the smart specialisation strategy aims at attracting private sector investments in R&I (RIO 2017).

RDI strategy is focused on smart specialisation and takes advantage of Structural Funds. The R&I framework programme for the programming period 2014-2020 was launched in 2016 under the name "RESTART 2016-2020 Programmes". The programme implements the smart specialisation strategy, and forms part of the Structural Funds Operational Programme "Competitiveness and Sustainable Development". RESTART is run by the Research Promotion Foundation and has a total budget of EUR 99 million (EUR 45 million to be covered from Structural Funds). It is divided into three pillars: Smart Growth, Sustainable RTDI System, and RTDI System Transformation (RIO 2017).

Cyprus has highly skilled graduates but many face challenges in employment. The tertiary education attainment rate is very high (54%), but a low proportion of graduates study STEM fields and many work in positions below their qualifications. The tertiary attainment rate reached 54% in 2016, well above the national target of 46% and among the highest in the EU area. In 2014, 44% of students were studying social science, business and law, one of the largest proportion in the EU, while only 0.82% of Cypriots aged 20-29 have a STEM degree. An action plan has been developed to increase the proportion of STEM students to 20-22% by 2020. Employability prospects for recent graduates are more modest than in Europe on average (72.4% vs. 80.5% for EU-28 in 2014). A large proportion of tertiary graduates work in occupations which do not require a university education (Education and Training Monitor). In 2015 the number of new young doctoral graduates per thousand populations was 0.4, compared to the EU average of 1.8. The number of researchers per thousand population was 2.97 (2014 data). In 2016 there were 855 researchers (FTE). A cause of concern is also the deteriorating basic skills base and a high proportion of low achievers at schools despite a relatively high (albeit declining) level of government expenditure on education (5.8 % in 2014) and expenditure per pupil, especially at primary and secondary level (E&T Monitor 2017: Cyprus)

The key strength of the R&I system of Cyprus is international research cooperation. The public research system is open and well connected to global knowledge and to international scientific collaboration innovation networks. EIS 2017 data shows that in 2016 Cyprus had 1 140 international scientific co-publications per million population compared to the EU average of 463 (best performing country: 2 229). The growth rate of publishing has been more rapid than the European Union in general. About 9% of these publications are within the top 10% most cited scientific publications worldwide, more than in Estonia or Malta and close to EU average of 10.5% (EIS 2017).

University-business cooperation and knowledge transfer and commercialisation of research results and support for science-based entrepreneurship are at early stages of development. The Research Promotion Foundation is planning the establishment of a Central Technology Transfer Office to support academic and research institutions, but the implementation has been delayed. The supply of venture capital or business angel funding, which would be a means to support university spin-offs after their creation, is almost negligible. At the end of 2015, Cyprus developed a "National Policy Statement for the Enhancement of the Entrepreneurial Ecosystem in Cyprus"⁴², setting out a vision for the framework conditions that foster innovative entrepreneurial activities. Two of its five priority axes, namely "Cultivating the entrepreneurial culture", and "Facilitating access to finance" are also relevant to improving commercialisation of research results. Cyprus has also developed a Start-up Visa programme to attract entrepreneurs from third countries. In 2016 the Ministry of Energy, Commerce, Industry and Tourism announced a call for the development and operation of the Science and

⁴² <http://www.reform.gov.cy/en/growth-reform/entrepreneurship-and-investments/setting-up-a-policy-framework-for-the-enhancement-of-the-entrepreneurial-ecosystem>.

Technology Park. The supply of venture capital or business angel funding, which would be a means to support university spinoffs after their creation, is almost negligible.

2 Estonia

2.1 Estonia's performance in Horizon 2020

With a population of 1.32 million (0.3% of the EU-28) Estonia is one of the least-populous member states of the European Union but among the successful Widening countries in Horizon 2020, reaching the level of the best performing EU countries in some measures. The Horizon 2020 mid-term evaluation 2016 shows that Estonia is among the best performing countries in terms of the Horizon 2020 funding contribution normalised per inhabitant, researcher and RDI investment. For each inhabitant, Estonia received 50 euros, the fourth highest funding support after Luxembourg, Cyprus and Slovenia, above the average of 44 euros for the EU-13. For each full-time researcher, Estonia received 15 767 euros, the fourth highest sum among the Widening countries after Luxembourg, Malta and Cyprus and nearly four times more than the average for the EU-13 (EUR 3 812). Finally, for each million euro invested R&I, Estonia received EUR 217 990, which is the fourth highest sum among the member states after Cyprus, Greece and Malta, over three times more than for the EU-13 and EU-15 averages (EUR 67 524 and EUR 63 277, respectively).

By the end of October 2017, Estonia had 306 Horizon 2020 participants who had received 82.22 million euros from the programme, including 1 ERC principal investigators (EU 26.33 million), 33 Marie Skłodowska-Curie Fellows (EUR 2 million) and 91 SMEs (EUR 26.33 million). Estonia was 22nd among the EU countries in terms of number of signed contracts and 21st in terms of the budget share⁴³. Two of the six public universities – Tartu University (EUR 18.19 million for 53 participants) and Tallinn Technological University (EUR 11.37 million for 28 participant) were the biggest recipients (about 36% of the total) represent over 70% of the research conducted in Estonia (Interview). Estonia's 2 482 applications represent 0.57% of all applications and had a success rate 13.1% comparable to the average EU rate (13.5%).

2.2 Policies to facilitate participation in Horizon 2020 in Estonia

To facilitate the Horizon 2020 participation and to bridge the R&I gap, Estonia has developed a broad range of measures. These include:

- Alignment of the national RDI strategy with the smart specialisation growth areas, directing EU Structural Funds to the development of R&D infrastructure, human capital and entrepreneurship;
- mobility grants to support ERA chairs, ERA net and KICS (Mobilitus+);
- a programme to support applied research for the sector ministries (RITA);
- co-financing of scientific counsellors in sector ministries to set their R&D priorities and priorities in Horizon 2020;
- a support for firms to commission applied research in RIS3 areas, small support to those who have been successful in Horizon 2020;

⁴³ Estonia country profile and featured projects: Horizon 2020 country participation, updated 2 October 2017: http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=estonia

- a highly professional NCP system concentrated in the research agency and enterprise support in Enterprise Estonia Foundation.

Estonia has made efforts to pursue realistic policies for a small country. For example the authorities made a decision that given the limited resources Estonia can sustain only one Teaming 2 centre of excellence. The fact that a rigorous country-level selection process and national co-funding commitment were not rewarded by the Commission had been a disappointment (Interview).

Estonia's strong performance in Horizon 2020 and progress in R&I is explained by the system learning effects based on a long tradition in cross-border research collaboration and bilateral links in research as well as rapid modernisation underpinned by European and national funds. Before the collapse of the Soviet regime Estonia was the most economically developed region (along with Slovenia) in Eastern Europe with close contacts to the West⁴⁴. Top researchers were active in international collaboration particularly with Sweden and Finland. After the restoration of independence, Estonia introduced widespread and rapid liberalisation and deregulation, with the fastest pace of the systemic modernisation in the region (Ibid). Since accession to the European Union, Estonia has implemented structural reforms and an enabling legal framework, and has channelled a large part of the EU Structural Funds to the development of R&D infrastructure, human capital and entrepreneurship: this has helped create modern conditions and environment for research, and increased the number of researchers and international cooperation⁴⁵. Estonia also has a long experience in Framework Programmes since FP3 and the national RDI system is based on quality competition, use of English and international peer review (Interview). A support structure for the entrepreneurship sector has been created⁴⁶.

Despite progress in implementing RRDI strategies, Estonia's research and innovation ecosystem remains fragile. Key challenges include: low private investment in R&D, insufficient business-academia cooperation, low efficiency of public R&D spending, shortage of skills (RIO 2016⁴⁷).

2.3 Research and innovation performance in Estonia

Estonia is a Moderate Innovator at 80% of the EU average (European Innovation Scoreboard 2017). Relative strengths of the innovation system are in Finance and support, Human resources and Innovation-friendly environment. Relative weaknesses are in Innovators, Linkages, and Sales impacts. Notable differences are a larger share of employment in Manufacturing but a smaller share in High and Medium high-tech manufacturing, a larger share of employment in Utilities and Construction, a larger share of Micro enterprises and SMEs in turnover, a smaller share of large enterprises in turnover, a smaller share of enterprise births, lower GDP per capita, a higher growth rate of GDP, a lower and negative growth rate of population, and lower population density.

Estonia's R&I spending is low with difficulties to reach the pre-crisis level. In 2015, Estonia's R&D intensity was 1.50% of GDP, half of the national target for 2020,

⁴⁴ Adam, Frane; Tomsic, Matevz; Kristan, Primož (2008) Political elite, civil society, and type of capitalism: Estonia and Slovenia, in East European Quarterly. Boulder Vol. 42, Iss. 1, (Spring 2008): 43-67.

