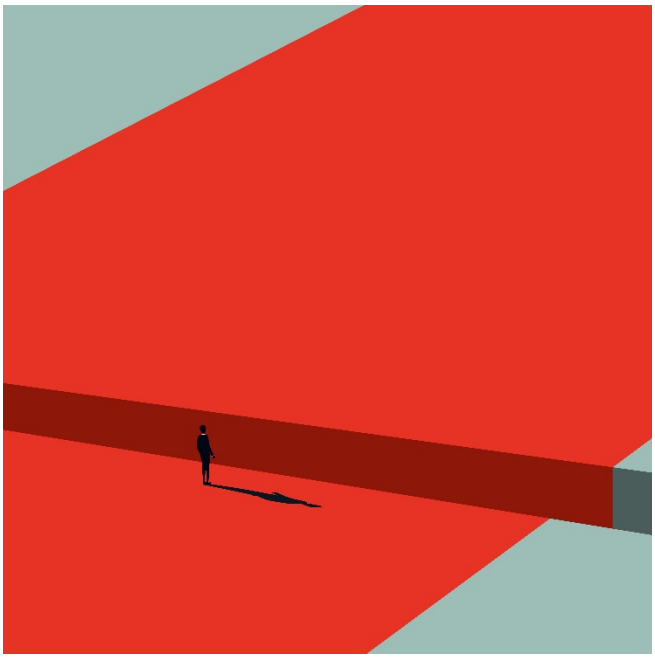
European Parliament

Exploring the performance gap in EU Framework Programmes between EU13 and EU15 Member States



IN-DEPTH ANALYSIS

Panel for the Future of Science and Technology

EPRS | European Parliamentary Research Service

Scientific Foresight Unit (STOA)
PE 641.542 – June 2020

EN

Exploring the performance gap in EU Framework Programmes between EU13 and EU15 Member States

The research and innovation framework programmes of the European Union (EU) are the largest programmes in the world for international research collaboration. Repeated reports point to the issue of under-performance in the framework programmes by the EU13 Member States – the countries that joined the EU in and after 2004 – in comparison with the EU15 Member States – which had entered the EU before 2004. This paper explores the background of various challenges in research and development faced by the EU13 in comparison to the EU15, in order to investigate the gap between the two groups.

A set of hypotheses, divided into five domains, are tested empirically. This includes research and innovation system structure; scientific level of research institutions and quality of proposals; quantity of submitted proposals; level of international collaboration and other factors related to the framework programmes.

The weak positions of most EU13 Member States on several of the indicators analysed show that the field of research in EU13 Member States requires further structural changes. This report concludes with various policy options that would help to mitigate the innovation gap in Europe.

This document presents an update of the STOA study 'Overcoming innovation gaps in the EU-13 Member States'. The study was requested by the Panel for the Future of Science and Technology (STOA) and managed by the Scientific Foresight Unit (STOA) within the Directorate-General for Parliamentary Research Services (DG EPRS) of the European Parliament. Members of the project team were: Michal Pazour, Vladimir Albrecht, Daniel Frank, Vlastimil Ruzicka, Jiri Vanecek, Ondrej Pecha, Zdenek Kucera, Technology Centre CAS, Prague; Edwin Horlings, Barend van der Meulen, Rathenau Institute, The Hague; Leonhard Hennen (ETAG co-ordinator), KIT/ITAS, Karlsruhe. In addition, hypothesis 6 discussed in the present report is obtained from the STOA study 'Internationalisation of EU research organisations: A bibliometric stocktaking study', written by Marek Kwiek, Director of the Center for Public Policy Studies, UNESCO Chair in Institutional Research and Higher Education Policy at the University of Poznan, Poland.

AUTHORS

Gianluca Quaglio with Sophie Millar, Scientific Foresight Unit (STOA)
Michal Pazour, Vladimir Albrecht, Tomas Vondrak, Technology Centre CAS, Prague, Czechia
Marek Kwiek, Center for Public Policy Studies, University of Poznan, Poland
Klaus Schuch, Centre for Social Innovation, Vienna, Austria

To contact the publisher, please e-mail stoa@ep.europa.eu

Acknowledgements

We are indebted to Vincenzo Guardabasso, University of Catania, Italy and Richelle Nathalie Boone, Scientific Foresight Unit (STOA), European Parliament, for their suggestions in the preparation of the manuscript.

We are grateful to Giulio Sabbati, EPRS, for table 2 included in this study.

LINGUISTIC VERSION

Original: EN

Manuscript completed in June 2020.

DISCLAIMER AND COPYRIGHT

PE 641.542
ISBN 978-92-846-6461-0
doi: 10.2861/654637
QA-04-20-141-EN-N

http://www.europarl.europa.eu/stoa (STOA website)
http://www.eprs.ep.parl.union.eu (intranet)
http://www.europarl.europa.eu/thinktank (internet)
http://epthinktank.eu (blog)

Executive summary

Introduction

The research and innovation framework programmes (FPs) are multiannual financial tools through which the European Union (EU) supports scientific disciplines in research, technological development and innovation. They offer a competitive advantage through international collaboration opportunities, innovation and knowledge sharing. The success rate of Member States (MSs) in applying for grants and participating in the FPs varies.

Reports have identified that the MSs which joined the EU in or after 2004 (referred to as the EU13) have underperformed in comparison to those states which joined before 2004 (referred to as the EU15). This trend does not appear to have diminished over time. For example, in the Horizon2020 FP, EU13 countries have significantly fewer project coordinators in signed contracts compared to EU15 countries (5.1 % vs. 87.6 %).

This paper presents an update of the original STOA study 'Overcoming innovation gaps in the EU13 Member States', introducing updated bibliographic appraisals throughout. Some hypotheses developed in the original study have been omitted; on the other hand, a new hypothesis (hypothesis 6) has been included.

Tables and figures have been redesigned to facilitate reading, whilst the majority have been restructured with the most up-to-date available data. Finally, the updated policy options reflect the conclusions of the nine hypotheses formulated in this report, which are also inspired by the conclusions of other recent studies published on the same issue. Finally, eleven policy options are summarised under two dimensions: governance and capacity-building.

Methods

This paper presents an exploration of the challenges faced in research and development (R&D) in the EU13 and consequently their lower participation and success rates in the FPs compared to the EU15. A number of hypotheses have been developed under five domains, with each being empirically tested:

1. R&I systems
   Hypothesis 1 - Relative weakness of the research and innovation (R&I) systems of the EU13 compared to the EU15.

2. Scientific level of the EU13 R&D institutions and quality of proposals from the EU13
   Hypothesis 2 - Relative lack of scientific excellence in institutions from the EU13 compared to the EU15.
   Hypothesis 3 - The quality of proposals involving EU13 participants is lower than those that do not involve them.

3. Quantity of proposals from EU13 participants and alternative funding
   Hypothesis 4 - EU13 organisations submit fewer proposals than EU15 organisations.
   Hypothesis 5 - Participants in the EU13 have greater means of accessing alternative funding.

4. Collaboration and networks
   Hypothesis 6 - The level of internationalisation in the EU13 is weaker than that of the EU15.
   Hypothesis 7 - Participants from the EU13 have weaker connections to the collaboration network in FPs than those from the EU15.

5. The framework programme
   Hypothesis 8 - The problem of FP participation is related to the specific funding schemes of the FPs.
   Hypothesis 9 - The EU13 have an insufficient influence on the work programmes of the FPs.

Data were extracted from numerous sources, such as the European innovation scoreboard, the E-Corda database, the Eurostat database and other European Commission databases. Following analysis, a number of policy options were drawn-up to provide direction on the potential ways in which the disproportionate participation and success rates in FPs between EU13 and EU15 MSs could be mitigated.

Results

The most prominent reasons for the low performance of EU13 MSs in FPs can be summarised as follows: the relative weakness of the R&I systems of the EU13 compared to the EU15, with low levels of research expenditure and other structural causes (hypothesis 1); a relative lack of scientific excellence (hypothesis 2); a lack of quality in submitting proposals (hypothesis 3); a lower propensity to send proposals (hypothesis 4); and a lack of strong international research contacts and professional networks (hypothesis 6 and hypothesis 7). The problem of FP participation is also tied to specific FP instruments (hypothesis 8). However, the study does not find that the EU13 have greater opportunities to obtain alternative funding (hypothesis 5) nor that the EU13 have an insufficient influence in both the setting out of the work programmes and the evaluation processes of the FP proposals (hypothesis 9).

The explored factors are not independent of each other and do not carry equal importance with respect to the barriers to the participation of EU13 countries in FPs. The results of the hypotheses analysed should be viewed with caution. Although many of the indicators used are accepted as adequate analytical tools, they are only able to partially give an accurate picture of reality.

Moreover, what these hypotheses have in common is that they are not applicable to all EU13 MSs, having been confirmed for some EU13 MSs but rejected for others. In addition, parts of the EU15 perform at EU13 levels. This means that the problems represented by these hypotheses are not specific to the entire EU13 nor absent from the EU15. However, on the whole they give a telling picture of the different conditions in the two areas analysed, the EU13 and the EU15.

EU13 MSs' levels of FP participation remain low. Additionally, the level of GERD (gross domestic expenditure on R&D) in almost all EU13 MSs has remained low, which indicates in general a weak political commitment to science and technology. The weak positions of most EU13 MSs on several of the indicators analysed show that the field of research in EU13 MSs requires further structural changes and sustainable reforms.

Policy options

Eleven policy options are presented under two dimensions: i) governance and ii) capacity-building.

Governance
Policy option 1. Establishing a strategic plan for long-term objectives.
Policy option 2. Improving the link between the national research system and the EU R&I priorities.
Policy option 3. Improving coordination between different stakeholders.
Policy option 4. Strengthening collaboration between business and academia.
Policy option 5. Encouraging collaboration with top European research organisations.
Policy option 6. Putting international research collaboration at the forefront of national research policies.

Capacity-building
Policy option 7. Increasing research financing.
Policy option 8. Improving administrative procedures.
Policy option 9. Strengthening the work of national contact points.
Policy option 10. Developing synergies between different funding schemes.
Policy option 11. Creating and exploiting existing pockets of excellence.

Table of contents

List of figures

List of tables

1. Introduction

The European Union's framework programmes (FPs) for research, innovation and technological development intend to give researchers powerful tools that enable them to enhance European competitiveness, growth and knowledge generation (Reillon, 2017). They are the world's largest programmes for international research collaboration. Participation in the FPs is based on competitive grant applications. This implies that a distribution of funds based on the principle of 'juste retour' cannot be applied.

Repeated reports point to the issue of underperformance by the EU Member States (MSs) that joined the EU in 2004 (Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia), 2007 (Bulgaria, Romania) and 2013 (Croatia) – referred to as the EU13 (Fresco, 2015; MIRRIS, 2016; Harap, 2017; Ukrainski, 2018a; Özbolat, 2018) – when it comes to participating in the FPs. Those MSs that entered the EU well ahead of 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Luxemburg, the Netherlands, Portugal, Spain, Sweden, the UK) are referred to as the EU15.

