UNIVERSIDADE CATÓLICA PORTUGUESA

A Brief Analysis of the European Funds for Research and Innovation

With Focus on the H2020 Program

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Resumo

Desde a sua criação, que a expansão da União Europeia (UE), quer como entidade interveniente nas políticas dos Estados Membros, quer pela aceitação de mais Estados Membros, tem gerado dúvidas em relação à sua eficácia e às suas repercussões. A UE possui vários tipos de programas para promover maior coesão entre os Estados Membros e que assumem a forma de investimento público na generalidade dos sectores económico. Um dos sectores que tem adquirido maior relevância nos últimos anos é o da investigação e desenvolvimento, que a Comissão Europeia vê como crucial na sua estratégia de criação de uma economia baseada no conhecimento para a UE (European Commission, 2010). No presente trabalho, pretendemos fazer uma breve análise do 7th Framework Programme for Research and Technological Development (FP7) e do Horizon 2020 Program (H2020) de forma a verificar se a aplicação destes programas foi capaz de atingir resultados satisfatórios em relação à quantidade de fundos atribuídos, qual foi o seu impacto geral na UE e se a maneira como foram desenhados e implementados foi bem sucedida no financiamento aos sectors de investigação e desenvolvimento na UE e nas *SMEs*.

A nossa análise demonstra que estes programas, à data, falharam os seus máximos de financiamento no geral, criando uma diferença entre a quantidade de fundos disponíveis e a quantidade efectivamente distribuída. Demonstramos que o método para a distribuição destes fundos contribui para o aumento do ratio entre fundos recebidos e o número de participações por parte dos Estados Membros mais desenvolvidos. Isto cria um fluxo monetário inverso à concepção geral de que todos os programas da UE beneficiam os países economicamente mais fracos e periféricos. Nós concluímos que a Comissão Europeia deveria tentar reformular, não as prioridades dos programs, mas sim o método de distribuição dos fundos.

Palavras chave: Fundos Europeus; FP7; H2020; Investigação e Desenvolvimento

Abstract

Since its creation, that the European Union (EU) expansion, both as an intervening entity in the Member States policies and its acceptance of more Member States, has created doubts regarding its effectiveness and repercussion. The EU has several programs to promote the cohesion between all the EU Member States that assume the form of public investment in practically all the economic sectors. One sector that earned more relevance in recent years is the research and innovation, that the European Commission sees has crucial for its strategy of creating a knowledge-based economy in the EU (European Commission, 2010). In the present work, we intend to make a brief analysis of the 7th Framework Programme for Research and Technological Development (FP7) and the Horizon 2020 Program (H2020) in order to check if these Programs application was able to achieve satisfying results with the amount of funding they granted, what was the general impact across the EU and if their design succeeded in funding the research and innovation sectors across the EU and SMEs.

Our analysis will find that both programs, to this date, missed their maximum available budgets in general, creating a gap between the funding they had access to and the amount of funding they ended up distributing. We demonstrate that the research and innovation sectors method for funding distribution contributes to the increase of the ratio between the granted funding versus total participations for the most developed Member States. This creates a flow of funding that is inverse to the general idea that all EU programs benefit the most peripherical and less developed Member States. We conclude that the European Commission should try to reformulate, not the Programs priorities, but their method of funding distribution.

Keywords: European Funds; FP7; H2020; Research and Innovation

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Introduction

In order to understand better, the following work, it is necessary to understand the functioning of the European Union (EU) regarding the preparation of budgets, best known as Multiannual Financial Framework (MFF), and the respective creation and funding of programs.

Just like any other major entity, the EU drafts and brings together a budget for an established period of time. This document describes all the predicted revenues and expenditures necessary for the EU and the European Atomic Energy Community.

The EU budget is then attributed and divided into 6 different areas. The budget for the time period 2014-2020 was distributed in the following way:

1. Competitiveness for growth and jobs (13%);
2. Economic, social, and territorial cohesion (34%);
3. Sustainable growth: natural resources (39%);
4. Security and citizenship (2%);
5. Global Europe (6%);
6. Administration of the EU institutions (6%);

The EU´s main investment policy is made of the European Structural and Investment (ESI) Funds (composed by 5 smaller topic specific funds). The EU Regional Policy is the biggest beneficiary from the ESI Funds. The budget allocated to The Regional Policy Funds, for the 2014-2020 framework, is about 1/3 of the total EU budget, representing 355,1 billion euros.

It was due to this Funds that first the FP7 and later the H2020 programs were created. The last one counts with more than 77 billion euros for the 7-year time frame (2014-2020).

Together with the single market and monetary union, the Regional Policy is one of the key axes of EU integration mechanisms. Its main purpose is to promote the "overall harmonious development" of the EU, to reduce disparities between the levels of development of the various regions, and to strengthen its "economic, social and territorial Cohesion" (Art. 158 Treaty on European Union).

In conclusion, the commitment of the several EU Commissions to Regional Policy has always been constant and financially supported, resulting in a considerable amount of money channelled to its respective programs. Considering the importance of areas such as research and innovation for our development, it becomes pertinent to ask: Is the money that Europeans spent in such programs achieving the expected results? How is it distributed among Member States? Are programs like these being well and properly designed in creating support for research, infrastructure and SMEs?