⁴⁵ <http://www.unksoc.org/index.php/case-studies/estonia-research-development-and-innovation-strategy-2014-2020/>

⁴⁶ <http://www.unksoc.org/index.php/case-studies/estonia-research-development-and-innovation-strategy-2014-2020/>

⁴⁷ Kattel, R, Stamenov, B (2017). RIO Country Report 2016: Estonia Research and Innovation Observatory country reports series. JRC Science for Policy Support

with business expenditure in R&D at 0.69%⁴⁸. The economic crisis caused a significant drop in the GDP and Estonia has not yet been able to bridge the gap. The level of GERD almost doubled from 1.4% in 2009 to the top rate of 2.31% in 2011, but declined 1.45% in 2014⁴⁹.

The reliance on structural funds poses a challenge to the sustainability of Estonia's R&I system. From 2007 to 2013, Structural Funds accounted for 50 to 60% of all public R&D spending and about 50% in the current programming period (Country Semester Report 2017). The government has developed an exit strategy in view of the need to compensate for the declining volume of structural funds with national funding (Interview).

The key strength of the Estonian R&I system is international cooperation. Estonia's public research system is well connected to global knowledge and innovation networks. EIS 2017 data shows that Estonia had 917 international scientific co-publications per million population compared to the EU average of 463. Estonia's growth rate of publishing has been more rapid than in the European Union in general⁵⁰. At the same time, only 7.4% of Estonia's scientific publications are within the top 10% most cited scientific publications worldwide, compared to 10.5% at the EU average (EIS 2017).

Estonia's favourable business environment is hampered by human resource challenges. The 2017 Country Semester Report shows that Estonia has one of the best performing labour markets in the EU, but a declining working-age population. While participation in lifelong learning is above the EU average and the government policies ensure active labour market participation, there is a short supply of highly qualified human resources due to ageing population, outmigration and low attractiveness of research careers. The share of population (aged 30-34) with tertiary education is above the EU average and the EU2020 targets but the supply of science and engineering graduates is low (in 2014, 13 new graduates per thousand population aged 25-34 compared to the average of 18). The number of young PhDs and researchers (4 338 FTE in 2016) has grown but the completion rate and impact of doctoral studies are still low⁵¹: 1.1 young doctorates for 1 000 population, compared to the EU-28 average of 1.8 (EIS 2017). The share of foreign doctorate graduates is also low at the European comparison (8.1% vs. 25%) but comparable to the best performing Widening countries Slovenia and Hungary. To address the low attractiveness of research careers, Estonia has introduced more and bigger scholarships for doctoral students (RIO 2016).

The government has supported mergers and restructuring of the HE and R&D system and research infrastructures. In 2014, the government adopted an institutional package to boost the competitiveness and increase the efficiency of higher education and R&D institutions, with a budget of EUR 129 million (RIO 2016). A large majority of this funding supports HEIs' comprehensive development plans, structural changes and mergers in higher education and R&D institutions, as well as measures to strengthen academic and research quality. In 2014, the government also revised the Research Infrastructures Roadmap with 18 research infrastructures of national importance, including the European Strategy Forum on Research Infrastructures (ESFRI)

⁴⁸ Estonia country profile: Research and Innovation performance, updated: 03 January 2018
http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=estonia

⁴⁹ Kattel, R, Stamenov, B (2017). RIO Country Report 2016: Estonia Research and Innovation Observatory country reports series. JRC Science for Policy Support.

⁵⁰ <http://www.unksoc.org/index.php/case-studies/estonia-research-development-and-innovation-strategy-2014-2020/>

⁵¹ <http://www.unksoc.org/index.php/case-studies/estonia-research-development-and-innovation-strategy-2014-2020/>

projects, to guide public investment in R&D infrastructure over the next 10-20 years (OECD STI 2016).

To improve the stability of the higher education system, the Estonian government has revised the higher education funding model. A key feature of Estonian HE and RDI system has been overreliance on competitive project-based policy measures, both in funding public universities and private companies. In 2016 the Government decided to allocate additional funds for basic funding of universities from 2017 thereby increasing the level of baseline funding compared to the competitive project-based funding. This means that the share of baseline funding is gradually increasing from 20% to 50% (target for 2018: 40%) (RIO 2016).

Science-industry collaboration is increasing in Estonia but from a low base. The volume of science-industry collaboration increased 25% in 2015, but its share of the R&D funded by business and performed by public research organisations is only 2.4% of the total R&D expenditure (RIO 2016). Estonia's public-private scientific co-publication per million population was only 6.8, below the EU average of 36.9 and significantly below the best performing country Denmark with 165.3 publications (EIS 2017). The reasons for the weak performance range from the industry structure dominated by SMEs in traditional sectors, investments concentrated in few big firms and the low levels of foreign investment in business R&D to the dominance of curiosity-driven basic research in the academia (RIO 2016). To face these challenges, Estonia has designed several policies to improve science-business cooperation, such as support to public research organisations for applied R&D of products in cooperation with business in the smart specialisation areas ('NUTIKAS strategy'), a one-stop shop for companies interested in research with universities ('ADAPTER' platform), industrial doctorates, and support for business to participate in technology development centres and clusters (Ibid).

Estonia features a strong focus on new entrepreneurship. The government aims to increase the number of startups to 1 000 by 2020 (350 in 2016). The Start-Up Estonia 2014-20 initiative, managed by the Estonian Development Fund and financed by the European Regional Development Fund, offers training programmes (OECD STI 2016).

Estonia has made efforts to reduce the administrative burden for businesses (RIO 2016). 'Zero bureaucracy' aims to reduce regulatory burden, bureaucracy and overlapping functions between different public bodies. In the World Bank 'Doing business' report 2017, Estonia ranks 12 out of 190 economies (Country Semester Report).

3 Slovenia

3.1 Slovenia's Horizon 2020 performance

With a population of 2.05 million (0.4% of the EU-28) Slovenia belongs to the most active and successful Widening countries in Horizon 2020, surpassing the average performance of the EU-15 countries. According to the Horizon 2020 mid-term evaluation in 2016, Slovenia is among the best performing EU-13 countries in terms of the Horizon 2020 funding contribution normalised per population, FTE researchers and national RDI investments. Consequently, for each inhabitant, Slovenia received 53 euros, which is the third highest amount among the EU-13 countries after Luxembourg and Cyprus, and nearly 6 times higher than the EU-13 average. For each fulltime researcher, Slovenia received 13 848 euros from the Horizon 2020, the fifth highest amount among the Widening countries (after LX, MT, CY, EE), which is over three times more than the EU-13 average (EUR 3 812) and also above the EU-15 average (EUR 11 423). For each million euro invested in R&I, Slovenia received EUR 128 243 from the Horizon 2020, about twice the amount of the average of the EU-13 (EUR 67 524), and the EU-15 (EUR 63 277).

By the end of 2017, Slovenia had 564 Horizon 2020 participants who had received 157.28 million euros, including 2 ERC principal investigators and 55 Marie Skłodowska-Curie Fellows and 156 SMEs (EUR 47.16 million)⁵². Slovenia was number 19 among all EU countries in terms of number of signed contracts and number 18 in terms of the budget share (Ibid). Slovenia's success rate was relatively low at 10.68%, comparable to Bulgaria, and significantly below the EU-average of 13.5%, reflecting the high number of applicants (5 341 or 1.23% of EU-28) (Ibid) which may imply that the country has reached its optimum level of participation in the Horizon 2020 (Interview 11 January 2018).

3.2 Policies to facilitate participation in Horizon 2020 in Slovenia

To facilitate the Horizon 2020 participation Slovenia has developed a range of support mechanisms:

- Funding instruments by the Slovenian Research Agency with the majority of funds distributed on a competitive basis;
- An online register of all researchers (maintained by the Slovenian Research Agency) which is based on a point system (mainly publications, and to a lesser extent also patents, registered innovations, income from industry collaboration);
- The introduction of the Research Information System SICRIS with a point system which has contributed to a rapid increase in research productivity;
- National co-funding for the Teaming Phase 2 Centre of Excellence;
- The National Contact Point system focused mainly in the Ministry. The NCPs conduct their tasks in addition to their other duties. the National Contact Point has advised Slovenian coordinators to take a Slovenian 'junior partner' to the Horizon 2020 projects for peer learning purposes;
- Small support (EUR 1 000) for Horizon 2020 applications above the threshold, based on a request for payment. In 2017, there was not sufficient funding to cover all eligible applications;
- Alignment of the national policies with the European policies. The strategy for Research and Innovation (2011-2020) was adopted in 2011 and uses H2020 as its main instrument. Currently 2 laws are under preparation: law on Higher Education and law on RDI;
- The Young Researchers Group since 1985 to reform the young research community;
- Dedicated, but insufficient funding for postdocs, currently improved via structural funds;
- A complementary small scale seal of excellence scheme covering the SME instrument, Marie Curie actions and ERC. Funding is taken from the bulk of the national project funding.