The EU13 began to participate in FP5 (1998–2002), so they already have more than twenty years of experience with FPs. It would be desirable to see the discrepancies in performance between the EU15 and the EU13 diminish as time passes, but there is no evidence to suggest that this is happening (Fresco, 2015; Makkonen, 2016). The interim evaluation of Horizon 2020 (H2020) (European Commission, 2017a) suggests that the differences in the participation patterns between the EU13 and the EU15 still remain. It shows that the share of funding allocated to the EU13 remains relatively low, reaching 4.4 % (4.2 % in FP7). The participation rate was 8.5 % (7.9 % in FP7), and the success rate was 11.1 % (18 % in FP7), compared to 14.4 % for the EU15. EU13 countries have a much smaller share of project coordinators in signed contracts: 5.1 % vs. 87.6 %. The decreasing success rate, however, is a common feature of H2020 in general and affected almost all countries. The average success rate in H2020 was 15.3 % at the end of 2018.

The issue of underperformance by the EU13 MSs in terms of their participation in the FPs has been debated at academic and political level, through several reports and analyses since their association to FP5 (Andreff, 2000; Schuch, 2005; Rauch, 2012; Schuch, 2014; Fresco, 2015; MIRRIS, 2016; Ukrainski, 2017; Ukrainski, 2018a; Kaló, 2019). It should be stressed that the EU13 – as well as the EU15 – are not a homogeneous group of countries and the research and development (R&D) dichotomy between these two clusters oversimplifies reality. The EU13 countries have marked differences between each other in geography, economic development, general research and innovation (R&I) efforts, research expenditure, areas of scientific excellence, degrees of internationalisation and number of researchers, as well as in the types of institutions responsible for developing science policy (Rauch, 2012; Pazour, 2018).

The EU13 not only differ in these parameters characterising the competitiveness of their national R&D systems, but also show varied behaviour in their participation in FPs (Scherngell, 2013; Macilwain, 2015; Özbolat, 2018; Pazour, 2018; Ukrainski, 2018a). This in-depth analysis explores a number of factors that may underlie the lower participation rate of the EU13 in FPs compared to the EU15. It represents an update of the STOA study entitled 'Overcoming innovation gaps in the EU-13 Member States' (Pazour, 2018), introducing updated bibliographic appraisals throughout. Some more speculative hypotheses developed in the original study have been omitted, whilst a new hypothesis (hypothesis 6) has been included. Tables and figures have been redesigned to facilitate reading: many of which have been updated to include current data. Finally, updated policy options reflect the conclusions of the nine hypotheses formulated in this report, which are also inspired by the conclusions of other recent studies published on the same issue.

2. European framework programmes and technology upgrading in EU13

The relatively low participation rate of most but not all EU13 MSs compared to the majority of EU15 MSs in the European FPs is sometimes subconsciously perceived to indicate a relative lag of the R&I systems of these countries. European and international indexes, such as the European innovation scoreboard or the global innovation index, as well as a categorisation of the EU13 in just one or two 'blocs' fortify this impression (Havas, 2015).

The questions 'what can the FPs contribute to overcome this perceived lag' and 'can a higher FP participation of EU13 countries solve the perceived problems' are less frequently asked. Such questions, however, are important, because they do not identify the issue of participation in FPs as an isolated phenomenon, but place it in the wider context of adequate policy within both national and local innovation systems.

Some scholars argue that current policies in the EU13 countries are too narrowly focused on R&D-based growth and do not adequately address the key drivers of technology and productivity growth (Kravtsova, 2012; EBRD, 2014; Leitner, 2014; Radosevic, 2017). Instead of fostering the traditional idea of research-driven growth, which is also essential for the FPs, more focus should be placed on alternative approaches to improve positions in the global value chains and to enter into new markets. These include knowledge not generated solely by R&D activities (Havas, 2015), but also the development of production capabilities and activities related to management practices, quality enhancement and technology transfer by increasingly coupling imported knowledge with domestic knowledge generation (Radosevic, 2017).

In other words, shifting from an R&D-based growth focus to the more systemic approach of the science, technology and innovation (STI) policy – which embraces a broader approach to innovation and learning – seems to be more beneficial for the EU13. Such an approach aims to tackle systemic failures hampering the generation, diffusion and utilisation of any type of knowledge required for successful innovation (Freeman, 1994; Lundvall, 1999; Foray, 2009; Edquist, 2011). The approach cannot offer a linear 'one-size-fits-all' solution, but it enables the identifcation of those failures that are blocking innovation processes in a particular part of a given innovation system (Havas, 2015).

A systemic understanding would assume that countries at different innovation levels require different policy combinations that reflect each country's specific challenges. However, Izsak et al. (2015) have shown that the policy combinations in the EU28 are overall quite comparable. This fosters the suspicion of policy failure, despite the availability of substantial EU structural funds. Havas et al. (2015) argue that STI policy documents and the opinions of policymakers from the region largely follow the science-push model of innovation. Existing policies excessively focused on R&D as a major driving force for growth, neglecting other sources of technology upgrading and productivity growth (Izsak, 2015; Radosevic, 2017).

Investment in cutting-edge R&D excellence, which is supposed to trickle-down into production knowledge and innovation, was always a core concern of the European FPs. This approach was especially true when the EU13 (except Croatia) became associated to FP5 and later FP6 (Schuch, 2005). Both FPs tended to reproduce a narrow focus on scientific research and technological development by overlooking the importance of other types of innovative efforts. Although the FPs increasingly included different policy approaches and instruments, R&D-based knowledge generation remains its dominant focus. The trickle-down of R&D, however, requires adequate absorption and learning capabilities, which are complex, path dependent and cumulative, posing high entry barriers for newcomers (Cohen, 1990; Malerba, 2009; Peneder, 2010).

Although a broader understanding of innovation became increasingly important in H2020 and will be further articulated in Horizon Europe, it can be argued that the FPs are generally advocating an

excellence-based R&D driven policy-mix with a strong collaborative element, where the overall aim is to secure the EU's overall global competitiveness. Whilst this objective is a logical and necessary policy rationale at EU level, it is probably more appropriate for more technologically and economically advanced actors and countries in Western and Northern Europe.

3. Hypotheses explored

In order to explore possible explanations for the low participation and success rate of EU13 countries in FPs, we chose a number of hypotheses and used data analysis to test them. The hypotheses – divided into five domains – are presented in Table 1.

Table 1. Hypotheses analysed in the study

R&I systems
1) Relative weakness of the R&I systems of the EU13 compared to the EU15
Scientific level of EU13 R&D institutions and quality of proposals from EU13
2) Relative lack of scientific excellence in institutions from the EU13 compared to the EU15
3) The quality of proposals involving EU13 participants is lower than those that do not involve them
Quantity of proposals from EU13 participants and alternative funding
4) EU13 organisations submit fewer proposals than EU15 organisations
5) Participants in the EU13 have greater means of accessing alternative funding
Collaboration and networks
6) The level of internationalisation in the EU13 is weaker than the EU15
7) Participants from the EU13 have weaker connections to the collaboration network in FPs than the EU15
The Framework Programme
8) The problem of FP participation is related to the specific funding schemes of the FPs
9) The EU13 has an insufficient influence on the work programmes of the FPs

3.1. Research & innovation systems

H1. Relative weakness of the R&I systems of the EU13 compared to the EU15

Low rates of participation in the European FPs and the shortfall in scientific quality compared to the EU15 may be symptoms of more fundamental structural problems. It is possible that the development of the knowledge economy in the EU13 lags behind that of the EU15 and that this lag weakens the R&I systems of the EU13 MSs.

Methods

For this hypothesis, R&D capacity of the two MS categories was compared based on the percentage of people with tertiary education, the level of R&D expenditure – public, private and total – as a percentage of GDP and the number of researchers as a percentage of the population aged 15-64. Innovation performance was compared using the European innovation scoreboard, which tracks innovation using indicators on eight dimensions of innovation performance. Information was retrieved from the Eurostat database and the European Commission (2019a).

Results

The R&D expenditure as a percentage of GDP is higher in the EU15 (2.2 %) than in the EU13 (1.1 %). Hungary (1.35 %), Czechia (1.79 %) and Slovenia (1.86 %) approach the average level of the EU28. Levels of R&D spending in Ireland (1.05 %), Greece (1.13 %), Spain (1.2 %) and Portugal (1.33 %) are comparable to those in most EU13 MSs. The difference in the percentage of research personnel is also significant: 0.8 % in the EU13 versus 1.4 % in the EU15. A similar difference is reported for the level of tertiary education: 33.4 % in the EU13 versus 40.1 % in the EU15 (Table 2).

Table 2. General R&D indicators of EU13 and EU15

Population[1]				
Indicator	**Unit of measurement**	**EU13**	**EU15**	**EU28**
Population	Million	104.0	408.4	512.4
Over 65 years old	Million	18.9	82.2	101.1
Over 65 years old	Share of total population	18.2 %	20.1 %	19.7 %
Tertiary education (ISCED 5-8)	Million	16.0	77.2	93.2
Tertiary education (ISCED 5-8)	Share of total population	33.4 %	40.1 %	38.8 %
Population (aged 15-64)	Million	69.2	262.3	331.5
Active population (aged 15-64)	Million	47.8	193.4	240.5
Active population	Share of population aged 15-64	69.1 %	73.7 %	72.5 %
GDP[1]				
Indicator	**Unit of measurement**	**EU13**	**EU15**	**EU28**
GDP	Billion euros	1 415.2	14 469.6	15 884.0
GDP per capita	Euros	13 612.5	35 428.6	31 000.5
GDP per capita	% of EU28 average	43.9 %	114.3 %	100.0 %
R&D expenditure[2]				
Indicator	**Unit of measurement**	**EU13**	**EU15**	**EU28**
GDP	Billion euros	1 322.9	14 067.5	15 389.3
R&D expenditure – all sectors	Billion euros	14.2	302.9	317.1
Business enterprise sector	Billion euros	8.9	200.3	209.2
Government sector	Billion euros	1.9	33.7	35.6
Higher education sector	Billion euros	3.4	66.6	70.0
Private non-profit sector	Billion euros	0.1	2.3	2.4
R&D expenditure – all sectors	Percentage of GDP	1.1 %	2.2 %	2.1 %
Business enterprise sector	Percentage of GDP	0.7 %	1.4 %	1.4 %
Government sector	Percentage of GDP	0.1 %	0.2 %	0.2 %
Higher education sector	Percentage of GDP	0.3 %	0.5 %	0.5 %
Private non-profit sector	Percentage of GDP	0.004 %	0.016 %	0.015 %
R&D personnel[2]				
Indicator	**Unit of measurement**	**EU13**	**EU15**	**EU28**
Active population (15-64)	Million	48.0	192.6	239.9
R&D personnel – all sectors	1 000 persons	381.6	2 686.4	3 068.0
Business enterprise sector	1 000 persons	187.0	1 549.6	1 737.2
Government sector	1 000 persons	60.1	300.3	360.5
Higher education sector	1 000 persons	132.2	811.4	943.9
Private non-profit sector	1 000 persons	2.2	24.1	26.3
R&D personnel – all sectors	Share of population aged 15-64	0.8 %	1.4 %	1.3 %
Business enterprise sector	Share of population aged 15-64	0.4 %	0.8 %	0.7 %
Government sector	Share of population aged 15-64	0.1 %	0.2 %	0.2 %
Higher education sector	Share of population aged 15-64	0.3 %	0.4 %	0.4 %
Private non-profit sector	Share of population aged 15-64	0.005 %	0.012 %	0.011 %

Note: 1: year 2018; 2: year 2017.

The European innovation scoreboard (European Commission, 2019a) tracks innovation in the EU28 using eight dimensions of innovation performance, namely: human resources; attractive research systems; finance and support; firm investments; linkages & entrepreneurship; intellectual assets; innovators; and economic effects. The report divides the MSs into four groups (Table 3). Among the EU13, only Estonia is classified as a strong innovator. Ten EU13 MSs are classified as moderate innovators, while Romania and Bulgaria are labelled modest innovators. No EU13 countries are identified as innovation leaders.