In the present work, we will make a macro analysis of the numbers related to the two main programs, FP7 and H2020. We will also try to analyse the proposed post- 2020 path that the new European Commission leaders have defined and planned.

Importance of Structural Funds and Public Investment

As stated earlier, the Regional Policy includes approximately 1/3 of the EU´s budget. In the 2014-2020 period the total amount allocated was around 355.1 billion euros. Since the 1970s the amount dedicated to this specific policy has been increasing.

There has been a large and growing interest in studying and analysing the policy´s contribution to economic growth and convergency(Pellegrini et al., 2013).

In fact, all literature combined, there is a variety and range of conclusions that go from a significant positive impact of Regional policy to the statistical insignificance or outright negative effects of such policy. De la Fuente & Vives, (2013) conclude that the accumulation of education and infrastructures in poorer regions reduces regional disparities since these 2 factors have an impact on productivity. Cappelen et al. (2003) also defend a positive impact of the Regional Policy in less developed regions. Their study suggests that "EU regional support through the structural funds has a significant and positive impact on the growth performance on European regions and, hence, contributes to greater equality in productivity and income in Europe" (page 24). (Beugelsdijk & Eijffinger, 2005) analyses the pre 2004 ten country addition, and state that Structural funds "may indeed have" positive results making the poorer countries more close to the "richer" countries (page 50). This indicates that the structural funds impact cannot be neglected. More interesting is (Mohl & Hagen, 2011) where the authors argue that, not only the Objective 1 Regions are the most benefited from the application of

Cohesion Funds, but also that the spill over effect, no matter the region nor the time lag analysed, has a robust effect on the growth as well.

Another interesting conclusion regarding the context for application of cohesion funds is the possibility of the existence of "Growth Clubs" in Europe (Fagerberg & Verspagen, 1996). The first notion of the so-called "growth clubs" was first applied regarding groups of countries divided in not centralized economies and centralized ones (Baumol, 1986). However, this concept, when applied in the EU context, was used to describe 3 different "growth clubs" (Fagerberg & Verspagen, 1996). Their conclusion was that the EU direct investment or direct action through funds was largely ineffective in the regions where unemployment was higher. Fagerberg & Verspagen (1996) also concluded that "growth and unemployment are strongly inversely related" (page 444).

However, regarding the issue of region type clusters in the EU Fagerberg & Verspagen (1996) aren´t alone. In fact, the measurement of local spatial autocorrelation in the distribution of per capita incomes by region showed that rich (or poor) regions tend to cluster themselves (Dall'erba, 2005). They demonstrate that spatial heterogeneity through rich (poor) clusters is a persistent and significant core-periphery pattern of EU regions.

Besides, other study affirms that since late 1980´s/ early 1990´s the convergence of different regions in the EU has slowed or stopped completely. In fact, they state that the cohesion policy and it´s funds haven´t had a positive impact on labour productivity[1], the most common metric used to evaluate such impacts (Boldrin & Canova, 2001). The same authors state that, if the objective of such EU policies is to "maximize aggregate economic growth" or even "to foster economic growth in the poorer regions and promote

[1] Labour productivity is in general defined as the total output produced in an economy divided by the total number of hours worked (Georghiou et al., 2017, page 3)

convergence" (Boldrin & Canova, 2001, page 35), the current policies cannot be supported by nowadays common economic knowledge or hard statistical evidence and, therefore, should be changed. Most important, the authors point to the fact that in Europe, even with a single market, capital "is moving around Europe" while "labour is most definitely not" (page 36).

Regarding the application of funds and its effectiveness it is also necessary to have in mind the spillover effect. This effect is important because it influences the reaction of neighbouring regions when shocks happen. In the more peripheral regions, the spillover effects are almost inexistent. This can be one of the causes, at a certain level, of the "backwardness" of such regions (Dall'erba & Le Gallo, 2008).

The principle of additionality, which is national funding should guarantee 25% of any project while the EU covers the rest, has been implemented in Regional and Cohesion Policy in order to prevent the presentation of unviable projects. However, this presents a bias since the middle or highly incomed regions have much more capacity to achieve this additionality principle and therefore can double or even triple the available funds (Martin, 1998).

The Cohesion Fund and the program where it is inserted are responsible for providing better infrastructure, invest in labour force or grant structural aid in general to firms (public and private). The aggregated effects of such investments point to positive substantial effects(Bradley et al., 1995). Using the HERMIN model the same authors concluded that such policies have "potentially important effects" (page 333) on GDP growth of the peripheral regions and respective countries' economies.

However, the use of not so sound empirical models to assess the contribution of the Structural Funds (specially the Cohesion Fund) in reducing regional disparities among EU regions derives from the lack of well-established methodology. The many

theories surrounding the issue have not yet provided relevant policy instruments, target variables and, to make everything worse, there is a lack of adequate regional statistical databases that could allow a better understanding and better models (Cancelo et al., 2009).

As explained above until now, the main importance of the Structural Funds is given to investment in major infrastructure and in productivity increase programs. However, the Structural Funds in the Cohesion Policy also focus in the Research and Innovation Programs. A big part of the Cohesion Policy focus in financing projects of all sectors that are crucial to address Europe´s technological, societal and environmental challenges. Since the European Union has several types of regions, each one with different cultures, backgrounds and development levels it has been widely considered that the European societies "face multiple, complex and urgent challenges" such as energy efficiency, security, climate change and Europe´s ageing population. The EU considers R&I (Research and Innovation) a fundamental tool in anticipate and help respond to these challenges (Georghiou et al., 2017, page 3).