Slovenia's solid performance in Horizon 2020 and RDI in general is partly explained by the system learning effects based on a long tradition in cross-border research collaboration and bilateral links in research, as well as concentration of RDI activity. As part of the former Yugoslavia, Slovenia's development trajectory was characterised with a more market-oriented economy,

⁵² Horizon 2020 country profile updated 24 October 2017:
http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=slovenia

relative openness towards the West and a softer transition the Eastern European countries⁵³. Consequently Slovenia was able to develop bilateral research links and also became a founding member of COST. Slovenia's research activity is concentrated in Ljubljana where the country's two most successful Horizon 2020 participants - the University of Ljubljana and the Jozef Stefan Institute - are located. These institutions, which received about 27% of the total funding allocation to Slovenia (EUR 42.36 million) belong to the most active universities and research institutes in the Horizon 2020 among the EU-13 (In FP7 they were both the leading institutions.)⁵⁴ As an exception the Teaming Phase 2 coordinator comes from the University of Primorska.

Despite the success in Horizon 2020, the academia lacks competitive culture due to the 'retention of the elite' where established professors protect their privileges. To enhance Horizon 2020 participation, the National Contact Point has advised Slovenian coordinators to take a Slovenian 'junior partner' to the Horizon 2020 projects for peer learning purposes. There is also need to professionalise the administrative staff at the institutional level. An effective but unpopular measure would be to introduce an obligation for professors to bring part of their salary from external sources.

3.3 Slovenia's research and innovation performance

According to the European Innovation Scoreboard (2017), Slovenia is a Strong Innovator, above all other Widening countries (96% of the EU average). The relative strengths of Slovenia's innovation system are its human resources, firm investments, and innovation-friendly environment. Relative weaknesses are in Finance and support, Sales impacts, and Innovators. Notable differences are a larger share of employment in Agriculture & Mining and Manufacturing, a larger share of micro enterprises and SMEs in turnover, a smaller share of large enterprises in turnover, a larger share of foreign controlled enterprises, a lower number of Top R&D spending enterprises and a lower average R&D spending of these enterprises, a smaller share of enterprise births, lower buyer sophistication, a lower growth rate of GDP, and a lower growth rate of population. However, Edquist and Zabala-Iturriagagoitia (2015)⁵⁵ rank Slovenia 18th among the EU countries in terms of innovation outputs and 25th in terms of productivity (innovation performance), pointing to a low efficiency of the national innovation system, especially in the private sector.

Slovenia benefits from highly educated human resources: over 40% of the younger generation have completed tertiary education; at the same time adult skill levels vary because of low proficiency among the older people⁵⁶. Slovenia also generates a large number of young doctoral graduates (3.5 per thousand population i.e. Number 1 in EU-28), but the higher education and research system is no longer able to absorb these skills: since 2012 there have been signs of a brain drain (Interview). The government has used structural funds to alleviate the situation (Ibid). In 2015, the R&D sector employed 14 225 people (FTE) including 7 900 researchers, which grew to 8 102 FTE researchers in 2016, still below the peak year of 2012 with 8 884 researchers. The employment decline in 2015 was disproportionately high for young researchers in the HE

⁵³ Adam, Frane; Tomsic, Matevz; Kristan, Primož (2008) Political elite, civil society, and type of capitalism: Estonia and Slovenia, in East European Quarterly. Boulder Vol. 42, Iss. 1, (Spring 2008): 43-67

⁵⁴ Horizon 2020 country profile updated 24 October 2017:
http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=slovenia

⁵⁵ Edquist, C., Zabala-Iturriagagoitia, J.M. (2015). The innovation Scoreboard is flawed: the case of Sweden - not being the innovation leader of the EU. Lund University.
<https://charlesedquist.files.wordpress.com/2012/10/201508-cwp-27.pdf>

⁵⁶ In the OECD Survey of Adult Skills (PIAAC) about one in four Slovenes aged between 16 and 65 had poor literacy and numeracy skills and almost half had weak digital problem-solving skills.

system and the government sector due to budget cuts and ending of several instruments funded by the EU structural and investment funds (ESIF), whereas the business sector remained stable (RIO 2016).

The language requirements may act as a barrier to attract and retain international talents. Recently a law proposal to relax the language requirements was rejected by the Parliament (Interview). The share of foreign doctorate students is low but above the average of EU-13 countries (EIS 2017).

After years of continuous growth, peaking in 2013, Slovenia's R&D business intensity has dropped in recent years and public R&D intensity is also declining. The R&D intensity peaked in 2013 at 2.6% but has declined since then to 2.21% in 2015 below the national target of 3% for 2020. Although R&D investment as percentage of GDP is above the EU average, the R&D funding has decreased and the efficiency of spending is low. "Slovenia lacks an effective governance structure for R&I given the weak coordination across responsible departments and collaborative links between major stakeholders in innovation policy." (EC Country Semester Report)

Slovenia's R&I system suffers from an implementation deficit. The Slovenian Research and Innovation Strategy for the period of 2011 – 2020 puts an emphasis on the RTD evaluation as a precondition for RTD quality, specialisation of research community and the competitive distribution of limited budgetary funds. Currently the implementation of the related policy reforms to develop a modern, transparent, well-co-ordinated and comprehensive national RDI system is on hold, and the new laws on higher education and R&D are under preparation. There are concerns among the research community that the changes in the legislation will lead to a system where the larger part of the funding will be channelled to support the smart specialisation areas (interview). The policy coordination problems and the "implementation deficit" date back to the reorganisation of the RDI sector (RIO 2017).

The Slovenian Research Agency, the largest investor in basic science, provides a range of funding instruments with the majority of funds distributed on a competitive basis including a two stage evaluation system with international peer review. All researchers are registered and the national bibliographic system which is connected with ISI Thomson Reuters and Scopus databases. This provides data about the research productivity.

The introduction of the current Research Information System SICRIS with a point system has contributed to a rapid increase in research productivity, but the quality should improve. In international co-publication Slovenia is the leading Widening country at a comparable level with Ireland and the UK, and slightly above Cyprus, Estonia and countries like Germany and France (EIS 2017). Slovenia also generates large numbers of public-private co-publications (EIS 2017). At the same time only 8.61% of Slovenia's scientific publications are within the top 10% most cited scientific publications worldwide, compared to 10.56% at the EU average⁵⁷.

Despite the benefits of boosting research activity, the SICRIS system has created some undesired impacts such as focus on quantity over quality (e.g. fragmenting research to gain more points), and efforts are being made to reform the system. The system may create barriers for young researchers who in Slovenia typically co-publish with their mentor. Co-publishing generates an equal number of points to all parties, and in research programmes the programme leader normally gains the largest

⁵⁷ http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles

number of points. (For researchers out of the research programmes there is also a complex system for reporting). The system also undervalues innovation. There is a point system for collaboration with industry and EU funding, but the way the points are collected is counteractive.

Current measures to boost innovation seem to lack ambition. They include an open call worth EUR 45 million for a sporting company and vouchers for firms to co-finance research (EUR 2000). There is limited focus on creating open innovation systems or incentives for HEIs to engage in industry collaboration (e.g. in the form of sectoral mobility).

Slovenia's start-up community is rapidly developing and there are a growing number of globally successful start-ups. At the same time Slovenia has one of the lowest entrepreneurship scores in the EU with many entrepreneurship-related indicators showing declining and low results. The government has adopted policy measures to promote entrepreneurship across the education system but it is still too early to evaluate the results of this change. (Education and Training Monitor 2017: Bulgaria)

4 Bulgaria

4.1 Bulgaria's performance in Horizon 2020

With a population of 7.28 million (1.4% of EU-28), Bulgaria has a weak track record in Horizon 2020. The 2016 Horizon 2020 interim evaluation shows that Bulgaria is one of the lowest performing EU-13 countries in terms of Horizon 2020 funding contributions normalised per inhabitant, FTE researchers and RDI investments. For each inhabitant, Bulgaria along with Romania received the lowest level of funding – 4 euros – compared to the average of 9 for EU-13 countries. For each full time researcher, Bulgaria received 2 095 euros, which is the second lowest amount among the EU-13 countries after Poland, and significantly below the EU-13 average (EUR 3 812). For each million euro invested in R&I, Bulgaria received a slightly higher sum from Horizon 2020 than the EU-13 countries on average (EUR 68 791 and EUR 67 524, respectively), but much less than the top 3 EU-13 countries: Cyprus (EUR 768 657), Estonia (EUR 217 990) or Slovenia (EUR 128 243).