Table 3. EU Member States' innovation performance 2019

Group	Description	EU MSs
Innovation leaders	Innovation performance well above the EU average	Sweden, Denmark, Finland, the Netherlands
Strong innovators	Innovation performance above or close to the EU average	Germany, Belgium, Ireland, Austria, France, UK, Luxembourg, Estonia
Moderate innovators	Innovation performance below the EU average	Czechia, Portugal, Malta, Spain, Cyprus, Italy, Lithuania, Hungary, Greece, Slovakia, Latvia, Poland, Croatia, Slovenia
Modest innovators	Innovation performance well below the EU average	Bulgaria, Romania

A comparison between EU13 and EU15 performance on European innovation scoreboard dimensions and composite scores was made for the period 2010–2017 (Table 4). The innovation performance of the EU13 – illustrated by the summary innovation index – was approximately 40 % lower than the performance of the EU15 over the entire period. The EU13 lags behind the EU15 particularly in the dimensions 'attractive research systems', 'finance and support', and 'innovators', where the score for the EU13 in 2017 was less than half that of the EU15 score. On the other hand, the EU13 scored relatively better in the innovation indicators related to 'firm investment', to the impact of the R&I activities on employment ('employment impacts') and sales ('sales impacts'). In those dimensions, the EU13 achieved more than 70 % of the EU15 score.

What stands out in Table 4 are the different dynamics in various European innovation scoreboard dimensions for the EU13 compared to the EU15. Significant progress in the convergence of EU13 scores to the EU15 level can be observed in the dimension 'attractive research systems', particularly in the openness and attractiveness of research systems for foreign doctorate students. Substantial improvement in the EU13 has also been achieved in the dimension 'intellectual assets', due to the increase of trademark and design applications. On the other hand, the EU13 has fallen further behind the EU15 in the dimensions 'innovators' and 'linkages'. With respect to the 'innovators' dimension, a relatively sharp decline can be seen in all partial indicators relating to innovation activities in small and medium-sized enterprises. In the dimension 'linkages', the EU13 performs much worse than their EU15 counterparts with respect to the sub-indicator that measures the collaboration of innovative small and medium-sized enterprises with others, as well as in the sub-indicator relating to the public-private co-publications.

Table 4. EU13 and EU15 performance on EIS* dimensions and composite scores, 2010–2017

Indicators	EU13 performance (EU15 performance = 100)	
	2010	2017
Human resources	54	59
New doctorate graduates	47	52
Population completed tertiary education	74	81
Lifelong learning	41	41
Attractive research systems	33	45
International scientific co-publications	37	45
Scientific publications among top 10 % most cited	40	48
Foreign doctorate students	21	42
Innovation-friendly environment	63	69
Broadband penetration	73	72
Opportunity-driven entrepreneurship	50	57
Finance and support	50	45
R&D expenditure in the public sector	50	41
Venture capital investments	49	51
Firm investments	84	71
R&D expenditure in the business sector	31	41
Non-R&D innovation expenditure	206	153
Enterprises providing ICT training	69	58
Innovators	56	39
SMEs with product or process innovations	54	38
SMEs with marketing or organisational innovations	59	37
SMEs innovating in-house	55	43
Linkages	66	56
Innovative SMEs collaborating with others	63	49
Public-private co-publications	55	43
Private co-funding of public R&D expenditures	84	87
Intellectual assets	44	65
PCT patent applications	23	23
Trademark applications	78	94
Design applications	36	78
Employment impacts	76	86
Employment in knowledge-intensive activities	51	65
Employment in fast-growing firms' innovative sectors	107	115
Sales impacts	86	74
Medium & high-tech product exports	98	104
Knowledge-intensive services exports	52	50
Sales of new-to-market and new-to-firm innovations	112	68
Summary innovation index	*61*	*59*

*Note: EU13 and EU15 aggregate scores are the unweighted averages of MSs' scores; *= European innovation scoreboard*

3.2. Scientific level of EU13 R&D institutions and quality of proposals from EU13

H2. Relative lack of scientific excellence in institutions from the EU13 compared to the EU15

Scientific excellence is the core principle of the EU FPs. Lower quality research teams have principally lower chances to succeed in FP projects. If the quality of research in EU13 lags behind the EU15, this would be a systematic barrier preventing the successful participation of the EU13 in FPs.

Methods

Hypothesis 2 carried out an analysis of the average citation impact of scientific output per MS. Two indicators were used to approximate the quality of prospective participants: i) average citation impact of scientific output per MS, and ii) the position of national universities using two different university rankings. Citation impact is one of the most pervasive indicators of quality in science. Web of Sciences data extracted from the InCites dataset (Web of Sciences, 2019) has been used to calculate a weighted average of the fields normalised citation score (FNCS) for the total scientific output of the individual EU13 and EU15 countries. This FNCS gives an indication of the quality of science systems relative to the world, where FNCS for the world equals one. We focused on the years 2014-2016. The two university rankings used were the CWTS Leiden ranking and the Times Higher Education world university ranking. The first ranking is based entirely on scientific output, the second is a more hybrid ranking, including various dimensions of university performance and other characteristics.

Results

Figure 1 presents the FNCS for each of the EU28 countries (y-axis) and the number of publications per 1 000 inhabitants (x-axis). The size of the bubbles refers to the total number of publications in absolute terms. The EU13 MSs generally produced fewer scientific publications per 1 000 inhabitants than the EU15 (2.3 and 4.9 respectively) and have an average FNCS that is almost 30 % lower. Some EU13 MSs achieve an average FNCS as high as or near to the level of the EU15. These countries are Cyprus, Estonia, Malta, Slovenia, and Hungary.

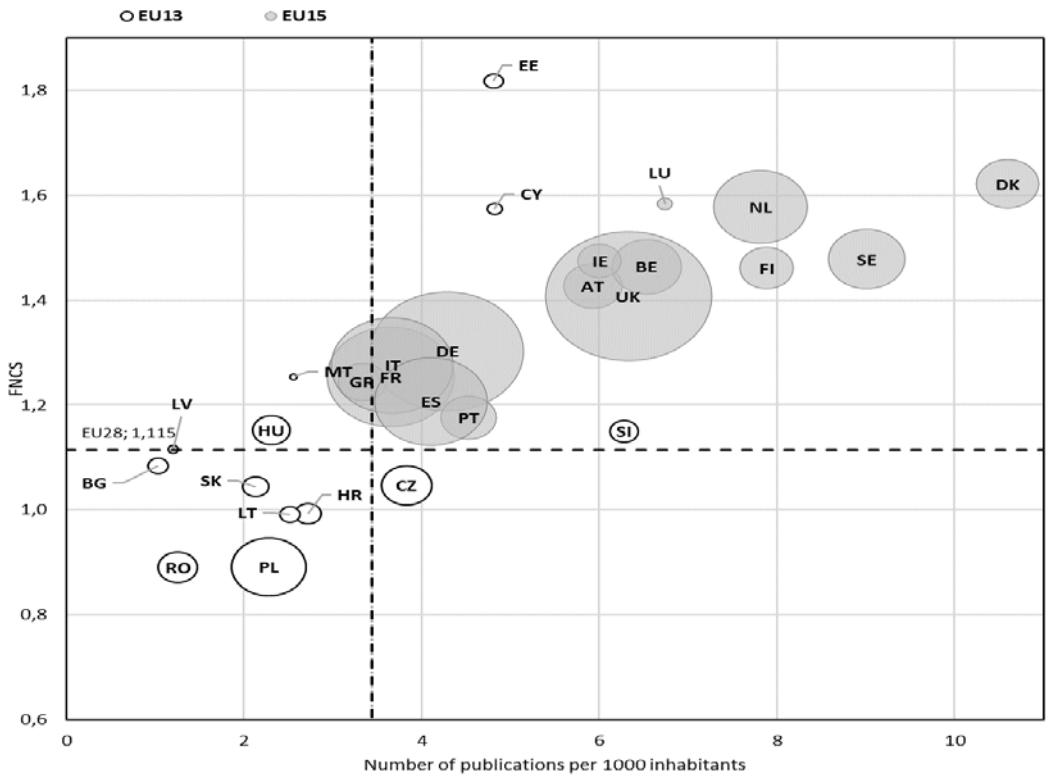


Figure 1. Field-normalised citation scores and number of publications in EU28 MSs, 2014-2016

As mentioned, the positions of national universities of the EU MSs were analysed using the CWTS Leiden ranking and the Times Higher Education world university ranking. It should be noted that rankings are not always transparent about their measuring methods and data, and that different rankings produce different results for the same universities. However, to get a general idea, both rankings did not include universities from the EU13 MSs amongst the top 200 universities. On the contrary, there are 90 universities from EU MSs included in the top 200 in the CWTS Leiden ranking and 85 in the Times Higher Education world university ranking (Table 5).

Table 5. Number of EU universities in the top 200 in Times Higher Education world university ranking and CWTS Leiden ranking

Ranking	top-10	11-50	51-100	101-200	200-1000
Times Higher Education World University Ranking (2017)					
EU13	-		-	-	47
EU15	3	9	24	54	211
CWTS Leiden Ranking (2016-2017)					
EU13	-	-	-	-	28
EU15	1	9	26	49	175

H3. The quality of proposals involving EU13 participants is lower than those that do not involve them

EU13 organisations may be just as active in the FP as EU15 organisations, however they generally participate in proposals of lower quality, resulting in lower success rates.

Methods

The quality of submitted proposals involving EU13 participants and submitted proposals involving EU15 organisations in FP7 was evaluated using two indicators: i) the ineligibility rate, and ii) the participation success rate. The ineligibility rate is the ratio between the number of participations in submitted proposals and the number that did not enter into the evaluation process due to serious formal errors. This indicates the administrative quality of proposals. The participation success rate, measured by the ratio of participations in successful proposals to the number of participations in total submitted eligible proposals, indicates the scientific quality of proposals. Information was collected from the E-Corda database (European Commission 2015a).

Results

Table 6 shows the ineligibility rate and the participation success rate in submitted proposals involving EU13 and EU15 organisations in FP7. Submitted proposals involving EU13 organisations score lower than those involving EU15 organisations in both dimensions.

Table 6. Success rate and eligibility in submitted proposals by EU13 and EU15 organisations in FP7

	Submitted proposals	Ineligible (%)	Eligible	Rejected	Reserve	Success rate
EU15	478 449	9 240 (1.9 %)	469 209	70 %	8 %	21.8 %
EU13	59 827	1 981 (3.3 %)	57 846	75 %	7 %	17.8 %

The percentage of submitted proposals that were found to be ineligible was higher for proposals involving EU13 organisations (3.3 %) than for proposals involving EU15 organisations (1.9 %). Furthermore, the success rate of eligible proposals in FP7 was 21.8 % for EU15 MSs and 17.8 % for EU13 MSa. The differences between the EU13 and EU15 in rejection rates and success rates might seem small, but they are systematic throughout the whole FP7 funding period. Statistically, the EU13 have a significantly higher ineligibility rate than the EU15 (the t-statistic for testing this difference amounts to 3.77, which is significant at 1 %). Similarly, the EU13 have a statistically smaller participation success rate than the EU15 ($t = 3.51$, $p < 5$ %). It should again be noted that there are differences amongst the individual countries within the two MS categories. Whilst the EU13 countries Czechia, Estonia, Hungary and Latvia are all countries with a success rate close to the EU15, the success rates of EU15 countries Spain, Italy, Luxemburg and Portugal trend more towards the EU13 average (data not shown).