The importance of R&I is attested in the fact that each successive EU commissions have specific papers attempting to assess the economic impact of the R&I programs. The ample empirical evidence, as demonstrated above, indicates that the Structural Funds give mixed results regarding their benefits.

However, most of the empirical evidence that presents not so positive results does not indicate they do harm, they merely suggest that the policies might be done in a wrong frame and/or should be changed. Regarding R&I, on the other hand, the empirical evidence "demonstrates that R&I is a key driver of productivity and economic growth"(Georghiou et al., 2017, page 3).

In fact, from 1995 to 2007, most of the economic growth in Europe was tech-driven deriving from R&I investment (Bravo-Biosca et al., 2013). In the period between 2000 and 2013, 15% of the productivity gains in Europe are due to R&I. The most interesting fact in these results is that it is possible to verify the existence of the so-called clusters that Dall'erba (2005) had already demonstrated. This clusters regarding the correlation between the R&I and the productivity gains are easy to detect. The western countries and the Nordics form the group were the R&I more accounts to productivity and the eastern bloc as well as the southerners are the group were R&I contributes the least for labour productivity increase (Georghiou et al., 2017).

Due to the context of the last decade, where the financial crisis has been a fundamental structural barrier in the economy, public R&I funding has taken an even more important role than before. Specially in the support of the market-creating innovations that Europe particularly lacks. The benefits of the R&I funded by the public are well documented. It is also know that the public R&I funding "creates new knowledge, methodologies" and enhanced skills that are crucial for the creation and diffusion of innovations that the private sector will then use to make Europe competitive (Georghiou et al., 2017).

Indeed, an increase in 10% in public R&D results in an 1.7% in Total Factor Productivity (Guellec et al., 2001)

The economic impact of FP7 program has been revealed to be a very good one. This program has been estimated to be responsible for the increase of 500 billion euros in the EU GDP for a period of 25 years, an increase of 130 000 research jobs in a period of 10 and 160 000 jobs in the general economy for 25 years as well (Georghiou et al., 2017). It goes without saying that these results can only be achieved through the existence of this broad financing programs that only derive from the public sector.

In the European reality, the investment in R&I have a very important side-line objective that normally is overlooked. The public funding of R&I leads to a faster absorption of new knowledge and to a wider diffusion and utilisation of the innovation that has been recently created. This aspect, although secondary for the main purpose of economic and productivity growth, is fundamental for the objective of achieving bigger cohesion inside the EU and its common market. In the current globalized world, it is important that the EU market can compete with bigger economic powers at the same speed and adaptability capacity. Diffusion of knowledge and innovation is important to achieve the cohesion that the EU so desperately needs to be a serious contender on the world stage.

Despite the good results R&I investment bring to the economy in general, the EU tends to have a lower benefit from such funds compared with other developed economies, namely the US. In fact, the EU (15 member states) have shown lower rate of return from R&I investment (Kokko et al., 2015).

However, most analysis do not assess the full impact of the R&I in the economy because a lot of the public R&D does not focus on obtaining direct economic return. From a policy perspective such should be considered. Since the benefits of R&I and R&D in the economy are considerably positive, the EU and its consecutive Commissions have been promoting a "more open, more collaborative, more inclusive, more interdisciplinary and more global" science and innovation (Georghiou et al., 2017, page 7).

Chapter I - EU Funding Programs - What they are and what do they tell us

7th Framework Program

FP7 – The basics

The 7th Framework Programme for Research and Technological Development, also known as FP7, lasted for 7 years since its beginning in 2007 until 2013. In this 7-year period, the program counted with an approximately 50 billion euros budget. This value has represented (at 2004 prices) an increase of 41%[2] compared to the previous program, the FP6.

The FP7 program intended to fund mostly grants to research actors across Europe (but not exclusively) in order to co-finance research, technological development and administration projects. The FP7 intends to implement Specific Programs (explained in detail latter). The Program started by issuing a group of calls for determined topics (called tenders) that were proposed by the Commission. By answering with a proposal to these calls, a consortium or entity, after an evaluation by the commission, would get, if approved, the respective funding. This has been the standard procedure for the EU research and innovation Programs.

[2] https://ec.europa.eu/research/fp7/understanding/fp7inbrief/what-is_en.html

The main reasoning behind programs as the FP7 is the addition of a "European added value" (European Commission et al., 2016, page 6) where the purpose is to add transnationality to the actions in order to facilitate the complement of national research programs. It's this transnationality that helps bring cohesion to the continent and, therefore, competitiveness. On the other hand, there are challenges so complex that can only indeed be addressed at the European level. However, there is cases where it´s possible that this "European added value" comes from advanced research where the main focus is raising competition at a fundamental "frontier".

The FP7 program came to substitute the FP6, a program of similar objectives and structures. The FP7, however, was bigger (much more money for funding), more comprehensive (regarding more topics and issues) and more flexible (with simplified procedures and criteriums).