By October 2017, Bulgaria had 315 Horizon 2020 participants which had received 51.64 million euros from the framework programme, including 1 ERC principal investigator (EUR 0.15 million), 39 Marie Skłodowska-Curie Fellowships (EUR 4.54 million) and 58 SME participants (EUR 9.04 million). The Center of Plant systems Biology and Biotechnology was the biggest beneficiary with 7.35 million euros. Bulgaria's 3 123 applicants (0.72% of EU-28) had a lower than average success rate (9.7% vs. 13.5% for EU-28). Among all EU countries, Bulgaria was 21st in terms of the signed Horizon-2020 contracts and 24th in terms of the budget share⁵⁸. Bulgaria's performance in the Horizon 2020 has been poor especially in relation to other Widening countries of similar size. The total income since the beginning of Horizon 2020 has been EUR 51.64 million compared EUR 74.27 million for Slovakia with a smaller population. The PSF review for Bulgaria noted that Bulgaria's participation in ERA-net joint calls was also lower than in comparable countries (e.g. Romania), and "there is a general view that Bulgaria has been pulling out of co-operations (e.g. an ERIC infrastructure) rather than engaging in new European scale co-operations, due to a lack of national funding priority" (PSF review of Bulgaria). Under these circumstances, securing funding for Bulgaria's first Teaming Phase 2 Centre of Excellence is a great achievement.

⁵⁸ Horizon 2020 country profile updated 24 October 2017:
http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=bulgaria

4.2 Policies to facilitate participation in Horizon 2020 in Bulgaria

Bulgaria offers a modest level of national support to facilitate participation in Horizon 2020:

- There is no professional fulltime National Contact Point Network but a loose network of NCPs who have many other duties;
- The system does not offer funding for travel grants to meet collaborators or for coordinators to prepare proposal;
- The current funding schemes do not complement or prepare for participation in EU research and innovation programmes or in activities funded through the European structural and investment funds;
- The system lacks matching-funds schemes that provide national funding to Bulgarian R&I proposals that have been submitted for funding in Horizon 2020 and positively evaluated, but did not receive EU funding;
- There is no targeted support for potential participants to build their abilities in preparing and managing European R&I projects (e.g. preparation and coordination of proposals and promotion of projects);
- So far the government has not taken steps to develop mechanisms to take advantage of the 'Seal of Excellence' for Horizon 2020 projects proposals evaluated as excellent but not funded.

The RIS3 approach and the establishment of the Council for Smart Growth (CSG) offer a new opportunity for the Bulgarian authorities to revitalize research and innovation policies as well as to reorganize the fragmented landscape of R&I and related sectoral policies (RIO 2016).

Bulgaria's weak performance in the Horizon 2020 reflects the low investments in the science base, inefficient funding allocation, lack of synergies between the national and the EU RDI systems, lack of alignment with the European funding programmes, as well as lack of emphasis on supply of human resources and incentives for excellence and internationalization. There is a lack of a long-term support for RDI investments and sub-optimal coordination of national and European R&I funding (RIO 2016). The funding allocation is not aligned with the international best practice and the salaries for PhD candidates and HEI staff are very low. The public perception of the role of RDI is low (as in many low performing European countries) and the country lacks an empowering National Science Agenda, despite the elaboration of New Vision for Development of Scientific Research in Support of Society and Economy "Better Science for Better Bulgaria" 2016-2025. The results of the international evaluation such as the PSF review in 2015 have not been implemented.

4.3 Research and innovation performance in Bulgaria

Bulgaria is a modest innovator with an innovation performance at only 47% of the EU average, and its performance has not changed over the years relative to that of the EU 2010. Relative strengths of Bulgaria's innovation system are in Intellectual assets, Employment impacts, and Human resources. Relative weaknesses are in Innovators, Finance and support, and Attractive research systems. Notable differences are a larger share of employment in Agriculture & Mining and in Manufacturing, a smaller share of employment in High and Medium high-tech manufacturing and in Knowledge-intensive services, a larger share of Micro enterprises and SMEs in turnover, a smaller share of Large enterprises in turnover, a larger share of foreign controlled enterprises, a larger share of enterprise births, lower GDP per capita, a higher growth rate of GDP, a

lower and negative growth rate of population, and lower population density. (European Commission, European Innovation Scoreboard 2017)

The Bulgarian research and innovation system suffers from significant underfunding and low level of public funding. While the RDI intensity reached 0.96% in 2015, the public RDI intensity has stagnated at a very low level which constrains the development of R&D capabilities. Business R&D represents well over 70% of total R&D expenditure with foreign companies the largest sources, while universities' R&D funding is the lowest in the EU, around 0.05 % of GDP.

Bulgaria's R&I system is fragmented due to extensive thematic coverage, gaps in institutional coordination and the funding system, which stimulates whole institutions to compete against each other for institutional budgets, instead of collaborating on thematic priorities. The RIS3 approach and the establishment of the Council for Smart Growth (CSG) offer a new opportunity for the Bulgarian authorities to revitalize research and innovation policies as well as to reorganize the fragmented landscape of R&I and related sectoral policies.

Only a small number of Bulgaria's more than 50 HEIs have significant research activity. Bulgaria has introduced performance-based funding of universities which is expected to improve the quality and labour market relevance of higher education. In 2016, nearly 30% of public funding for higher education was allocated on the basis of the quality and labour market relevance. This proportion is expected to reach 60 % by 2020. (The Country Semester Report 2017).

Inefficiencies in the funding allocation system and weak evaluation practices hamper the competitiveness of Bulgarian research. The low R&D investment is not distributed to the research organizations according to clear, transparent rules (interview): The limited competitive funding from the National Science Foundation covers only direct costs. During the last two years there have been no calls for science funding and even before this the calls were for small sums only (EUR 20 000-60 000 per year). For several years, research projects submitted to the NSF have been evaluated mainly by Bulgarian reviewers, while limited efforts to expand the pool of international reviewers. For the last few years, only Bulgarian language has been used in the submission of the proposals, contributing the lack of qualified reviewers in some fields and potential conflicts of interest and lack objectivity. Bulgaria should make efforts to align with international peer review standards to guarantee an adequate evaluation of R&I projects and performance-based institutional funding in order to improve the efficiency and impact of public R&I funding (PSF review of Bulgaria 2015; The Country Semester Report 2017).

Bulgaria suffers from a short supply of human resources due to ageing population, massive outmigration and low attractiveness of research careers. The share of population (aged 30-34) with tertiary education is below the EU average (32.1% in 2015) and the supply of science and engineering graduates is low. Bulgaria has fewer researchers (about 15 990 FTE) in all main research categories compared to the EU average: nearly half of professors are over 65 years of age, and migration of younger researchers to other EU countries or to jobs outside R&D is common (PSF review). Bulgaria generated 1.4 young doctorates for 1 000 population, compared to the EU-28 average of 1.8 (EIS 2017). PhD candidates have very low salaries (EUR 250 compared to EUR 2 000-4 000 in the Netherlands, Germany and Switzerland) which makes doctoral studies abroad more attractive, contributing to brain drain and making talent attraction difficult (interview). PhD training is mostly traditional and lacks modern elements, including the use of English language and training in transferable skills. The share of foreign doctorate graduates is also low at the European comparison (4.1% vs 25%) and the best performing Widening countries Slovenia and Hungary (8.2% and 8.5%, respectively).

Bulgaria's public research system is not yet well connected to global knowledge and innovation networks. Low public funding and inefficiencies in funding allocation hamper the development of the public science base: EIS 2017 data shows that Bulgaria had the second lowest number of international scientific co-publications per million population (180) after Romania compared to the EU average of 463. In 2014, only 4.04% of these publications were within the top 10% most cited scientific publications worldwide, the lowest score in the EU area⁵⁹.

Science-business collaboration, knowledge transfer and science-based entrepreneurship are at early stages of development with a separation of the publically funded "research and development pillar" and the private sector "innovation pillar". Business investment in the higher education R&D sector is very low. Public-performed R&D funded by business, as % of GDP (2014) 0.015% vs 0.052% (compared to 0.12% for the top performer)⁶⁰. Bulgaria generates 2.3 public-private co-publications per million inhabitants, the lowest number after Romania, and significantly below the EU average of 10.3 (EIS 2017). At the same time there is a high share of employment in high-growth enterprises: In 2014, the share of employment in high-growth enterprises was 17.95% vs. 13% for the EU average (Idem.). Still Bulgaria underperforms in the field of entrepreneurship, as highlighted by the Global Entrepreneurship Monitor Report for Bulgaria (GEM, 2016). To address the gaps in the business ecosystem, the government has adopted the 'Entrepreneurship Bulgaria 2020' plan (2015) and introduced an entrepreneurship module in all levels of education (2016). (The Country Semester Report 2017). There are many early stage innovation initiatives, but these tend to lack links with public universities and public research institutes.