In addition, there is a difference in success rates between proposals in which EU13 organisations act as a participant and ones where they act as a coordinator. Table 7 compares the success rates of eligible

proposals involving EU13 and EU15 organisations as participants and as coordinators. The success rate of eligible proposals involving EU13 as coordinators was 11.7 % versus 18.3 % for EU15 organisations ($p < 0.0001$). As a participant, the success rate was 18.9 % in the EU13 versus 23 % for the EU15 ($p < 0.0001$).

Table 7. Success rate of eligible proposals of EU13 and EU15 organisations as coordinators and participants in FP7

Role	Eligible participations	Success rate of eligible proposals	EU15 =100	Financial success rate	EU15 =100
EU13					
Coordinator	8 765	11.7 %	64	6.1 %	45
Participant	49 081	18.9 %	82	15.6 %	68
Total	57 846	17.8 %	81	11.4 %	62
EU15					
Coordinator	117 750	18.3 %	100	13.7 %	100
Participant	351 459	23.0 %	100	23.1 %	100
Total	469 209	21.8 %	100	18.5 %	100

3.3. Quantity of proposals from EU13 participants and alternative funding

H4. EU13 organisations submit fewer proposals than EU15 organisations

Low participation of EU13 MSs may have its origins in the low number of submitted proposals. In order to test this hypothesis, the number of participations in submitted proposals, both ineligible and eligible, in the FP7 were examined.

Methods

The number of participations in submitted proposals was analysed in relation to: i) the size of the country, measured by the population in millions; ii) the size of the research system, measured by the number of researchers; and iii) the average number of submitted proposals per active organisation. Information on the FP7 data on submissions was extracted from the E-Corda database (European Commission 2015a).

Results

The total participation of the EU15 MSs in submitted proposals to the FP7 was eight times higher than that of the EU13 (Table 8). However, taking into account the size of the countries, the gap in the total participation between the two MS categories decreases significantly, whereby the EU15 exceeds the EU13 two-fold. Considering the size of the research population, there were 334 participations in proposal submissions for every thousand full-time equivalent (FTE) researchers in the EU15 versus 299 in the EU13. The EU15 organisations in FP7 participated in 22 proposals on average, compared to 18 for the EU13 organisations.

Table 8. Participations in submitted proposal in FP7 for EU13 and EU15 MSs

	Number of participations in submitted proposals per			
EU area	Participations in submitted proposals	Population in millions	Thousand FTE researchers	Number of active research organisations
EU15	478 449	1 184	334	22
EU13	59 827	546	299	18

H5. Participants in the EU13 have greater means of accessing alternative funding

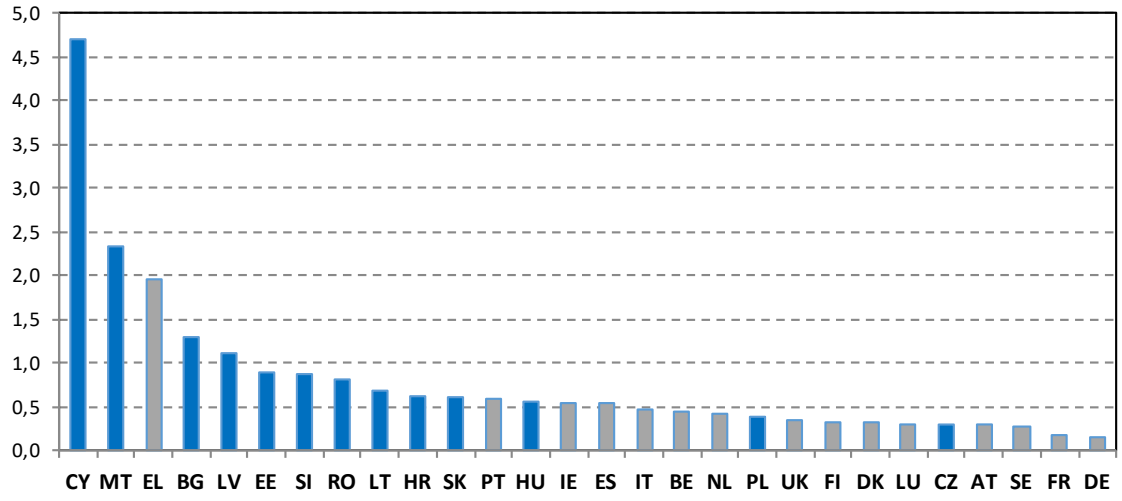
Many EU13 countries have made use of European structural and investment funds (ESIF) to support their research systems. It has been argued that the comparatively 'easily' accessible, nationally administered (but EC co-financed) ESIF might distract the attention of research institutes in the EU13 MSs away from the more competitive FPs (MIRRIS 2014; Schuch 2014; Özbolat, 2018; Ukrainski, 2018; Ukrainski, 2018b).

Methods

In order to check this hypothesis, two indicators were analysed: i) the 'willingness to submit', measured by the number of participations in submitted proposals normalised for the size of the research systems in financial terms (gross domestic expenditure on R&D [GERD]); and ii) the relative size of the budget of ESIF. In hypothesis 4 we looked at the number of participations in proposals in relation to the size of the population and number of researchers. In hypothesis 5, we explored the number of participations in proposals in relation to GERD. Whereas hypothesis 4 investigated whether researchers from EU13 submit fewer proposals, hypothesis 5 looked specifically at the activity in submitting proposals in the context of R&D expenditures and alternative sources of funding. Data for the measurement of 'willingness to submit' was taken from the E-Corda database (European Commission, 2015a). ESIF expenditures per MS were extracted from the report published by the UK Royal Society (2015) that uses data from the European Commission (2015b; 2015c). Data on GERD was extracted from the Eurostat database (Eurostat, 2019).

Results

The 'willingness to submit' is reported in Figure 2. The smallest EU13 countries – Cyprus and Malta – have the highest number of participations in project proposals submitted in FP7 per million euro of GERD. The other EU13 MSs – Bulgaria, Latvia, Estonia, Slovenia, Romania, Lithuania, Croatia, Slovakia and Hungary – form a more or less homogeneous group, with more than 0.5 participations in submitted proposals per million euro of GERD. Only Czechia and Poland have fewer than 0.5 participations in submitted proposals per million euro of GERD. On the other hand, most of the EU15 MSs – with the exception of Greece and Portugal – participated in fewer submitted proposals per million euro of GERD than the majority of the EU13 MSs. Overall, the submission activity related to the financial size of the research systems in the EU13 is more than three times higher than in the EU15.



Note: In blue EU13 MSs.

Figure 2. Number of participations in submitted proposals in FP7, normalised per million euro of GERD (PPS – Purchasing Power Standard)

Researchers in EU13 MSs are less active in submitting proposals (results of the hypothesis 4). The expenditures on R&D are much lower than EU15 MSs, thus the number of participations in submitted

proposals involving the EU13 per million euro of GERD (hypothesis 5) shows that the lower the GERD, the higher the participation in project proposals. The more the R&D system is underfinanced, the more research teams try to find different sources of funding other than their home finance. However, this may apply only to a limited number of research teams (who may be more connected and entrepreneurial). Thus, a low GERD situation will not automatically lead to a high mobilisation in FPs, but rather to a level of saturation that differs between countries.

Figure 3 shows the amount of funding received from FP7 and the ESIF in 2007-2013 in proportion to GERD in the EU28 countries. In total, the EU15 received €26.5 billion from ESIF for R&D in the period 2007-2013, which corresponds to 1.7 % of the EU15 GERD. In the same period, the EU13 received €23.7 billion from the ESIF for R&D, which amounts to 15.3 % of their GERD. The figure confirms that the ESIF played a more significant role in funding R&D for EU13 MSs than for EU15 MSs.

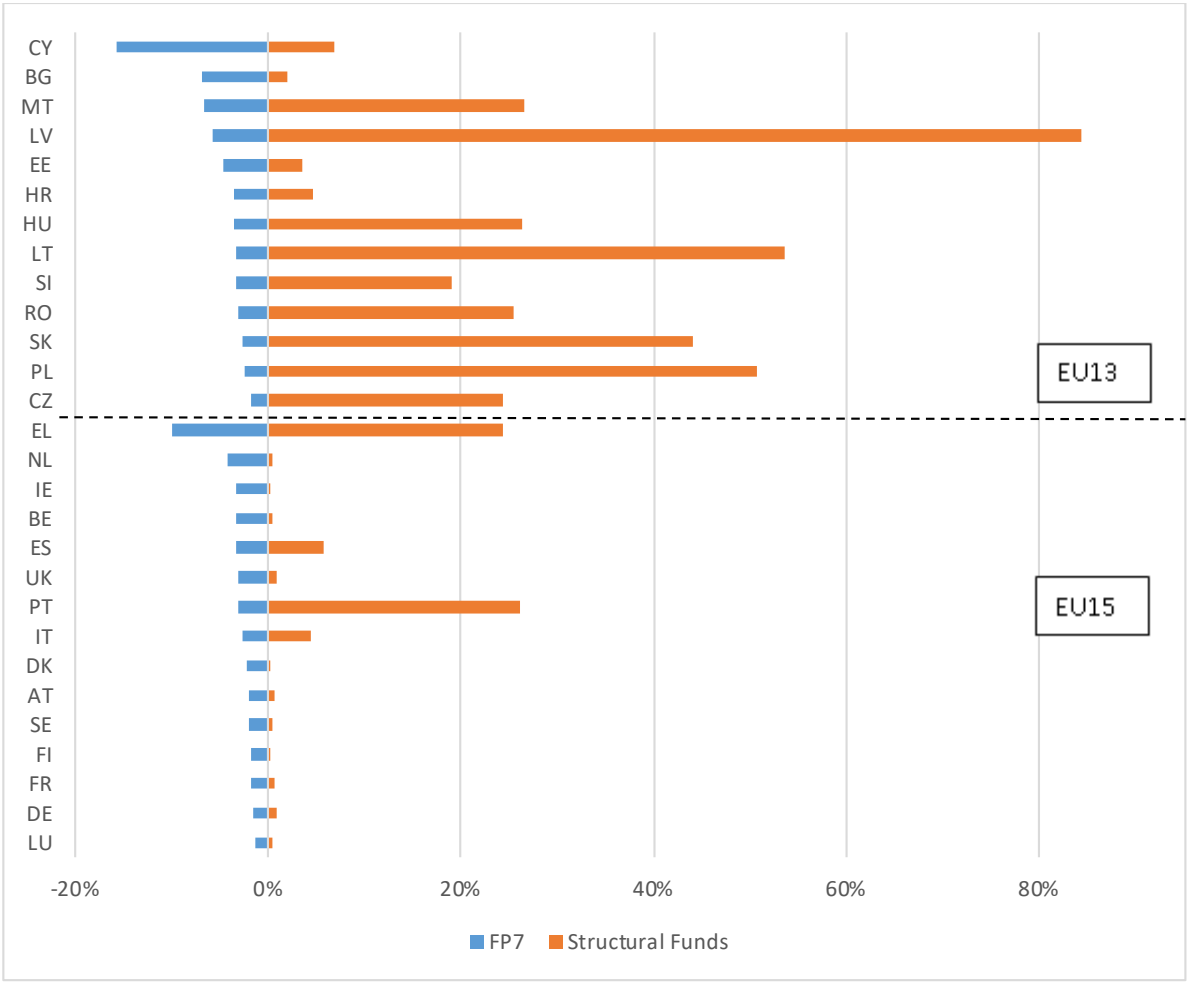


Figure 3. Funding from FP7 and the structural funds on R&D in 2007-2013 as a % of GERD

Only the Mediterranean EU15 countries received similar substantial funding from ESIF on R&D relative to their GERD. However, although the ESIF contributed substantially to the R&D funding in the EU13, there is no systematic link between the amount of funding coming from the ESIF on R&D and the willingness to submit proposals in FP7. For example, in Latvia the ESIF funded more than 80 % of GERD, yet the willingness of Latvian researchers to submit proposals in FP7 per million euro of GERD was one of the highest among the EU13 MSs. The lack of a systematic link between ESIF funding and willingness to submit proposals in FP7 has been proven by mutual statistical comparison of the amount of ESIF funding as a share of GERD to the number of participations in FP7 proposals per million euro of GERD.