The Commission indicates that the FP7 program was created to help developing research for the global knowledge-based economy and had 2 main strategic objectives[3]:

- "to strengthen the scientific and technological base of European industry";
- "To encourage its international competitiveness, while promoting research that supports EU policies."

One of the interesting parts of these programs (FP7 and all the ones before it) is that they intend to propel the EU in areas such as research and innovation having always in mind the promotion of cohesion. In order to achieve that, the Commission admits that the EU itself should collaborate with other countries from all over the world in order to progress. That's why every single entity from all around the world can apply for FP7 having always in mind that "the procedures for participation and funding possibilities

[3] https://ec.europa.eu/research/fp7/understanding/fp7inbrief/what-is_en.html

vary for different groups of countries"[4]. The EU member states, and countries associated with FP7 (countries that also participate in the funding of such program) are those with broadest rights and access to funding.

There is also the International Cooperation Partner Countries which operate under the same rules and conditions as all the EU member states. Their only issue is that the consortium where they are included must have a minimum number of EU members and/or associated countries in it.

The "third countries" cooperation is encouraged by the commission, under 2 key objectives:

1. Initiatives that encourage the best third-country scientific and academia to work with European peers or even come to Europe to work in order to benefit European competitiveness in selected fields;
2. To tackle very specific issues that have a global reach or when third countries are important players, either because they are the ones closer to the issue or the ones most affected by it;

In short, the EU Commission divides those who can participate in:

- No barriers to funding or applicability to the program:
    - EU member states;
    - Associated countries;
- No barriers to funding but conditions regarding applicability:
    - International Cooperation Partner Countries
- Barriers to funding and to applicability:
    - Third countries

[4] https://ec.europa.eu/research/fp7/understanding/fp7inbrief/what-is_en.html

- High-income industrialized countries

In these types of programs, there aren´t restrictions regarding the type of entities that can apply for funding, regardless of the country they are applying from. According to the European Commission Research & Innovation website (European Commission et al., 2016) the organizations and individuals that could apply for FP7 were:

- research groups at universities or research institutes;
- companies intending to innovate;
- small or medium-sized enterprises (SMEs);
- SME associations or groupings;
- public or governmental administration (local, regional or national);
- early-stage researchers (postgraduate students);
- experienced researchers;
- institutions running research infrastructures of trans-national interest;
- organizations and researchers from third countries;
- international organizations;
- civil society organizations;

The FP7 program intended to achieve such objectives by focusing on collaborative research, coordinating national or European consortiums, setting up research networks and increasing the mobility of individual researchers. In this way, the FP7 hoped to bring cohesion to the European research landscape because, since the creation of the EU, that this vital economic sector has been divided, individualistic and naturally non cooperative between Member States.

The FP7 Program, as designed by the commission, has been divided in 5 major Specific Programs (European Commission et al., 2016).

1. Cooperation

a. The core of the FP7 program, to where two thirds of the overall budget had been programmed to go, is the Cooperation specific program. The main objective of this program is to speed, foment and spread research across Europe, with the involvement of partner countries, through projects by transnational consortium of all types of entities, from industry to academia. This program will focus in key thematic areas:
    i. Health;
    ii. Food, agriculture and fisheries, and biotechnology;
    iii. Information and communication technologies;
    iv. Nano-sciences, nanotechnologies, materials and new production technologies;
    v. Energy;
    vi. Environment (including climate change);
    vii. Transport (including aeronautics);
    viii. Socio-economic sciences and the humanities;
    ix. Space;
    x. Security;

2. Ideas

a. This program intends to support "frontier research". This means funding scientific excellence with the sole purpose of breaking barriers, inventing new technologies, products and services in order to help transforming the European economy and making it more competitive. Unlike the Cooperation program, this one does not require cross-border/international partnerships since projects can be implemented by "individual teams"

around a "principal investigator". This Specific Program was implemented through the European Research Council (ERC) which was created for this effect.

3. People

    a. The People Program is about investing in one of the biggest focus of the European Union – people. This means, supporting and funding researcher mobility and career development, in the EU and abroad. For this effect, the FP7 has the Marie Curie actions with the purpose of providing fellowships and funding for:
        i. Initial training of researchers - Marie Curie Networks;
        ii. Industry-academia partnerships;
        iii. Co-funding of regional, national and international mobility programmes;
        iv. Intra-European fellowships;
        v. International dimension - outgoing and incoming fellowships, international cooperation scheme, reintegration grants;
        vi. Marie Curie Awards;

4. Capacities

    a. The Capacities program focus on improving the capacitation of research. This is, improving the conditions in which researchers work by strengthening research capacities though funding of:
        i. Research infrastructures;
        ii. Research for the benefit of SMEs;

iii. Regions of Knowledge;
iv. Research Potential;
v. Science in Society;
vi. Specific activities of international cooperation;

5. Nuclear Research

a. This program aims to fund research, technological development, international cooperation, dissemination of technical information, and exploitation activities, as well as training for nuclear related research. The FP7 comprised 2 specific programs for this topic:

i. the first program includes: fusion energy research (in particular ITER), and nuclear fission and radiation protection;
ii. the second program covers the activities of the Joint Research Centre (JRC) in the field of nuclear energy, including nuclear waste management, and environmental impact, nuclear safety, and nuclear security. In addition to direct actions in the nuclear field, the JRC carries out research in a number of other areas to provide scientific and technological support to EU policy making