5 Poland

5.1 Poland's Horizon 2020 performance

Poland, one of the most populous countries in Europe (38.5 million or 7.6% of EU-28, 6th in rank) has a relatively weak track record in the EU Framework Programme for research and innovation. The Horizon 2020 interim evaluation (2016) shows that Poland is one of the lowest performing EU-13 countries in terms of Horizon 2020 funding contributions normalised per inhabitant, full time researchers and RDI investments. Poland receives 5 euros per inhabitant compared to the average of 9 for the EU-13 countries (and 37 for EU-average), the third lowest sum after Bulgaria and Romania. For each full-time equivalent researcher, Poland receives the lowest amount among all Widening countries: EUR 1 908, half the EU-13 average (EUR 3 812). For each million euro invested in R&I, Poland receives EUR 42 743, the lowest sum after Czech Republic, significantly below the EU-13 average of EUR 67 524, and the EU-15 average of EUR 63 277.

By October 2017, there were 1 030 Horizon 2020 participants based in Poland who had received 241.65 million euros from the framework programme, including 9 ERC principal investigators (EUR 10.44 million), 136 Marie Skłodowska-Curie Fellows (EUR 35.93 million) and 189 SMEs (EUR 54.12 million). Among all EU countries, Poland was No 15 in terms of number of signed contracts and the budget share (EU-28). Two institutions – a research institute in bio-organic chemistry of the Polish Academy in Science in Poznan and the University of Warsaw – were the best performing institutions in H2020 scene

⁵⁹ http://ec.europa.eu/research/horizon2020/pdf/country-performance/bg_research_and_innovation_performance.pdf#zoom=125&pagemode=none

⁶⁰ http://ec.europa.eu/research/horizon2020/pdf/country-performance/bg_research_and_innovation_performance.pdf#zoom=125&pagemode=none

each receiving over 13 million euros. Poland's 9 362 Horizon 2020 applicants (2.16% of EU-28) had a lower than average success rate at 12.1% (13.5% for EU-28).⁶¹

5.2 Policies to facilitate participation in Horizon 2020 in Poland

To facilitate the Horizon 2020 participation Poland offers range of support mechanisms. These mechanisms include:

- Directing European Structural and Investment Funds to the development of RDI infrastructure, human capital and entrepreneurship;
- Developing a new systematic approach for participation in Horizon 2020 based on a mapping study (interview);
- Developing an NCP system concentrated in the Institute of Fundamental Technological Research of Polish Academy of Sciences;
- Designing funding incentives such as a national bonus funding for projects funded by the Horizon 2020 in the form of grants for coordinators and work package leaders, funding for top scientists, irrespective of their nationality, to create a centre of excellence in Poland, linked with the Widening Teaming projects ("International Research Agendas, PLUS Module")⁶², grants for winners of the ERC Starting Grants competitions in the EU's 7th Research Framework Programme to implement the grant in Poland ("Ideas for Poland"⁶³) and a seal of excellence for SME instrument (in future also Marie Skłodowska-Curie actions);
- Synergies with the Cohesion Funds are pursued also at the regional level where Masovia, Poland's biggest region, will provide extra points for Horizon 2020 evaluated projects (Interview);
- A significant part of R&D funding is allocated by means of competitive project-based funds through the National Science Centre (NCN), the National Centre for Research and Development (NCBiR) and the Foundation for Polish Science based on quality competition, use of English and international peer review⁶⁴;
- There is also support structure for the entrepreneurship sector (PARP).

Poland's modest performance in Horizon 2020 and progress in RDI can be explained by a combination of lack of long term investments in the science base and universities, lack of progress in modernising the higher education and science system, weak tradition of mobility, a presence of adverse incentives and limited absorptive capacity in the economy.

While research and innovation are increasingly seen as engines of long-term growth, Poland's R&D intensity is growing from a very low base mainly by increasing the demand pull from industry. After 1989 Poland introduced widespread reforms, but made limited progress in transforming the higher education and science systems which suffer from fragmentation, lack of international cooperation and mobility

⁶¹ http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=poland

⁶² <https://www.fnp.org.pl/en/oferta/miedzynarodowe-agendy-badawcze-plus-mab-plus/>

⁶³ <https://www.fnp.org.pl/en/oferta/ideas-for-poland/>

⁶⁴ For example two H2020 Cofund initiatives: QUANTERA (quantum technologies) with 32 organizations from 26 countries led by NCN (the first ERA-NET coordinated by a new MS), and POLONEZ for researchers visiting Poland (up to 24 months) who under the Marie Skłodowska-Curie Actions rules benefit from generous salaries by Polish standards (Last application round in 2016). <https://ncn.gov.pl/polonez?language=en>

and an outdated career system. There is limited funding for international researchers to apply for (interview)⁶⁵ and no formal obligation of international mobility for postdoc researchers. The research evaluation system supports the growth of research productivity but provides inadequate incentives for quality, international publication and cooperation, or knowledge transfer. The salaries for PhD candidates (and HEI staff) are low⁶⁶ and the system of doctoral training inefficient. While the national RDI system is increasingly based on quality competition⁶⁷, it also creates incentives for researchers to compete for national rather than EU funds. Most HEIs and PROs lack adequate in-house support for FP funding applications. Given that the gap has not been filled, e.g. by the NCP, some resort to non-Polish expertise for preparing funding applications (interview). There is also limited access to networks and inadequate capacity to anticipate emerging opportunities e.g. among the Polish support units in Brussels (interview).

5.3 Poland's research and innovation performance

Poland's R&I performance has improved marginally over the last decade, but the quality of science and innovation outputs are below the EU average.

According to the European Innovation Scoreboard (2017), Poland is a moderate innovator (56 relative to EU in 2016): over time, its performance has increased by 2% relative to that of the EU in 2010, but relative weaknesses remain linked to innovators, linkages and entrepreneurship and attractive research systems. The 2017 results show that Poland's ranking has declined, given the more rapid progress by other countries, and it is now among the bottom four lowest performers. Since 2010, the number of new PhD graduates fell by 13.2% and foreign doctorate students by 2%. The numbers of innovators and the science-industry have also declined. Compared to other EU countries, Poland also has a smaller share of employment in high and medium high-tech manufacturing and services, a lower number of top R&D spending enterprises and a lower average R&D spending of these enterprises, lower GDP per capita but a higher GDP growth rate, and a lower growth rate of population.

Research and innovation are increasingly seen as engines of long-term growth, but R&D spending and R&D intensity are low. R&D investment in Poland relies on public financing, with important support provided by the ESIF. Gross domestic expenditure on R&D amounted to EUR 4.31 billion in 2015 and increased by 54.5 % respectively compared to 2011. R&D intensity rose from 0.6% of GDP in 2007 to 1% of GDP in 2015, half the EU average of 2% and one of the lowest in Europe. The government is committed to reaching the EU2020 national R&D intensity target of 1.7% by 2020. The increase has been achieved by targeting R&D funding mainly to enterprise.

The public science system is an important R&D performer but its potential is constrained due to fragmentation, low funding and outdated practices. Poland features hundreds of universities and public research organisations – research institutes and the institutes of the Polish Academy of Science – often small narrowly focused institutions. Only two universities institutions are listed in the Shanghai- (ARWU-) ranking of the world's 500 leading institutions (category 401 to 500). Investment in public science is low for both institutions and personnel. The inflexible salary structure Polish universities is a barrier to attracting and retaining talent and for participation in Horizon 2020. For instance in the Warsaw University, the regulations allow to pay ERC

⁶⁵ The Foundation for Polish Sciences provides grants for postdocs ("Homing"), for top researchers to establish research centres in Poland ("International Research Agendas"), and scholarships for German scholars conduct scientific research in Poland.

⁶⁶ The salary levels in Polish academia are lower than in EU-15: average salary for a professor is 2000 euros and 1000 euros for a postdoc. Research institutes have more flexibility in salaries, based on the performance.

⁶⁷ The NCN structure and grant evaluation system are based on the ERC experience, using English and international evaluations. The system is transparent and competitive (success rate: 10% - 30%).

postdocs about 1 000 euro per month, compared to over 2 000 euro for the standard NCN postdocs and more than 4 000 euro for the NCN's POLONEZ, under Marie Curie-Skłodowska Actions regulations. A PI from Poland with an ERC grant can be paid much less than by the national NCN grant (which is easier to get).