3.4. Collaboration and networks

H6. The level of internationalisation in the EU13 is weaker than the EU15

International scientific collaboration is the most remarkable feature of the new global geography of science. Publishing defines academics more than any other academic activity. It is of critical importance to academic careers and progression across academic rank, as well as academic recognition (Kwiek, 2019).

Methods

In this hypothesis, international research collaboration refers to publications co-authored by authors who are affiliated with institutions located in different countries. International research collaboration was analysed in comparison with the three other collaboration types: i) institutional research collaboration (multi-authored research outputs, where all authors are affiliated with the same institution in a European country); ii) national research collaboration (multi-authored research outputs, where all authors are affiliated with more than one institution within the same European country), and iii) single authorship (or no collaboration, single-authored research outputs where the sole author is affiliated with an institution in a European country). The data analysed for this hypothesis were retrieved from Scopus and SciVal, using 2007-2017 academic research. The analysis was limited to bibliometric data alone. Articles were the only publication type studied.

Results

The number of articles written in international collaboration in the study period was 2 193 504 in the EU28 (Figure 4). Of them, 2 090 453 were attributed to authors affiliated with EU15 institutions and 271 846 to authors from EU13 institutions. Some articles were co-authored in the collaboration of EU13 and EU15 scientists and therefore the total for EU28 is smaller than the sum of publications with EU15 and EU13 affiliations.

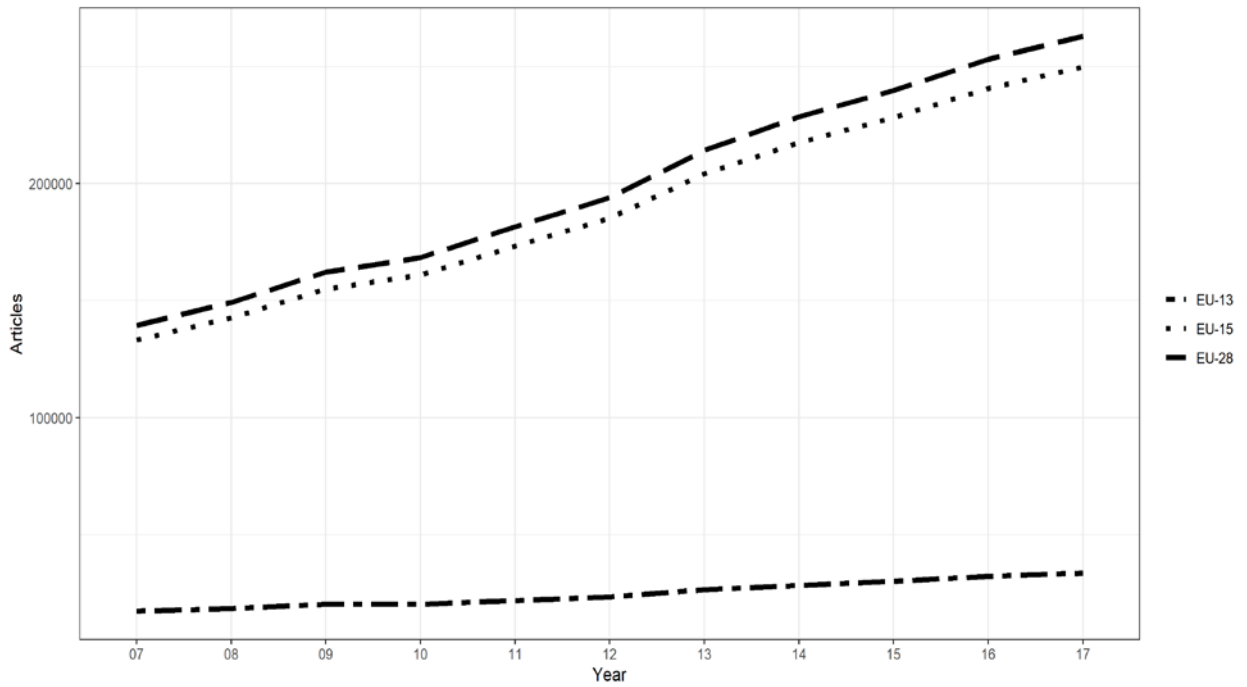


Figure 4. Number of articles written in international collaboration, 2007-2017

Figure 5 shows the percentage of articles written in international collaboration by EU28, EU15, and EU13 scientists. Between 2007-2017, the average percentage of international collaboration articles was 41 % in the EU15 versus 34.8 % in the EU13 (38.5 % for EU28). In 2017, this was 47.1 % for EU15 versus 39.2 % in the EU13 (44.4 % for EU28). Figure 6 shows the four types of research collaboration in 2017. Notably, the internationally co-authored outputs produced that year by EU15 scientists account for 95.3 % of the total.

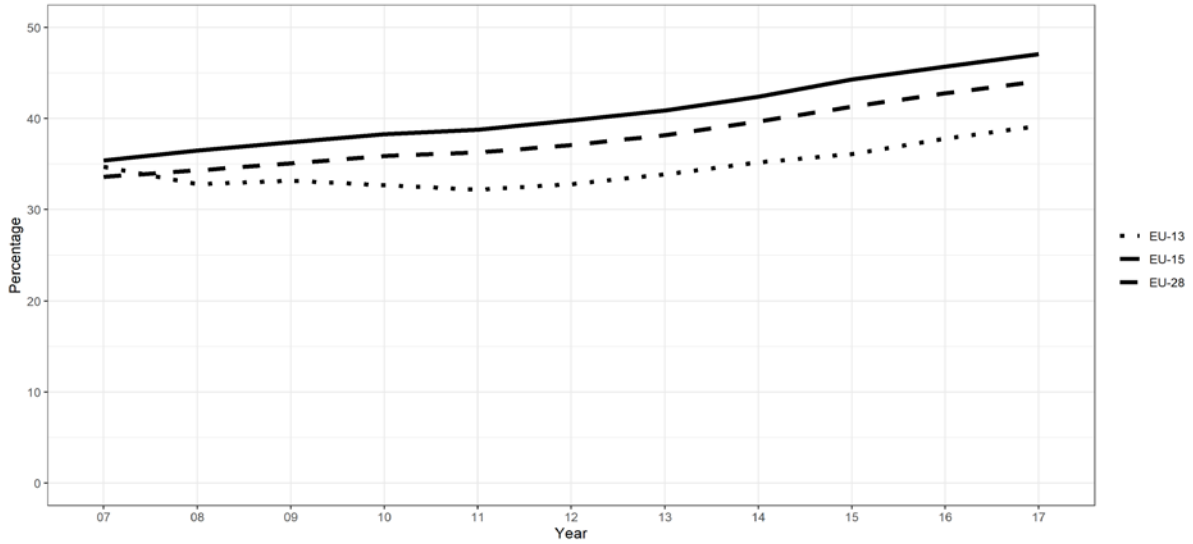


Figure 5. Percentage of articles written in international collaboration, 2007-2017

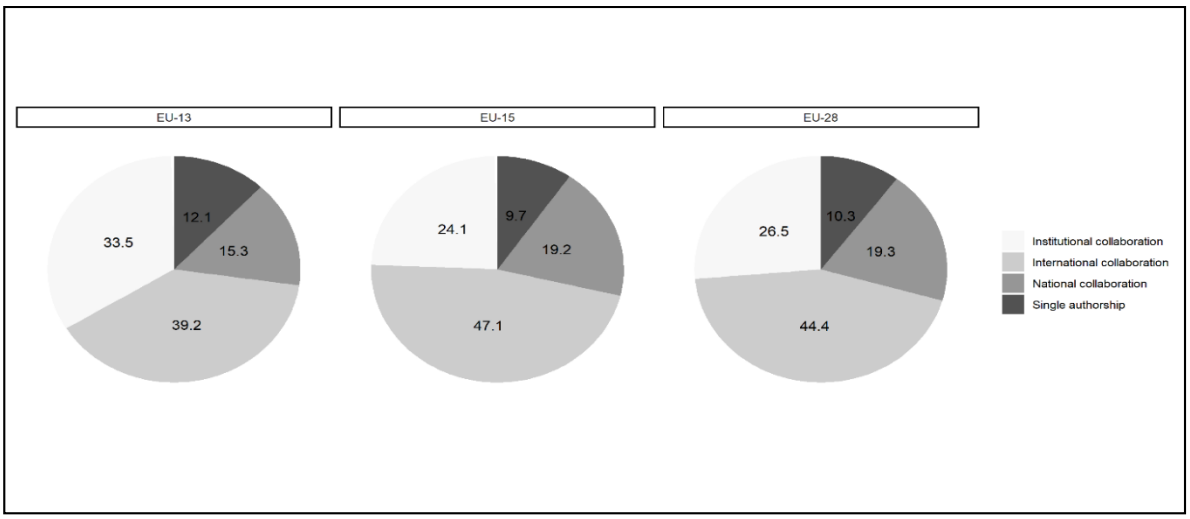


Figure 6. Comparison of the four collaboration types in 2017 (in %)

H7. Participants from the EU13 have weaker connections to the collaboration network in FPs than the EU15