The FP7 predicted budget was 50.521 billion euros (at 2007 prices) (European Commission et al., 2016). That budget was divided as follows:

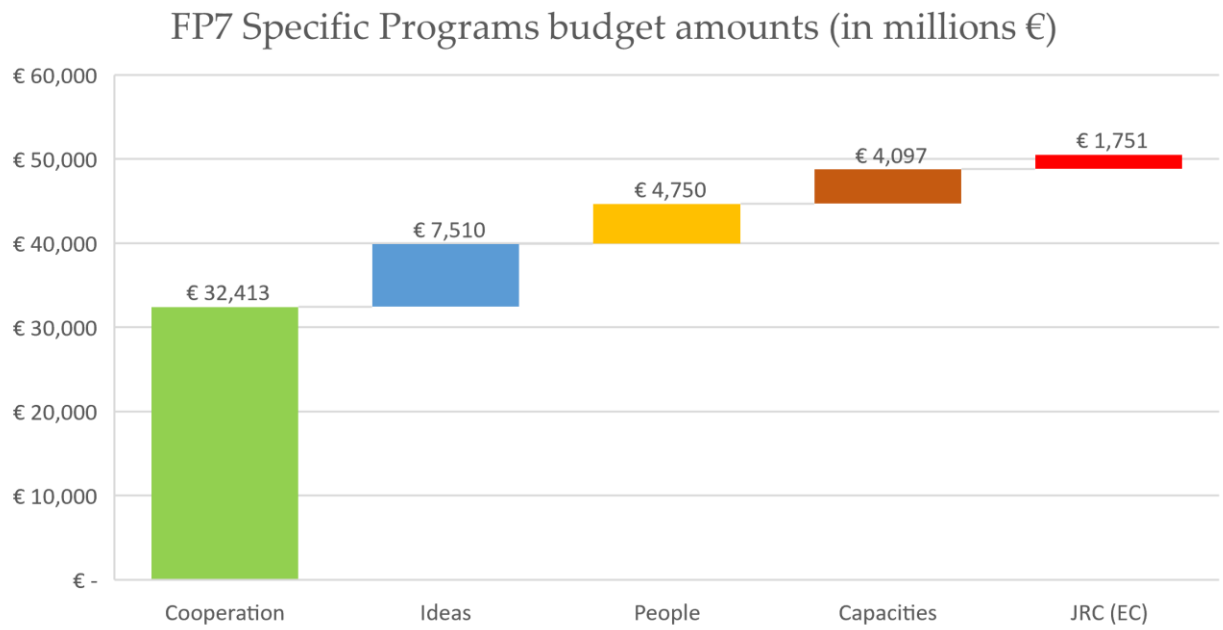


Figure 1 - FP7 Specific Programs budget amounts (in million €) – others calculation;

Source: (European Commission et al., 2016)

The FP7 Program, in order to be implemented, funds certain types of projects that pursue the achievement of the 5 Specific Programs (mentioned above). Those types of projects are defined as "Funding Schemes" (European Commission et al., 2016, page 20). The EU Commission does not acquire or outsources research services by signing contracts. FP7 works on the basic principle of co-financing. The way it works is that the Commission, in order to promote research, co-finances a certain percentage of the projects through grants.

The maximum amount of fund that projects can acquire, through reimbursement rates to the costs of the projects, depend on the Funding Scheme by which the project was approved, the legal status of the participants and the type of activity the project plays. According to European Commission et al., (2016), page 22, the "standard reimbursement rate for research and technological development activities is 50%. Certain legal entities can receive up to 75% (non-profit public bodies, SMEs, research organisations, higher education establishments). For demonstration activities, the reimbursement rate may

reach 50%. For other activities (consortium management, networking, training, coordination, dissemination etc.), the reimbursement can be up to 100% of the eligible costs. The 100% rate applies also to frontier research actions under the European Research Council."(European Commission et al., 2016). For more information on the 6 Funding Schemes see Appendix 1.

The FP7 program, in order to distribute the funding once a grant for a project was approved, used the Person-month system (European Commission, 2019c)[5]. The European Commission determines that the method for funding distribution requires an accurate calculation "human effort"[6]. The estimated human effort can be calculated "as follows **(indicative method)**: if 1 year = 220 (working) days, then 1 month = 220/12 = 18.33 (working) days. So, 24 full working days for one person would be 24/18.33 = 1.31 person-months."[7] The system calculates the human effort by multiplying "the proportion" of an entity employee "effort associated with the project by the number of months of the appointment."[8]

In order to better visualize the 5 pillars and respective project types associated to those pillars it's possible to verify the following image that depicts very basically the FP7 Specific Programs (European Commission et al., 2016) and the respective project types for each one of them:

[5] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967
[6] "Idem"
[7] "Idem"
[8] "Idem"