Poland's ambitions to develop a knowledge society are constrained by human resource challenges due to ageing, low employment rates, skills mismatches and the failure to supply the advanced human capital. While the share of tertiary education graduates is well above EU average (In 2016, 44% of the population aged 30-34 have successfully graduated from tertiary education), compared to the EU average of 39%), there are skills mismatches at both ends of the skills spectrum. Poland is also among the four weakest EU countries when it comes to generating young doctoral graduates due to inefficiencies in doctoral training: there are 0.6 PhD graduates per 1000 population aged 25-34, one-third of the EU average (1.8) (EC 2017b). There were 82 594 FTE researchers in 2016.

A key challenge for the RDI system and Horizon 2020 participation is internationalisation. While international student mobility is growing, at 1.7% Poland has the lowest share of non-EU doctoral candidates in the EU (25% for EU-28). Only 5% of Poland's publications are among the top-10% most cited publications worldwide (2014), less than half of the EU average (10.6%). In 2016, Poland had 277 international scientific co-publications per million population (2016), compared 494 for EU average⁶⁸. At the same time the Polish science is slowly gaining international competitive edge: the "Nature Index Rising Stars" 2016⁶⁹ identified Poland as number six among the 'big hitters' with China, India, UK, Australia and Russia, and among the top three most improved countries between 2012 and 2015.

Despite improved the framework conditions for doing business, the RDI activity in firms and science-industry collaboration are modest. Poland has improved its position in the World Bank Ranking 'Ease of doing business' (2016) with easy access for enterprises to R&D tax incentives, small loans and public financial support to finance technological innovations and science-to-business cooperation. Business expenditure in R&D (BERD) has increased, but is still one of the lowest in the EU and the number of private-sector R&D performers lag behind the EU average. In 2014, only 2 814 from over 200 000 companies reported R&D activities. According to the European Innovation Scoreboard (EC 2017), at 14%, Poland had one of the lowest rate in the EU for SMEs that innovate in-house (introducing product or process innovations), compared to 36% for the EU average and 52% for the highest performer⁷⁰. Many companies only embark on formal R&D projects if public co-funding and grants are available, while the number of firms applying for H2020 funding or other international support is small (RIO 2017)⁷¹. Many SMEs are risk averse and have a low absorptive capacity for R&D (Interview). Only 10% of innovative companies cooperate with universities and HEIs, and Poland lags behind its regional peers for public-private co-publications. Less than 4% of innovative SMEs cooperate with other firms and/or research organisations in their innovation activities.

The Polish government is in the process of launching a comprehensive reform of the higher education and science system, but a significant part of the system is left outside of the reform. The reform is focused on the reorganisation of the higher

⁶⁸ http://ec.europa.eu/research/horizon2020/pdf/country-performance/pl_research_and_innovation_performance.pdf#zoom=125&pagemode=none

⁶⁹ Nature, Vol. 535, Issue No. 7613 (July 28, 2016); <https://www.nature.com/articles/535S50a.pdf>

⁷⁰ http://ec.europa.eu/research/horizon2020/pdf/country-performance/pl_research_and_innovation_performance.pdf#zoom=125&pagemode=none

⁷¹ Klineciewicz & Marczevska 2017

education sector and (some of) the research institutes. Measures announced include the introduction of new formulae for financing HEIs and PROs and a new evaluation system for RDI activities. The plans do not cover the Polish Academy of Science institutes, which employs about 8 000 staff, and research institutes, outside of the purview of the Ministry of science and higher education.

6 Serbia

6.1 Serbia's performance in Horizon 2020

Serbia is a Widening associated country with a population of 7.1 million. The European Council granted Serbia the status of candidate country in 2012. The Stabilisation and Association Agreement (SAA) between Serbia and the EU entered into force in September 2013 and the accession negotiations were launched in January 2014, creating an impetus for reform and opportunities to attract investment. Serbia has set a self-declared objective of entering the EU in 2020⁷² Serbia is active in the European Research Area Committee and in the EUREKA, COST and NATO Science and Peace for Security programmes.

Since the start of participation in Horizon 2020, 1 309 applicants from Serbia have taken part in 1 006 projects and 91 of them have been selected for financing. Participation in the Widening actions is helping to change the R&I ecosystem support. Serbia's key success in the Horizon 2020 is the Teaming Phase 2 Centre of Excellence (Antares) which can help modernise the agriculture sector help address the urban-rural divide in Serbia.

6.2 Serbia's Policies to facilitate participation in Horizon 2020

To facilitate the participation in Horizon 2020, Serbia has introduced the following policies:

- The Serbian Innovation Fund provides matched funding for co-financing the EU-funded projects. For the Teaming Centre of Excellence co-funding is available from two sources: the IPA component for research (Pre-accession instrument for associated countries) and the European Investment Bank loan (taken in 2010 but not fully used).
- The main priorities of the European Research Area roadmap were incorporated in the new strategy for scientific and technological development in March 2016.
- The law on scientific research has been amended, enabling a more targeted approach to public funding of research institutions (Idem).
- The Law on Research and Innovation is currently under development and will facilitate the long term sustainability of HEIs.
- The development of the national smart specialisation is currently under development and the topic of the Teaming 2 will be part of it.
- Serbia has developed NCP network within the Ministry of Education, Science and Technological Development. NCP is a well-organised but there is no full time staff, given the staffing constraints of the ministry.

⁷² Brussels, 9.11.2016 SWD(2016) 361 final COMMISSION STAFF WORKING DOCUMENT Serbia 2016 Report Accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions 2016 Communication on EU Enlargement Policy {COM(2016) 715 final}

- So far there are no funding for Horizon 2020 projects which have been evaluated above the threshold but which have not received funding.
- Another simple way to improve the alignment of national and EU RDI systems could be introducing the H2020 application templates to the national projects, covering excellence, impact and quality, in order to change the mindsets of Serbian researchers.
- At the local level, the BioSense Institute offers the Regional Government of Vojvodina public courses in Horizon 2020 targeting the government and NGO people in order to prepare the ground for the time when Serbia will access the funding from the Structural Funds. The 4-month course takes place during the weekends and is delivered by the Teaming coordinator.
- For Serbian research institutes a facilitating factor for the participation can be the decentralised university structure which ensures that each university constituent, faculty and research centre can independently set their salary levels and human resources policies. (The same system does not work in Croatia where the staff are civil servants.)

Serbia's low performance in Horizon 2020 is explained by the lack of system learning effects, the low investments in the science base and universities, lack of synergies between the national and the EU RDI systems and the European funding programmes, and insufficient institutional support and unfavourable and heavy regulation. There is a lack of a long-term support for RDI investments and sub-optimal coordination of national and European R&I funding. The level of investment in research is low at less than 1% of GDP. The cooperation between the public and private sector is weak and so far the government has not development systematic mechanisms to support it. The funding allocation system (currently under development) and the project evaluation system are not aligned with the international best practice. The public perception of the role of RDI is low like in many other low performing European countries.

For the Teaming 2 Centre of Excellence, the key factor for participation has been the coordinator's cumulative experience from the European programmes since FP5 in 1998-2002, including COST and REGPOT: "COST actions were a useful entry mechanism, they helped identify partners and learn the mentality". While it was difficult to access existing networks, "the RegPot projects provided a quantum leap for the institute" which used the funding to develop long term sustainability. Several practical barriers were overcome in the Horizon 2020 participation ranging from the first mover disadvantages, lack of institutional support and Serbian regulation which does not support staff exchange so a mechanism had to be invented to allow sending research staff for 3, 6, and 12 month Marie Curie international exchange of researchers. The securing of the national co-funding for Teaming 2 took one year, the entire T1 phase.

6.3 Research and innovation performance in Serbia

The European Innovation Scoreboard (2017) shows that Serbia is a Moderate Innovator (64% of the EU average). Over time, its performance has increased by 17.3% relative to that of the EU in 2010. Relative weaknesses are in Intellectual assets, Innovation-friendly environment, and Linkages, whereas its strengths are Firm investments, Employment impacts, and Innovators, while weaknesses are linked to Intellectual assets, Innovation-friendly environment, and Linkages. Notable differences of the Serbian system include a smaller share of employment in Services, lower buyer sophistication, lower GDP per capita, a lower growth rate of GDP, a lower and negative growth rate of population, and lower population density.

The level of investment in research is low at less than 1% of GDP. The law on research and innovation, currently under development, will revise the funding allocation system to enhance sustainability of the public R&I system. The new law will introduce basic formula-based funding for research (sustainability component) and very competitive project funding.