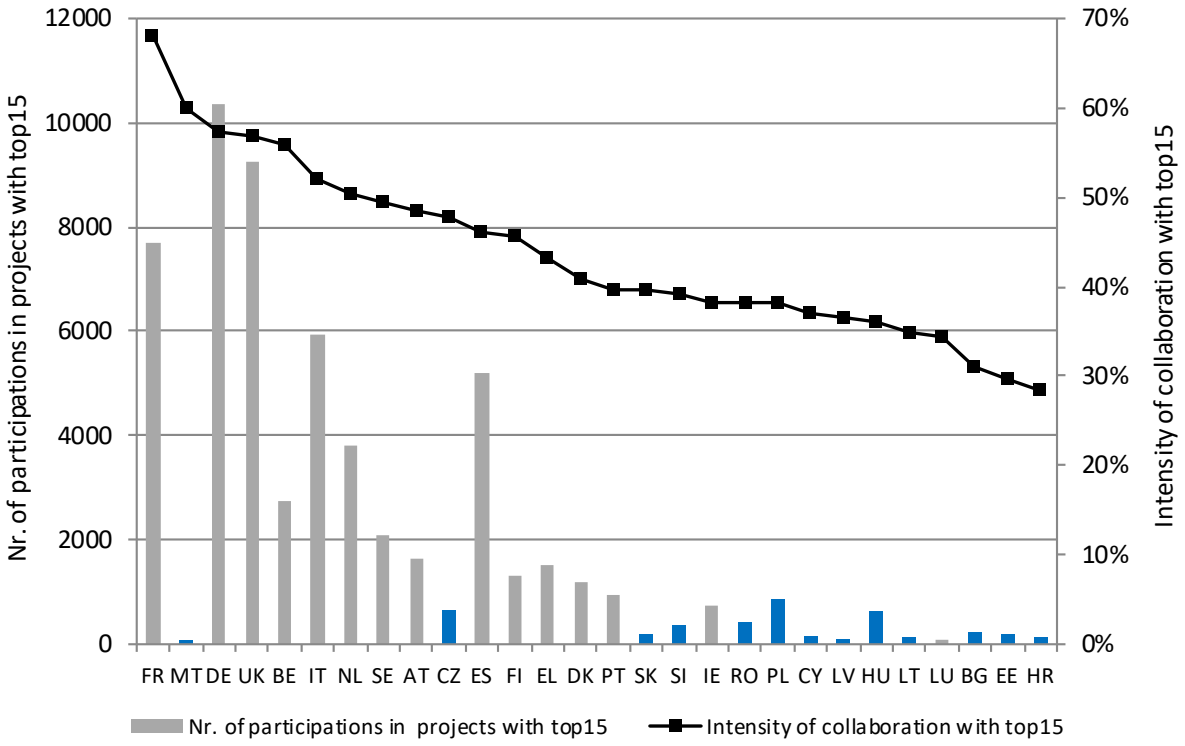
The FPs networks are dominated by core organisations – the so-called 'top-15' institutions – that are consistently successful in applying for funding from FPs and have a higher than average number of projects in the collaboration networks. The top-15 FP7 institutions, five based in the UK, three in France, two in Germany, two in Switzerland, and one each in Italy, Belgium and Spain, received 51 % of the whole FP7 budget, and are the most active and experienced research organisations in the EU.

Methods

Collaboration with the top-15 institutions has been used as a proxy indicator of the EU13 position in European collaboration networks. The total measure of participation with top-15 institutions was calculated and compared with the position of the EU15 and the EU13 research teams. Since the total participation of the EU13 is much lower than that of the EU15, an indicator of intensity of collaboration with the top-15 was constructed. This indicator was expressed as a sum of eligible cost in FP7 projects conducted with the top-15 divided by the total eligible cost in FP7 projects. Information was extracted from the E-Corda database (European Commission, 2015a).

Results

Figure 7 shows the number of participations and the intensity of collaboration with the top-15 in the FP7. The MSs were ranked according to their intensity of collaboration with the top-15 institutions. The number of EU13 collaborations with the top-15 organisations is much lower than that of the EU15. For example, Belgium and Sweden together have more collaborations with the top-15 than all EU13 MSs together.



Note: grey bars indicate the EU15, blue bars the EU13

Figure 7. Number of participations in projects with the top-15 and intensity of collaboration with the top-15 in FP7

3.5. The framework programme

H8. The problem of FP participation is related to the specific funding schemes of the FPs

The FPs consist of different instruments and activities. The lower participation and success rate of the EU13 may be related to the specific funding schemes of the FP.

Methods

The analyses focused on five specific funding schemes that are comparable across FP7 and H2020 (Table 9). The participation per different FP funding scheme was investigated by: i) normalising the participation for the size of the researcher population and ii) for investments in R&D. Results on the H2020 programme reflect only the 2014-2016 period. Information was extracted from the E-Corda database (European Commission, 2015a).

Table 9. Funding schemes studied for hypothesis 8

Objective	FP7 Funding schemes	H2020 funding schemes
Frontier research	European Research Council (ERC)	ERC
Training and career development	Marie Skłodowska-Curie Actions (MSCA)	MSCA
Development of new knowledge/technology; closer-to-the-market activities	Collaborative projects (CP); Integrating project (IP);	R&I actions (RIA); Innovation actions (IA)
Coordination and research networking	Coordination and support actions (CSA); Coordination/networking actions (CSA-CA); Support actions (CSA-SA)	CSA
Benefit of specific groups	BSGs	BSGs

Results

Table 10 shows the participation of the EU13 in different funding schemes (where the number of participants per type of funding schemes from EU15=100). Considering the participations per FTE researcher, there is a gap between the EU13 and EU15 in the participation in ERC grants. Only small EU13 countries, i.e. Malta and Cyprus, perform better in the ERC grants than the EU15 average (data not shown). A similar gap exists in the MSCA, even though the differences between the EU13 and the EU15 MSs are smaller. In CP, IP, IA and RIA (collaborative projects), the participation of EU13 per number of researchers comes up to 60 % of the EU15 level. On the contrary, participation of the EU13 in BSG projects is similar to that of the EU15, and participation in CSA projects is much higher in the EU13 compared to the EU15.

Considering the participation per million euro of GERD, the EU15 exceeds the EU13 only in the ERC grants. In all the other funding schemes, the participation of the EU13 per million euro of GERD is higher than that of the EU15. These findings indicate that the EU13 participate relatively more in areas of the FPs where existing knowledge is used for specific purposes, and relatively less in funding schemes aimed at excellence and innovation.

Table 10. Number of participants per funding scheme, FTE researcher and million euro of GERD of EU13 in FP7 and H2020

Funding scheme	Participations per FTE researcher*		Participations per million euro of GERD*	
	FP7	H2020	FP7	H2020
ERC	18	16	65	51
MSCA	47	35	168	112
CP, IP; IA; RIA	59	60	212	191
CSA	145	165	523	528
BSG	115	83	173	265
Total	73	72	264	231

*EU15=100

H9. The EU13 have an insufficient influence on the work programmes of the FPs

The work programmes (WPs) of the FPs create opportunities for participation in the EU institutional ecosystem. MSs with more influence on the formulation of the WP and on the evaluation of submitted proposals may have better opportunities for participation than the MSs with less influence. The aim of this hypothesis was to test whether the space for influencing the design and governance of the FPs' WPs is the same for both the EU15 and EU13.

Methods

In order to quantitatively assess the involvement of EU13 MSs in designing and governing FPs, the composition of advisory expert groups (AEGs) to the European Commission in the area of R&I was explored. Such AEGs perform a number of tasks. In general, they enable discussion on a given subject and provide input stemming from a wide range of sources and stakeholders. They are involved with the setting-up of the FPs and assist in the evaluation of FP proposals as peer reviewers. The European Commission categorises the members of the AEGs as follows: individual expert appointed in her/his personal capacity (type A); individual expert appointed as representative of a common interest (type B); organisation (type C); Member State authority (type D), and other public entity (type E). This information was retrieved from the European Commission (2017b). The representation of the EU13 in comparison with the EU15 was explored from two perspectives: i) number of members in different types of AEGs, and ii) the number of members in different types of AEGs per 100 000 researchers, reflecting the size of the research systems.

Results

The constitutions of 64 AEGs (which comprised 1 121 members in total), related to the year 2017, were analysed (Table 11). The EU15 MSs had the highest share of members (67 %), whilst the EU13 MSs comprised 24 % of the members, with the rest of the members being from non-EU countries. This difference reflects the difference in size of the R&D systems in the EU13 compared to the EU15. If we look at the number of members in AEGs per 100 000 researchers, the EU13 countries actually have a relatively higher representation in all types of advisory groups than the EU15 MSs. In short, although the EU13 MSs may have lower representation in the EC AEGs in absolute terms, their representation relative to the size of their R&D systems appears to be adequate, and even higher than that of the EU15.

Table 11. Number of members from the EU13 and EU15 in the EC AEGs for R&I, arranged by member type

	Type A	Type B	Type C	Type D	Type E	Total (%)
Number of members						
EU13	127	28	8	107	0	270 (24)
EU15	401	185	35	135	0	756 (67)
Non-EU	61	0	33	0	1	95 (9)
Number of members per 100 000 researchers						
EU13	39	9	2	33	0	83
EU15	16	8	1	6	0	31

4. Discussion

The FP is the EU's primary instrument for the creation of the ERA, 'a unified research area open to the world based on the internal market, in which researchers, scientific knowledge and technology circulate freely and through which the Union and its MSs strengthen their scientific and technological bases, their competitiveness and their capacity to collectively address grand challenges' (European Commission 2012).

In FPs, the principle of 'juste retour' does not apply. Research needs to be of the highest quality, produced mostly in European collaboration and selected on a competitive basis. Under such conditions,

uneven participation is unavoidable. However, after almost twenty years of access to the opportunities of the FP, the EU13 still lag behind the EU15. The present study has explored the possible reasons behind the low success rate of EU13 MSs. The low success rate in FPs is not a problem faced by every EU13 MS, with the rate of success varying significantly between them.

From the hypotheses carried out in this study, the most prominent reasons for low performance of the EU13 in FPs can be summarised as follows: the relative weakness of the R&I systems of the EU13 compared to the EU15, with low levels of research expenditure and other structural causes (hypothesis 1); a relative lack of scientific excellence (hypothesis 2); a lack of quality in submitting proposals (hypothesis 3); a lower propensity to send proposals (hypothesis 4); and a lack of strong international research contacts and professional networks (hypothesis 6 and hypothesis 7). The problem of FP participation is also tied to specific FP instruments (hypothesis 8). The study does not find that the EU13 have easier access to alternative funding opportunities (hypothesis 5), nor does it find that the EU13 have an insufficient influence in the setting out of the WPs and the evaluation processes of the FP proposals (hypothesis 9).

Reasons for participations in FPs are differentiated and context-related, since they depend on the national setting in which research takes place, the field of research and types of organisations concerned (academia, research institutes, business enterprises etc.). A strong international research network, a low percentage of investment on research at national level and robust relations with organisations from MSs with more advanced research may affect an individual's motivation to participate (Reale, 2013; Lepori, 2014).

No single factor can fully explain the low performance of EU13 MSs in the FPs, the current state is the result of a combination of diverse aspects. Low rates of success of the EU13 in the European FPs and the lag in scientific quality compared to the EU15 appear to be symptoms of more fundamental problems. As the results of hypothesis 1 show, there is a significant weakness in the research systems of the EU13 compared to the EU15, with such disparity reflecting structural differences, gaps in R&I capacity, long-term research performances and low levels of research expenditure (Doryn, 2016; Harrap, 2017). The underfunding of research also contributes to the inadequacy of the existing research infrastructures in some EU13 MSs and more investment is required in order to undertake high-level scientific activities (Özbolat, 2018). Some small EU13 MSs – notably Cyprus, Malta, Estonia and Slovenia – perform better than the rest of the EU13.

The potential for innovation requires the hybridisation of elements from university, industry, government and knowledge transfer, and this process is weak in the EU13 area (Ranga, 2013; Özbolat, 2018). Commercialising the research results is a crucial step in the innovation process, but the business environment in the EU13 is mostly based on SMEs and micro-companies, which have limited research capacities and resources. To achieve a final product without systematic public support is difficult for these small enterprises (Özbolat, 2018).

Furthermore, in some EU13 MSs, there is a strict distinction between basic and applied research with little willingness for closer collaboration. In short, for almost all EU13 MSs, strengthening the linkages between academia, industry and government is one of the biggest innovation challenges that they face (European Commission, 2019b). As noted by Ukrainski et al. (2018a), under H2020 the FPs put much more emphasis on innovation activities that have had a direct benefit on the economy. This implies that besides the involvement of the academic sector, the participation of other actors – industry, SMEs, public-sector organisations, etc. – is increasingly relevant. This penalises countries with fewer connections between industry, SMEs and academia, such as EU13 countries (Ukrainski, 2018a).