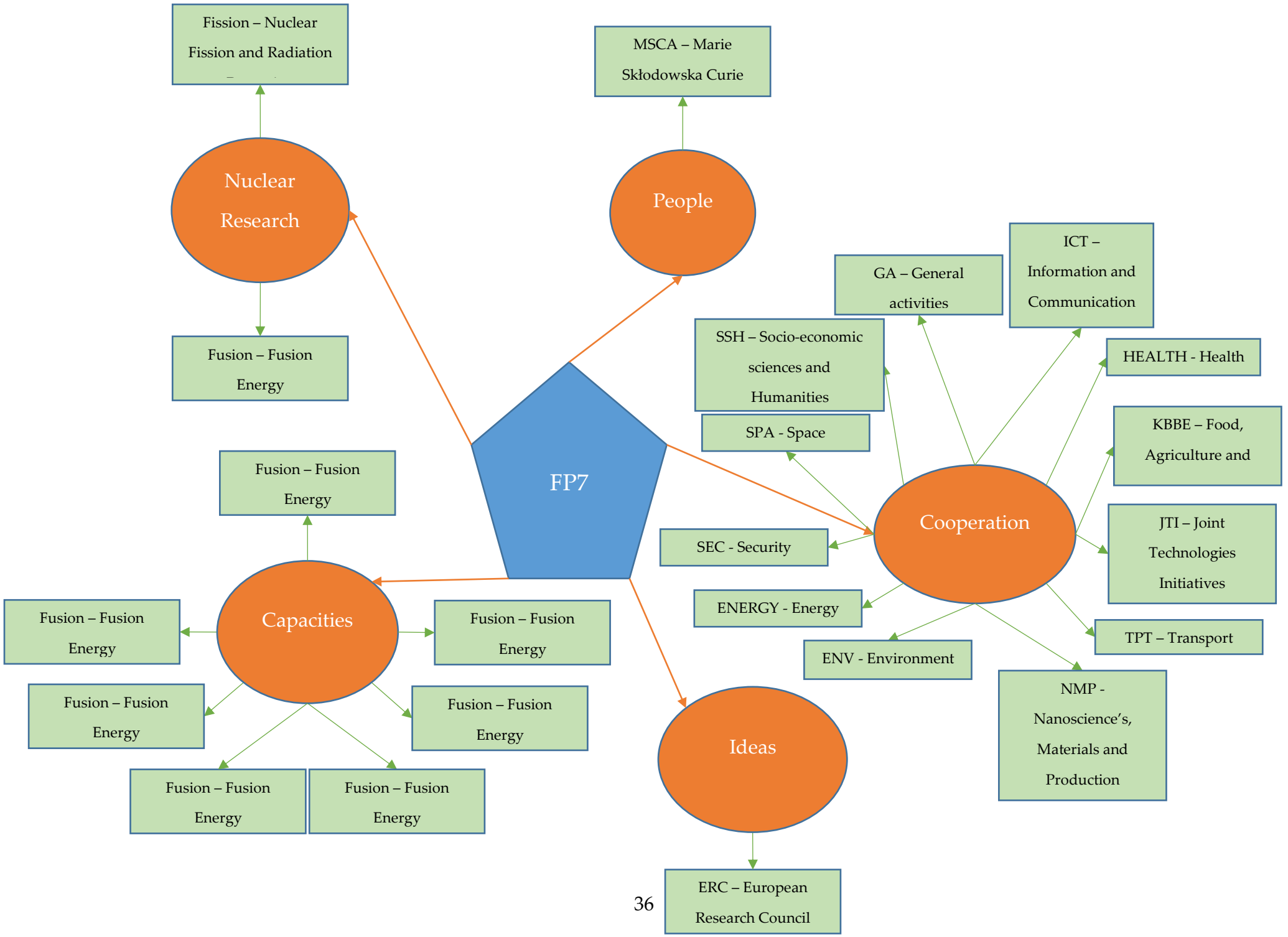


Figure 2 - FP7 Specific Programs and respective project types scheme – others calculation

FP7 – A statistical analysis

General View

First, it is interesting to notice that for the 50.521€ billions that were promised for the FP7 program, according to the FP7 dashboard (European Commission, 2020d)[9], only 45.5€ billions (90.06%) were actually granted for the implementation of the Program.