Serbia faces significant challenges in human capital and skills development. Serbia's population is ageing and shrinking by around 0.5% per year. While public spending on education is comparable to that of EU countries, the outcomes in terms of skills and key competences are weaker. The below-average PISA test scores show that around one-third of the population is functionally illiterate. The national strategy and action plan for education development aims to address the outdated curricula and teaching methods. An integrated national qualification framework for lifelong learning has been developed, but youth unemployment and higher education graduate unemployment (over 40%) is a cause of concern. Serbia generated 1.1 young doctorates for 1 000 population, the same level as Estonia, but below the EU-28 average of 1.8 (EIS 2017). The PhD training is mainly traditional and characterised by disciplinary silos (interview). The share of foreign doctorate graduates is low in European comparison (5.2% vs. 25%) but above Croatia (3.4%) and several other Widening countries (EIS 2017). Many young people are leaving Serbia in search of employment opportunities (World Bank 2015⁷³). There were 15 015 FTE researchers in 2016, steadily growing since 2008. The government is making efforts to address the brain drain by hiring young researchers. There is also an effort to reform the education at all levels.

Participation in Horizon 2020 participants is hampered by the skills development gaps and the lack of relevance of education. For example the T2 Centre of Excellence is faced with the skills challenges given the small number of highly trainer people (projects managers and researchers). There are also challenges in involving HE research faculty in university teaching, since the research faculty is normally not involved in teaching but based in research institutes (within or outside universities) (Interview)

The Serbian R&I system has a low level of international cooperation. Serbia's public research system is not yet well connected to global knowledge and innovation networks. EIS 2017 data shows that Serbia had a low number of 311 international scientific co-publications per million population compared to the EU average of 463. The productivity in publishing has been growing because of a points system which values quantity over quality (Interview). Consequently, only 4.5% of Serbia's scientific publications are within the top 10% most cited scientific publications worldwide, compared to 10.5% at the EU average (EIS 2017). The national point system has a focus on the number of publications and impact factor which then translates into points. The law defines a minimum number required for a university professor (3-5). Universities can increase the points, by focusing on the impact factor (which will enhance quality) or by

⁷³ World Bank Group (2015) Republic of Serbia. Country Partnership Framework 2016-2020. Report No 100464-YF, <http://pubdocs.worldbank.org/en/111121446462343202/Serbia-CPF-eng-web.pdf>

requiring researchers to increase the number of points (which will drive quantity). Establishing research groups, industry contacts or bringing external funding is not taken into consideration.

Science-industry collaboration remains at a low level, and so far the government has not developed systematic mechanisms to support it. The Serbian industry was decimated in the 1990s, which did not allow development of collaboration. The national researchers continue to focus on fundamental research rather than demand-driven research (interview). The share of the R&D funded by business and performed by public research organisations is low. The public-private scientific co-publication per million population was only 7.3, below the EU average of 36.9 and significantly below the best performing country Denmark with 165.3 publications (EIS 2017). The reasons for the weak performance range include the dominance of curiosity-driven basic research in the academia, as well as the current points system for research productivity which does not take into consideration industry contacts or success in acquiring external funding. The government is supporting the projects of the Teaming Phase 2 Centre of Excellence (Antares) such as the digital farming projects which develops an open access platform and showroom for IT solutions in agriculture.

The strategy to support the development of SMEs, entrepreneurship and competitiveness for 2015-2020 is being implemented and there is a focus on innovation and digitalisation. The Serbian Development Agency has been set up. Serbia joined the EU's competitiveness and SME programme (COSME) in January 2016. A new law on investment, aimed at improving the institutional framework for investment promotion and support, was adopted in October 2015. It sets criteria for State support to investors. The year 2016 was dedicated for entrepreneurship. The Serbia Innovation Fund has shown the possibilities to generate start-up businesses that can compete internationally (World Bank 2015). A shift towards an export-driven economic model can help Serbia grow faster and create jobs in high-productivity export sectors with a multiplier effect for jobs in non-tradable sectors (World Bank 2015). In addition to the scientific tech part in Belgrade, investments are being made to build scientific tech part also in Novy Svat. The Digital Serbia Initiative⁷⁴ is a private partnership which aims at developing functional Triple Helix collaboration between government, industry and education system. New high-tech firms⁷⁵ led by young Serbs are leading the 4th industrial revolution and contribute to the Digital Serbia Initiative which is also informing the education reform and the development of regulation for the use and reuse of open data. With the government support T2 Antares is developing an accelerator for IT firms to help them create their own products (interview).

7 Italy

7.1 Italy's performance in Horizon 2020

Italy, the fourth populous country in the European Union (nearly 60 million or 11.8% of EU-28 total population), has a declining track record in the EU Framework Programmes impacted by the recession and funding cuts. The Horizon 2020 interim evaluation (2016) shows that Italy had slipped from its fourth place in FP7 to the fifth place, behind Germany, United Kingdom, France and also Spain, in

⁷⁴ <https://www.prnewswire.com/news-releases/launch-of-digital-serbia-initiative-serbia-to-become-regional-digital-innovation-hub-625108784.html>

⁷⁵ Examples include the gaming firm Nordeus (<https://nordeus.com/>) and Seven Bridges which is a biomedical data analysis company accelerating genomics research for cancer, drug development and precision medicine (<https://www.sevenbridges.com/>). See also <https://www.techflier.com/2017/01/09/top-9-reasons-why-belgrade-might-be-the-next-silicon-valley/>.

terms of total funding received (1 664 million). Italy's funding share from the Horizon 2020 normalised per R&D investments and personnel is generally higher than for the EU-28 or EU-15. For each million euro invested in R&D, Italy receives EUR 75 991 from Horizon 2020, above the EU average of EUR 63 429 and the top three Horizon 2020 performers, but behind Spain (EUR 137 627). For each researcher (FTE), Italy receives EUR 13 786, above the EU-average of EUR 10 426 as well as the top three performers but behind Spain (EUR 14 806). When Horizon 2020 funding is normalised per inhabitant, Italy receives only 27 euros for each inhabitant, compared to the EU average of 37 euros, behind 17 countries including France (31 euros) and Spain (39 euros).

By the end of October 2017, Italy had 6 033 Horizon 2020 participants who had received 2 177.16 million euros from the programme, including 222 ERC principal investigators (EUR 249.29 million), 813 Marie Skłodowska-Curie Fellows (EUR 205.64 million) and 1 500 SME participants (EUR 428.53 million); Italy was No 4 in terms of the signed contracts and number 5 in terms of the budget share among EU-28⁷⁶. The three best performing institutions were the National Research Council CNR with 304 participants (EUR 131.28 million), Politecnico di Milano: 170 participants (EUR 81.35 million), and ENEA (National agency for new technology, energy and sustainable economic development): 75 participants (EUR 57.38 million).

Relying on the availability of FP funding as a substitute for the reduced national resources for R&D would require significant improvements in performance and support in the application process: Italy had a large number of applicants (54 220 or 12.48% of EU-28) but their success rate was lower than the EU average: 11.9% compared to 13.5%.

7.2 Italy's policies to facilitate participation in Horizon 2020

Italy has in the past few years taken steps to introduce new mechanisms to facilitate the Horizon 2020 participation and RDI in general. These include:

- Aligning the National Research Programme 2015-2020 (PNR)⁷⁷ and its six intervention programmes⁷⁸ with the Cohesion policies and the Horizon 2020. PNR prioritises fields for applied and translational research and allocates over 40% of the total resources of EUR 2.4 billion to Human Capital, with the aim of increasing the number of researchers and PhDs and attracting top talents⁷⁹.
- Aligning the National Smart Specialisation Strategy⁸⁰ with the Horizon 2020 and NRP to promote the complementarity.
- Improving coordination and collaboration between the Ministry, the National Contact Points, Italian representatives of the Horizon 2020 programme committees, ERA Task Force and the Permanent EU Representation.

⁷⁶ Horizon 2020 country profile updated 24 October 2017:
http://ec.europa.eu/research/horizon2020/index_en.cfm?pg=country-profiles-detail&ctry=italy

⁷⁷ <http://hubmiur.pubblica.istruzione.it/web/ricerca/pnr>

⁷⁸ 1) Internationalization 2) human capital, 3) research infrastructures; 4) public-private collaboration; 5) support for R&I in South of Italy; 6) Efficiency and quality of spending.

⁷⁹ The impact of the PNR has been hampered by: i) the delay in the approval process which left Italy without a national research strategy for nearly 2 years; ii) a lack of coverage of the whole public R&D system (i.e. PROs outside the purview of MIUR); iii) Limited availability of PNR resource for the years 2015-2017 only; and iv) a lack of clarity of the share of fresh resources and reallocation (see RIO 2017).