Quality is one of the most important and controversial concepts in science policy. Quality is a marker attached to individuals (e.g. talent, excellent researchers), to institutions (e.g. universities at the top of worldwide rankings), and to publications (e.g. papers in high-impact journals or that have received a

large number of citations). Definitions of quality vary by scientific discipline, by type of institution and from nation to nation.

Social sciences and humanities have different ideas about the quality of output than natural sciences. Universities of applied science and technical universities tend to attach higher value to applied results than general universities, whilst some nations allocate core funding based on quality assessments (notably the UK) where other nations rely mainly on block grants. Despite noting that all the indicators that assess the quality of research are incomplete and controversial, the results of hypothesis 2 seem to confirm the lower level of scientific excellence attained by the EU13 MSs. Some EU13 researchers not only lack excellence in implementing trans-national collaborative projects, but they also lack expertise and experience in doing the scientific work itself. A shortage of qualified professors is an issue in most EU13 research institutions (Özbolat, 2018).

The lack of excellence in submitted proposals is confirmed by hypothesis 3. The process has two dimensions: administrative quality, which determines eligibility, and scientific quality, which determines the success rate. Proposals involving EU13 organisations are more likely to be ineligible, and where they are eligible, they are less likely to be successful. The disparity between the EU13 and EU15 is more evident in proposals coordinated by EU13 organisations. Coordination requires special skills that are in short supply amongst EU13 organisations.

The lack of available skilled capacity to manage co-funded projects sometimes leads to senior scientists nominating themselves as project managers, despite lacking the relevant managerial or organisational skills (Özbolat, 2018). Hypothesis 4 shows that EU13 organisations are less active in terms of number of submissions compared to EU15 organisations. Several studies indicated that experience accumulated from prior participation in FPs is a strong determinant for the propensity to apply for future FP projects (Rauch, 2012; Enger, 2016). The fact that larger numbers from the EU13 countries are missing such experience is therefore detrimental to their participation in FPs.

In most of its funding schemes, the EU FPs call for a collaborative approach to research. Our results show that EU13 MSs lack strong international research contacts and professional networks (hypotheses 6 and 7). Patterns of collaboration are driven by proximity and past connections. Proximity relates to the distance between entities (e.g. partners in different countries) in geographical, social, organisational, institutional, and cognitive terms (Heringa, 2014). Evidence suggests that collaboration patterns in the EU FP projects primarily depend on prior acquaintance, thematic proximity, technological proximity and geographical proximity (Scherngell, 2009). Scherngell and Barber (2011, pages 262-3) found that 'geographical distance and co-localisation of organisations in neighbouring regions are important determinants of the constitution of cross-region research collaborations in Europe. However, these geographical effects are much higher for intra-industry cooperative activities than for collaborations between public research organisations, where negative effects of geography nearly vanish. Technological proximity is more important than spatial effects. Research collaborations occur most often between organisations that are not too far from each other in technological space. R&D collaborations are also determined by language barriers, but language barrier effects are smaller than geographical effects'.

In relation to this, a study from Horlings et al. (2011), carried out an analysis of the scientific output of different countries from across the world during three different periods, 1993, 2000 and 2008 (Horlings, 2011). This study found that after the collapse of the Soviet Union, the scientific output of the new EU Eastern MSs – which constitute the vast majority of EU13 countries – shifted from a portfolio similar to that of the former Soviet Republics to a portfolio that was similar to those of emerging economies, and one which differed from the portfolios of the EU15.

5. Conclusion

This study helps us to understand the reasons behind the low participation of EU13 countries in EU FPs. The explored factors are not independent of each other and do not carry equal importance with respect to the barriers that prevent EU13 countries from participating more in FPs. The results of the hypotheses analysed should be viewed with caution. Although many of the indicators used are accepted as adequate analytical tools, they are only partially able to give an accurate picture of reality. Moreover, what these hypotheses have in common is that they are not applicable to all EU13 MSs, they have been confirmed for some EU13 MSs but rejected for others. In addition, parts of the EU15 perform at EU13 levels. This means that the problems represented by these hypotheses are not specific to the entire EU13 nor absent from the EU15. However, on the whole they give a telling picture of the different conditions in the two areas analysed, the EU13 and the EU15.

The EU13 MSs differ in their populations, economies, social structures and levels of research and technology innovation – including number of researchers, intensity of R&I, and scientific output. The low success rate of EU13 MSs in FPs might be understood by looking at various indicators in the context of their national research capacities. At the start of integration into the ERA, EU13 countries faced numerous challenges related to the legacy of previous governance systems and a lack of focus on developing science and technology. To develop research agendas, to accumulate structural capacity, to engage skilled scientists and research networks, to implement infrastructures and institutional frameworks takes time and a coordinated effort.

Such capacity is not simply put in place, but evolves and requires a high degree of internationalisation, and this is where a significant part of the inherent complexity of the process lies (Horlings, 2011). It was assumed that the association of EU13 MSs with the European FPs would boost internal reforms of the research systems, if local scientific and political stakeholders were proactive. However, after two decades of full association, the levels of FP participation in EU13 MSs remain low. Additionally, the level of GERD in almost all EU13 MSs has remained low, which generally indicates a low political commitment to science and technology. The weak positions of most EU13 MSs in several indicators analysed in this report show that the field of R&I in EU13 MSs requires further structural changes and sustainable reforms. For such an extensive objective, the structural funds in connection with the smart specialisation strategies probably represent a more relevant opportunity for industrial modernisation and technology upgrading for the EU13 (Radosevic, 2015).

6. Policy options

The policy options formulated below reflect the conclusions of the nine hypotheses formulated in this report. They are also inspired by the conclusions of the final report of the MIRRIS project (2016), the conclusions of the Research, Innovation and Science Policy Experts (RISE) report 'Europe's future' (2017) and the Stairway to Excellence (S2E) project report (Özbolat, 2018). From each of these reports, we have made a meditated selection of policies and have elaborated on those options that seem to be the most pertinent. Any strategy to improve patterns of persistent, low participation in the FPs requires action at different levels. The options are formulated at a general level, but of course, the degree of urgency varies greatly by country. Eleven policy options are summarised under two dimensions: i) governance and ii) capacity building.

6.1. Governance

Policy option 1. Establishing a strategic plan for long-term objectives

For reinforcing a shared vision of R&I policies, it is crucial to build up a consensus on the prioritisation and aligning of activities from different fields. The development of smart specialisation strategies has contributed to a more inclusive policy-building process and this development requires active involvement of different stakeholders, including the governmental, education, research and private sectors. However, some MSs have had limited involvement of specific actors in this process. Therefore, a major effort should be made in order to enhance the strategic alignment and the prioritisation of activities from different fields, establishing long-term monitoring tools and impact-based approaches.

Policy option 2. Improving the link between the national research system and the EU R&I priorities

Analysis of hypothesis 8 found that the EU13 participation is relatively higher in areas of the FPs where existing knowledge is used for specific purposes, and relatively lower in funding schemes aimed at excellence and innovation. The following improvements can be implemented in order to better link the national research system with the EU R&I priorities: i) include the European R&I priorities as well as networking and market opportunities for national actors when setting priorities and smart strategies for national R&I; ii) use national funding for research organisations more explicitly as leverage to increase participation in the FP; iii) establish a system for the periodic evaluation of research organisations, which would also look at international collaboration and research management; such schemes would reward excellence and improve the readiness of research organisations to take part in FP projects; iv) reinforce smart specialisation processes and activities, evaluate their implementation, and use various funding resources (national, ESIF, H2020 and others) in a synergistic way to strengthen the position of regions in areas that are to their competitive advantage.

Policy option 3. Improving coordination between different stakeholders

In most of the EU13 MSs, numerous agencies are responsible for implementing the R&I policies under the auspices of different ministries and at different levels of aggregation (urban, regional and national). This leads to uncoordinated agendas and a fragmented research system without a strategic focus and with a high risk of duplication. A suggestion is to establish an independent coordination body of different public and private representatives for communication with stakeholders involved in R&I activities. Such a body should align the related activities along with a long-term strategy to make best use of the FPs. (hypothesis 4).

Policy option 4. Strengthening collaboration between business and academia

The quadruple helix system, where the potential for innovation requires the hybridisation of elements from university, industry, government and knowledge transfer by including the needs, wants and

capacities of society, is weak in the EU13 area. Commercialising research results is a crucial step in innovation, but the business environment in the EU13 is mostly based on SMEs and micro-companies, which have limited research capacities and resources. To achieve a final product without systematic public support is difficult for these types of small enterprises. User-involvment is of utmost importance. Furthermore, in some EU13 countries, there is a strict distinction between basic and applied research with little willingness for closer collaboration.

In short, almost all EU13 MSs find strengthening the innovation linkages between academia, industry, government and society challenging. Possible actions could be the establishment of centres for the coordination of knowledge transfer from research organisations to businesses; including incubation/excellence/competency centres as well as lead market initiatives. Another action could be the establishment of clusters and platforms to facilitate business participation, as well as user and citizen engagement. Other actions include award systems for SMEs and tax subsidy for R&I investment activities.

Policy option 5. Encouraging collaboration with top European research organisations

Within Europe, a limited number of national research organisations have core positions in the overall network of EU R&I collaborations. From the evidence reported in this study (hypothesis 7) it is clear that existing relationships with leading participating research organisations improve the chance of success in the FP considerably. Therefore, collaboration between national research organisations and top European research organisations should be encouraged. Collaboration with the top 15 in FP7 and/or top 20 in H2020 has increased the participation success rate of EU13 organisations and may increase future participation opportunities in the FPs.

Policy option 6. Putting international research collaboration at the forefront of national research policies

There is a weaker level of internationalisation in the EU13 than in the EU15 (hypothesis 6). National higher education systems focused on increasing the international visibility of their academic knowledge production need to put the internationalisation of research at the forefront of their national research policies. If international research collaboration should become the focus of national research policies then the English language should also become more prominent, given its role as the language of global science.

Moving internationalisation of research to the forefront of national research policies refers to all levels of operation in higher education systems, from national to institutional to departmental to individual. Internationalisation-supportive research policies should promote top international publications rather than merely top national publications and should promote international collaboration in research rather than purely national collaboration in research. They should promote international publication channels both in direct block funding to their institutions and in indirect, individual-level competitive research funding.

National models of successful universities, departments, research teams and individual scientists need to be clear: no academic success is possible and no large funding is awarded at any level to those units and individuals that are not internationalised in research. No professorships are available (or renewable) to scientists whose research performance profile is predominantly national – rather than international. For the research internationalisation agenda to be successful, highly internationalised institutions, departments, research teams and scientists need to be preferred to local ones.

6.2. Capacity-building

Policy option 7. Increasing research financing

Although some EU13 MSs approach the average level of the EU28, the R&D expenditure as a percentage of GDP is considerably higher in the EU15 (2.2 %) than in the EU13 (1.1 %). The difference in the percentage of research personnel is also significant: 0.8 % in the EU13 versus 1.4 % in the EU15 (see the conclusions of hypothesis 1). There is a general consensus on the inadequacy of the research infrastructures in many EU13 MSs. Therefore, there is a need for continuous and sustainable financing of research infrastructures as well as capacity building to ensure more and better trained researchers and technicians. It is important to keep these two investments aligned, as infrastructure without qualified staff would be an inefficient use of public resources.