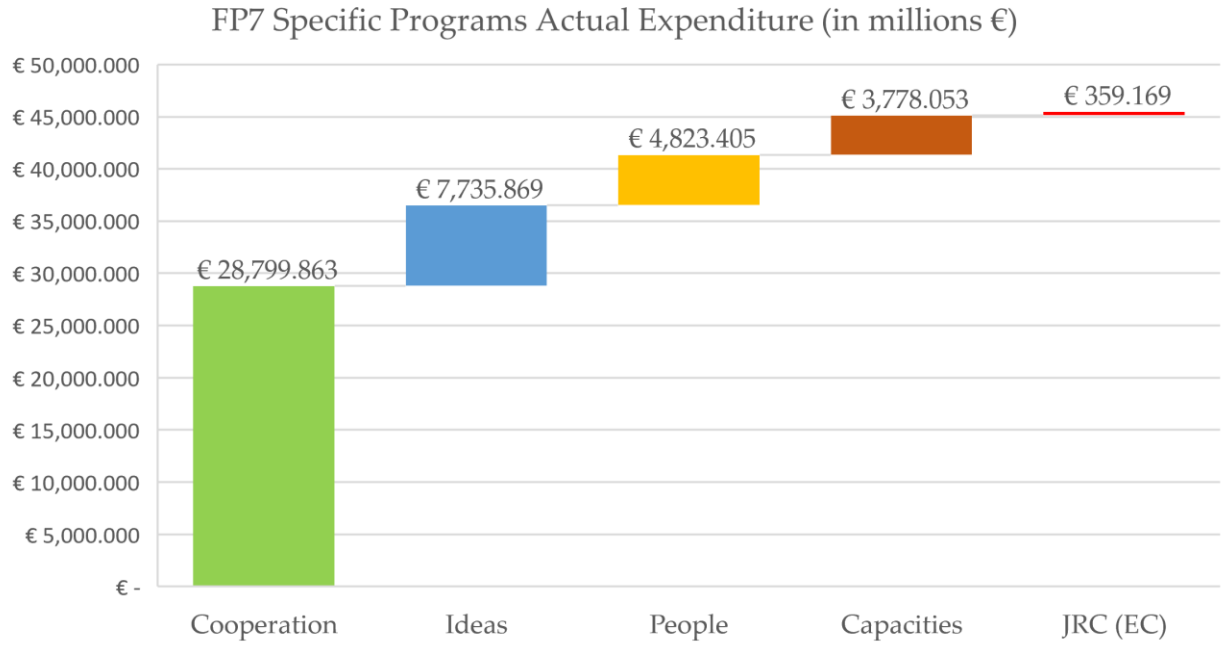


Figure 3 - FP7 Specific Programs actual Expenditure;

Source: https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1/sheet/076eedee-e14d-4554-a8a0-5545d89da416/state/0 – others calculation

As it is possible to verify, the amount of money granted didn´t corresponded to the European Commission expectations. The only positive differences were registered regarding the amount of money that went to projects under the Ideas and People Specific Programs while the other 3 Specific Programs didn´t reach the granting objectives. For more detailed information see Appendix 2.

[9] https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1/sheet/076eedee-e14d-4554-a8a0-5545d89da416/state/analysis

According to our personal experience, if the H2020 evaluation criteria are the same as the FP7 that preceded it, the justification can lay in 2 key factors:

The fact that for each call, the European Commission stipulates a minimum number of proposals that must be approved;

The fact that the evaluation of each proposal depends on the subjectivity of the evaluator. This means that the same exact proposal could receive different grades depending on the evaluator's subjectivity.

If the issue lays in factor number 1, it means that the proposals that were accepted weren´t as dynamic nor ambitious as the European Commission would hope for. This could explain the fact that lots of proposals were accepted due to the obligatory number (making the proposals success rate to be higher than the average) while, for being simplistic or less ambitious than predicted, (or preferable), the amount of budget that was required wasn´t as much as the Commission had intended leading to a higher unused budget amount. For a better understanding see Appendix 3

If the issue lays in factor number 2, it means that the subjectivity of the evaluators might had a bigger effect than expected and created an outlier situation were the proposal success rate is bigger than the average while the budget of the approved proposals are far away from the commission expectations.

The main issue, however, requires more analysis since the existence of such discrepancies in the existing data opens certain questions regarding the effectiveness of the existing measures in what concerns the evaluation and the criteria for the acceptance of proposals.

Regarding the remaining FP7 Specific Programs, the clear importance given to the Cooperation was visibly well received by the research community and economic sector that deals with such areas although, not has much as the European Commission was

expecting as it is possible to observe on table 1. For more detailed information regarding signed grants per Specific Program see Appendix 4

Table 1 - Correlation between the Total Number of Signed Grants and Total EU Contribution to each Specific Program;

Source:https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1/sheet/076eedee-e14d-4554-a8a0-5545d89da416/state/0 – others calculation

Specific Program	Signed Grants	EU Contribution (in millions)
People	11,129	€ 4,823.405
Cooperation	7,934	€ 28,799.863
Ideas	4,563	€ 7,735.869
Capacities	2,036	€ 3,778.053
JRC (EC)	140	€ 359.169
Correlation metric	0.450292062	
Average funding per signed grant (in millions)		
People	€ 0.43	
Cooperation	€ 3.63	
Ideas	€ 1.70	
Capacities	€ 1.86	
JRC (EC)	€ 2.57	

According to the 7th FP7 Monitoring Report, for the Cooperation Specific Program, until the end of June of 2014, there was a total of 40 158 submitted proposals. This means that the acceptance rate for this specific program was 19.42%[10].

Table 2 - Proposals Acceptance rate (based on June 2014 Numbers) for each Specific Program – others calculation

Specific Program	Total amount of	Total Amount of Proposals as of June 2014	Total amount of accepted proposals as of June 2014	Proposal acceptance rate (based on June

[10] The difference in the numbers regarding the amount of proposals submitted on June 2014 and the end of the program in 2015 is, in total 281 proposals. according to the FP7 dashboard. This amount is not being considered for the calculation of any proposal acceptance rate has shown in table nº2

	Signed Grants			2014 Numbers)
People	11,129	49639	11068	22.30%
Cooperation	7,934	40158	7798	19.42%
Ideas	4,563	35335	4473	12.66%
Capacities	2,036	10296	2020	19.62%
JRC (EC)	140	288	139	48.26%

The first important thing to observe is that the amount of proposals is positive to the point where there is margin for analysis and handling for future programs. The positive aspect of this observation is that it clearly means that there isn´t a lack of interested entities in participating in the program. In fact, the total amount of requested funds for all the submitted proposals for the Cooperation Specific Program was 132 974€ million (European Commission, 2010). This value is almost equivalent to 4 times more than the available budget for Cooperation Program and almost 2.5 times more than the overall FP7 budget. Again, the only conclusion it can be made is that the reason for this Specific Program to not hit the target budget is in the typology of proposals and the evaluation metrics.