⁸⁰ Aerospace and Defence; Health, food, quality of life; Smart and sustainable industry, energy and environment; Tourism, cultural heritage and creative industry; Digital Agenda, Smart Communities, infrastructure and international transport systems

- Planning incentives to target ERC such as: funding for ERC winners to create a research team in Italy, support for young researchers in the ERC calls, support for participants in the ERC calls who have been evaluated but not yet funded, and 3-year positions for top researchers who have won ERC Starting or Advanced Grants.
- Providing matched funding to underpin Italy's participation in the Joint Programming Initiatives and Knowledge and Innovation Communities KICs.
- Increasing the share of universities' performance-based funding from 20% in 2016 to 24% in 2018.
- Introducing 'Industria 4.0'⁸¹ and the Startup Act: a coherent set of tax incentives to firms in a range of R&I activities, a reform of the incentive system for firms for different phases of the R&I cycle, from investments (R&D tax credits) to IPR revenues (Patent box) and favourable conditions for innovative enterprise to enhance the development of an ecosystem of innovative start-ups.

Italy's performance in Horizon 2020 and RDI shows mixed results: Italy invests in R&D much less than its key partners, but its public science system has high productivity. R&D investments, in particular by the private sector, remain low due to structural factors. There is a combination of a lack of investments in the science base, aggravated by the recession and cuts in the higher education system, persistent regional inequalities and low absorptive capacity in the SME-based economy, as well as challenges in the coordination and management of RDI system.

7.3 Research and innovation performance in Italy

Italy's research and innovation performance is below the EU average. According to the European Innovation Scorecard 2017, Italy was a Moderate Innovator (75% of the EU average), ranked in the 19th place above Greece, but below Spain and Portugal. There has been limited change (-0.2%) in performance over time compared to other countries. Relative strengths of the Italian innovation system include intellectual assets, attractive research systems, and innovators, while relative weaknesses focus on linkages, finance and support, and firm investments. Notable differences include a larger share of micro enterprises in turnover, a smaller share of large enterprises in turnover, a smaller share of foreign controlled enterprises, a lower number of Top R&D spending enterprises, a smaller share of enterprise births, a lower and negative growth rate of GDP.

RIO 2017 shows that recent reductions of resources for R&I activities in Italy have widened the gap with the EU. Italy's R&D intensity (i.e. total R&D expenditure as a proportion of GDP) lags behind the EU average and the national 2020 target of 1.53%. In 2015, Italy's R&D intensity was 1.33%, compared to the EU average of 2.03%. The R&D investment particularly by the private sector was much lower than the EU average (0.74% of GDP in Italy vs. 1.3% for the EU average), whereas the gap was smaller for public R&D expenditure (0.56% of GDP in Italy 0.71% for the EU average). During the period 2007-2015, the Italian government's budget to R&D activities fell from EUR 9.9 billion to EUR 8.3 billion. In 2014, R&D funded from abroad accounted for 0.13% of GDP, of which 0.04% came from EC sources⁸².

The lack of high-skilled people is hampering Italy's innovation performance and the shortages of scientific and technical skills are holding back R&D and innovation activities. Italy's tertiary education attainment level is low and highly-skilled people are lacking in particular in science, engineering and ICT. In 2016, Italy's tertiary educational attainment rate was the lowest in the EU, at 26.2% for 30-34 year-

⁸¹ <http://www.sviluppoeconomico.gov.it/index.php/it/industria40>

⁸² Data from the RIO report 2017

olds, compared to EU average of 39.1%⁸³. In 2014, there were 12 new graduates in science and engineering per thousand population aged 25-34, compared to the EU average of 18 (half of the best performing country at 23).

Italy has a limited presence of researchers, but the productivity of Italy's public science base is above the EU average. Italy has over 258 000 FTE research personnel including 126 674 FTE researchers, which is less than for the Top 3 countries in Horizon 2020 but more than that of Spain which holds the fourth position. In 2011, there were 4 R&D employees per thousand inhabitants (3.7 in 2010) compared to a European average of 5.3 (data from PNR report).⁸⁴ Almost 60% of researchers were in the public sector and 37% in the private sector. During the period 2008-2014 the research staff in universities decreased by 20% involving 10 000 people (RIO 2017). An estimated 50 000 researchers have left Italy (RIO 2017). At the same time Italy's performances in terms of scientific productivity – as measured by publications per million R&D expenditure, articles per researcher, and citations per R&D units or researcher – are better than those of Germany and France (RIO 2017).

Italy has low international attractiveness among students, researchers and private R&D investments. In the global scene, Italy attracts only 2% of the foreign students who decide to study abroad⁸⁵. In 2015, 13.2% of new young doctorates were foreigners compared to the 25.6% for the EU-28 (EIS 2017). In 2013, about 24% of Italian business R&D expenditure comes from foreign multinationals, and the figure has declined in the last five years (-3.8% from 2007 to 2012).

Public funding for universities is insufficient but becoming better linked to performance. The resources devoted to the university system declined by 14% between 2008 and 2014 (RIO 2017). In 2014, the government expenditure on higher education was only 0.3% of GDP, due to large funding cuts during the economic crisis, which coincided with reduction in university staff and partial freeze on recruitment. In 2016, the recruitment freeze was relaxed. The general university funding amounted to EUR 6 900 million in 2016 – at the level of 2015, but 100 million less than in 2014 and 600 million less than in 2008. The share of performance-based funding will increase from 20% of 2016 to 24% of 2018, based on the results of the Research Quality Evaluation. The 2016 Stability Law provided funding for hiring new full and associate professors (Giulio Natta chairs)⁸⁶ and for 861 young researchers on tenure-track positions (1.6 % of teaching staff in 2015). The 2017 Budget Law increased public financial support for tertiary students. In 2017 and 2018 also excellence funding was introduced to reward the best researchers and university departments.

The low university-business cooperation hampers knowledge transfer and innovation but Italian SMEs are among the most innovative in Europe. In 2015, public-private scientific co-publications per million inhabitants in Italy numbered only 15.2 (down from 18), compared to the EU average of 28.7. In 2014, the volume of research performed by the public research and innovation system funded by businesses amounted to just 0.013% of GDP against the EU average of 0.052%⁸⁷. At the same

⁸³ According to the National Research Programme, in 2014, there were 12.5 new graduates in science and engineering and 0.5 new graduates in computing per thousand inhabitants aged 25-34 as against the EU average of 17.6 and 2.3, respectively.

⁸⁴ http://ec.europa.eu/research/horizon2020/pdf/country-performance/it_research_and_innovation_performance.pdf#zoom=125&pagemode=none

⁸⁵ OECD, Education at a Glance 2014

⁸⁶ The programme planned to introduce 500 positions for highly qualified full professors with allocations of EUR38m in 2016 and EUR75m in 2017, using a new recruitment channel, but the plan has been highly controversial and its implementation is uncertain

⁸⁷ http://ec.europa.eu/research/horizon2020/pdf/country-performance/it_research_and_innovation_performance.pdf#zoom=125&pagemode=none

time, the percentage of SMEs that have introduced product and product innovations is above the EU average (EIS 2017). At the end of 2016, the number of registered innovative start-ups amounted to 6 745, an increase of 6% (382 units) from the end of September 2016. These innovative start-ups represent 0.42% of the estimated 1.5 million limited companies active in Italy (up from 0.38% in June 2016).

Italy's significant regional disparities have deepened during the recession.

Between 2007 and 2014, real GDP in Southern regions fell by 1.9% on average per year, whereas the decline in the centre-north was 1.1%. GDP-per-capita divergences are substantial due to lower labour market participation and the higher unemployment rate in the south. R&D expenditure on regional GDP is 1.4% in the North and 0.9% in the South; also the patent activity and share of employees in high tech industries is much lower in the south⁸⁸. Two thirds of innovating firms and three quarters of total expenditure are concentrated in five regions only (Lombardy with 25% of innovators, Veneto, Emilia Romagna, Piedmont and Lazio) whereas less than 13% of Italian firms innovating in products and processes are located in Southern and island regions (RIO 2017). Universities in southern regions have been hard hit by funding cuts and show weaker performance and greater reductions in student enrolment, staff and funding.

⁸⁸ Patents at the European Patent Office per million inhabitants are 106.8 in the North and 10.1 in the South, the share of employees in high tech industries is 3.7% in the North and 2% in the South (RIO 2017).



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This report analyses the country participation patterns in Horizon 2020 as well as the underlying causes for the low participation of a number of EU Member States and Associated Countries. It highlights the key trends in bridging the research and innovation gap and in the research and innovation performance of the EU Member States and their regions, underlining the uneven convergence progress. With focus on Widening actions and seven case study countries it reviews the validity of the causes for low participation identified in the 2011 analysis by the Commission and highlights other causes which have gained importance in the recent years. It underlines the need for national reforms of research and innovation systems, for streamlining the Framework Programme procedures and efforts for more synergies between the Framework Programme and European Structural and Investment Funds.

Research and Innovation policy



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