Policy option 8. Improving administrative procedures

Lack of personnel with the necessary knowledge and capacity of managing public co-funded projects is a common phenomenon in most EU13 MSs. Hypothesis 3 showed that the ineligibility rate (which indicates the administrative quality of proposals) of submitted proposals involving EU13 organisations scored lower than those involving EU15 organisations. Possible actions are: i) to increase the public investment in the capacities and competencies of modernisation, technology upgrading, human resources, networking etc; ii) to offer professional advisory support activities and training for project applications for FPs; and iii) to provide guidelines, methodologies, good practices and other documents in national languages.

Policy option 9. Strengthening the work of national contact points (NCPs)

The network of NCPs is the main structure that provides guidance to any interested party on all aspects of participation in FPs. The system of NCPs is established, operated and financed under the responsibility of the MSs. It has been observed that NCPs frequently offer a simple update on the FPs calls rather than support related to project proposals, elaboration and management. NCPs should reform their structure, moving from their current activity of information-providing to a new role that promotes excellence and facilitiates knowledge.

Policy option 10. Developing synergies between different funding schemes

The European Commission puts significant effort into raising awareness of synergies of different funding schemes (at regional, national and European levels). Developing synergies between different funding sources would assist the MSs in the effective implementation of R&I.

Policy option 11. Creating and exploiting existing pockets of excellence

There seems to be a relative lack of scientific excellence in institutions from the EU13 compared to the EU15 (hypothesis 2). To increase the opportunities for researchers from EU13 MSs, it is vital to create or develop pockets of excellence within these countries. Such pockets of excellence can act as regional or national hubs within European R&I programmes. This requires the implementation of several policy options mentioned here, namely: long-term planning, a well-balanced interaction between funding instruments, improved organisational capabilities and more structured international network relationships.

7. References

Andreff W, Eleftheriou A, Horvat M, Krickau-Richter L, Nolan T, Pilotti AM, Ribeiro da Silva N. (2000) 1999 Five-Year Assessment Related to the Specific Programme INCO. Brussels: European Commission.

Cohen WM, Levinthal DA. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly, Vol. 35 (1), 128-152.

Doryn W. (2016) Innovation in low-technology industries - the same across Europe, International Journal of Management and Applied Science, 2: 213-17.

EBRD. (2014) Innovation in Transition. London: EBRD.

Edquist C. (2011) Design of innovation policy through diagnostic analysis: identification of systemic problems or failures. Industrial and Corporate Change, 20 (6): 1725-1753.

Enger SG, Castellacci F. (2016) Who gets Horizon 2020 research grants? Propensity to apply and probability to succeed in a two-step analysis (No. 20160225), Centre for Technology, Innovation and Culture. University of Oslo.

European Commission. (2012) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A reinforced European Research Area partnership for excellence and growth. COM (2012) 392 final.

European Commission. (2015a) External Common Research Data Warehouse (e-Corda).

European Commission. (2015b) Cohesion Policy Data. (See: https://cohesiondata.ec.europa.eu/)

European Commission. (2015c) Seventh FP7 Monitoring Report 2013.

European Commission. (2017a) Interim evaluation of Horizon 2020. ISBN 978-92-79-69545-2.

European Commission. (2017b) Register of Commission expert groups and other similar entities.

European Commission. (2018) 'Science, Research and Innovation Performance of the EU. Strengthening the foundations for Europe's future'.

European Commission. (2019a) Internal Market, Industry, Entrepreneurship and SMEs, Innovation Union Scoreboard.

European Commission. (2019b) Research and Innovation Observatory.

Eurostat. (2019) Intramural R&D expenditure (GERD) by sectors of performance.

Foray D. (ed.) (2009) The New Economics of Technology Policy. Cheltenham: Edward Elgar.

Freeman C. (1994) The economics of technical change: A critical survey. Cambridge Journal of Economics, 18 (5): 463-514.

Fresco LO. (2015) Commitment and coherence. Essential ingredients for success in science and innovation. Ex-Post-Evaluation of the 7th EU Framework Programme (2007-2013).

Harrap N, Doussineau M. (2017) Collaboration and networks: EU13 participation in international science, Stairway to Excellence Brief Series, Issue 2.

Havas A, Izsak K, Markianidou P, Radosevic S. (2015) Comparative analysis of policy-mixes of research and innovation policies in Central and Eastern European countries. GRINCOH Working

Hering, PW, Horlings E, van der Zouwen M, van den Besselaar P, van Vierssen W. (2014) How do dimensions of proximity relate to the outcomes of collaboration? A survey of knowledge intensive networks in the Dutch water sector, Economics of Innovation and New Technology, 23(7), 689-716.

Horlings E, Van den Besselaar P. (2011) Convergence in science: Growth and structure of worldwide scientific output, 1993–2008, Science and Innovation Policy, 2011 Atlanta Conference on (pp. 1-19). IEEE.

Izsak K, Markianidou P, Radosevic S. (2015) Convergence of national innovation policy mixes in Europe – Has it gone too far? An analysis of research and innovation policy measures in the period 2004-12. Journal of Common Market Studies 53:4, 786-802.

Kaló Z, van den Akker LHM, Vokó Z, Csanádi M, Pitter JG. (2019) Is there a fair allocation of healthcare research funds by the European Union? PLoS One, 14:e0207046.

Kravtsova V, Radosevic S. (2012) Are systems of innovation in Eastern Europe efficient? Economic Systems 36:1, 109-126.

Kwiek M. (2019) Internationalisation of EU research organisations. A bibliometric stocktaking study. European Parliament, Directorate-General for Parliamentary Research Services (EPRS).

Leitner SM, Stehrer R. (2014) Trade Integration, Production Fragmentation and Performance in Europe – Blessing or Curse? A Comparative Analysis of the New Member States and the EU-15. The Vienna Institute for International Economic Studies, GRINCOH Project, 2014.

Lepori B, Veglio V, Heller-Schuh B, Scherngell T, Barber M. (2015) Participations to European Framework Programs of higher education institutions and their association with organisational characteristics, Scientometrics, 105(3), 2149-78.

Lundvall BA, Borras S. (1999) The Globalising Learning Economy: Implications for Innovation Policy. Luxembourg: Office for Official Publications of the European Communities.

Macilwain C. Economic divide taking toll on European science. (2015) Nature, 517, 123.

Makkonen T, Mitze T. (2016) Scientific collaboration between 'old' and 'new' member states: Did joining the European Union make a difference?, Scientometrics, 106(3), 1193-215.

Malerba F. (2009) Increase learning, break knowledge lock-ins and foster dynamic complementarities: evolutionary and system perspectives on technology policy in industrial dynamics. In: Foray, D. (ed.), pp. 33-45.

MIRRIS. (2016) Mobilizing institutional reforms for better R&I systems/institutions in Europe. Final Report Summary.

MORE2. (2013) Support for Continued Data Collection and Analysis concerning Mobility Patterns and Career Paths of Researchers.

Özbolat NK, Harrap N. (2018) Addressing the innovation gap: Lessons from the Stairway to Excellence (S2E) project, EUR 29287, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-88821-2.

Pazour M, Albrecht V, Frank D, Ruzicka V, Vanecek J, Pecha O, Kucera Z. (2018) Overcoming innovation gaps in the EU-13 Member States' European Parliament, Directorate for Impact Assessment and European Added Value. Directorate-General for Parliamentary Research Services (EPRS).

Peneder M. (2010) Technological regimes and the variety of innovation behaviour: Creating integrated taxonomies of firms and sectors. Research Policy, 39 (3): 323-334.

Protogerou A, Caloghirou Y, Siokas E. (2013) Research networking and technology fusion through EU-funded collaborative projects, Science and Public Policy, 40(5), 576-590.

Radosevic S, Ciampi Stancova K. (2015) Internationalising smart specialisation: Assessment and issues in the case of EU new member states. Journal of the Knowledge Economy, 1-31.

Radosevic S. (2017) Upgrading technology in Central and Eastern European economies. IZA World of Labour 2017: 338.

Ranga M, Etzkowitz H. (2013) Triple helix systems: an analytical framework for innovation policy and practice in the knowledge society, Industry & higher education, 27; 237–62.

Rauch M, Sommer-Ulrich J. (2012) Participation of the Central and Eastern European EU Member States in the 7th Framework Programme: Analysis, Evaluation, Recommendations, Commissioned by the Federal Ministry of Education and Research (BMBF).

Reale E, Lepori B, Nedeva M, Thomas D, Primeri E, Chassagneux E, Laredo P. (2013) Investments in joint and open research programmes and analysis of their economic impact. JOREP, executive study. European Commission. Luxembourg: Publications office of the European Union.

Reillon V. (2017) EU framework programmes for research and innovation. Evolution and key data from FP1 to Horizon 2020 in view of FP9, European Parliamentary Research Service (EPRS).

RISE Group. (2017) Europe's Future: open innovation, open science, open to the world, DG Research and Innovation. https://bookshop.europa.eu/en/europe-s-future-pbKI0217113/

Scherngell T, Barber MJ. (2009) Spatial interaction modelling of cross-region R&D collaborations. Empirical evidence from the 5th EU Framework Programme, Papers in Regional Science 88, 531-546.

Scherngell T, Barber MJ. (2011) Distinct spatial characteristics of industrial and public research collaborations: evidence from the fifth EU Framework Programme. Annals of Regional Science, 46, 247-66.

Scherngell T, Lata R. (2013) Towards an integrated European Research Area? Findings from eigen-vector spatially filtered spatial interaction models using European Framework Programme data, Papers in Regional Science 92, 555-77.

Schuch K. (2005) The Integration of Central Europe into the European System of Research. Wien and Müllheim a. d. Ruhr: Guthmann-Peterson.

Schuch K. (2014) Participation of the new EU Member States in the European research programmes-A long way to go, Foresight-Russia, 8, 6-17.

UK Royal Society. (2015) UK research and the European Union. The role of the EU in funding UK research. DES3891.

Ukrainski K, Karo E, Kirs M, Kanep H. (2017) Participation in ERA and Baltic Sea RDI Initiatives and Activities: Analysis and Policy Implications for Widening Participation of Strong and Moderate Innovators. European Union. European Regional Development Fund.

Ukrainski K, Kirs M, Karo E, Kanep H, Hirv T, Shin Y. (2018a) Estonian Potential in Framework Programmes: Analysis and Policy Options.

Ukrainski K, Kanep H, Kirs M, Karo E. (2018b) Segregation of EU13 countries in EU Framework Programmes illuminates important challanges for cohesion policy. CESifo Forum, 19, 16-23.

Web of Sceinces (2019). InCites dataset.

The research and innovation framework programmes of the European Union (EU) are the largest programmes for international research collaboration worldwide. Repeated reports point to the issue of under-performance in the framework programmes by the EU13 Member States – the countries that joined the EU in and after 2004 – in comparison with the EU15 Member States – which had entered the EU before 2004. This paper explores the background of various challenges in research and development of EU13 vs EU15, in order to investigate the gap between these two groups.

A set of hypotheses divided into five domains, are tested empirically. The weak positions of most EU13 Member States, on several of the indicators analysed, show that the field of research in EU13 Member States requires further structural changes. This report concludes with various policy options that would help to mitigate the innovation gap in Europe.

OA-04-20-141-EN-N

This is a publication of the Scientific Foresight Unit (STOA)
EPRS | European Parliamentary Research Service

ISBN 978-92-846-6461-0 | doi: 10.2861/654637 | QA-04-20-141-EN-N