Just like with the Nuclear Research Specific Program, the justification can lay in 2 key factors:

The fact that the European Commission stipulates a maximum number of calls that can be accepted;

The fact that the evaluation is subjected to the evaluator's subjectivity;

Despite being under the predicted budget by around 3.6€ billion, which represents 11% of the available budget, the difference is significant. If we take into account that for

this Specific Program the average funding per signed grant was 3.63€ million, it gives us around 992 proposals that could had become projects and weren´t. Putting all this data together we were able to verify that even with a significant percentage of budget left, an high attendance and high average granted funding per proposal, this Program could not reach its available budget. Assuming that the amount of maximum vacancies for accepted proposals are projected to not create an 11% gap between available budget and effective granted budget, we are left with a solid conclusion that the Cooperation Specific program results were highly influenced by the subjectivity of European Commission evaluators.

The same case can be made for all the other pillars, either the ones that didn´t reach their budget target and the others that passed it. For such detailed analysis and more information see Appendix 5.

Table 3 - Proposal Acceptance Rate and Percentage of Deviation Between Predicted Budget and Effective Budget;

Source *https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1/sheet/076eedee-e14d-4554-a8a0-5545d89da416/state/0* *– others calculation*

Specific Program	Proposal acceptance rate (based on June 2014 Numbers)	Initial predicted Budget (in millions €)	Granted effective funding (in millions €)	Percentage of deviation between predicted Budget and effective Budget	Average funding per signed grant (in millions €)
People	22.30%	4,750.00	4,823.405	1.55%	0.433
Cooperation	19.42%	32,413.00	28,799.863	-11.15%	3.630
Ideas	12.66%	7,510.00	7,735.869	3.01%	1.695
Capacities	19.62%	4,097.00	3,778.053	-7.78%	1.856
JRC (EC)	48.26%	1,751.00	359.169	-79.49%	2.565

As it is clear in Table 3, two major things can be noticed and be taken as indicative of miscalculation on the European Commission's part regarding the formulation of the program and the attribution of budgets for each Specific Program. Assuming that no proposal was rejected for lack of funding and the only reason for not being accepted are the criteria defined by the European Commission, we can automatically see that the Cooperation Specific program was overappreciated and that the Ideas Specific Program was underappreciated. Due to their core objectives, these pillars were very different. The Ideas had the lowest proposal acceptance rate of them all because it was about frontier research and, reasonably, had much more tighter requirements for a proposal to be accepted. However, even with the lowest acceptance rate, it surpassed the predicted budget by 3.01% while its average funding for proposal was less than half of the Cooperation Specific Program. On the other hand, the Cooperation, that focus more on the dissemination and application of knowledge, had a relatively standard proposal acceptance rate with almost 1 in every 5 proposals being accepted and with an average funding per signed grant way bigger than the rest, still wasn´t able to reach their target budget by 11.15%. Removing the JRC due to the fact of being an outlier, the Cooperation program was clearly overappreciated. This means that the rules of acceptance of all the Specific Programs, except JRC, should be reviewed as well as their respective budgets. The Ideas Specific Program, or its main purpose, should in the future be given more importance while the Cooperation Specific Program, or its main purpose, should in the future not be given such relevance.

However, this compasses another important note. The main purpose of these programs was the improvement of the research and innovation wellbeing inside the Union and an increase of the cohesion between Member States. Regarding the first point, the fact that the Ideas Specific Program had, by all indicators, success regarding the demand it is very promising for the European Commission since their objective of

creating an economy based on high value added products and services can only be achieved by frontier research. In the demand for increased cohesion between Member States, the Cooperation specific program would be an important tool in reducing the disparities in research and innovation inside the Union. That program revealed to not have the success the European Commission hoped for.

A detailed analysis was made to provide more context regarding the FP7 and can be seen in Appendix 6. Only brief but very important points on the Ideas and People Specific Programs follow since they will be important in order to compare the H2020 and the FP7 performances.

Regarding the EU total budget, it is computed annually while the percentage value we observe in the previous map is the value of the total funding obtained across a period between 2007 and 2015. Therefore, for a reliable comparison we decided to use the following formula:

$$\frac{\sum Member\ State\ contributions\ for\ the\ period\ 2007-2015}{\sum All\ Member\ States\ contributions\ for\ the\ period\ 2007-2015}$$

The only assumption we made is that no contribution requires financial actualization since each year contribution by the Capacities Specific Program has not received any financial actualization as well. This means that every year a single country received Capacities funding it was contributing to the EU budget with a certain amount at the same time therefore there is an equalization. For this calculation we only used the Member States direct contributions to the EU. The EU has its own revenue sources that are collected all around the EU, however, to give us a clearer number regarding the direct budgetary effort made by each Member State we decided to use only the direct contributions.

Applying this formula to the available information in the European Commission website regarding the EU budget[11], we were able to present the following map.

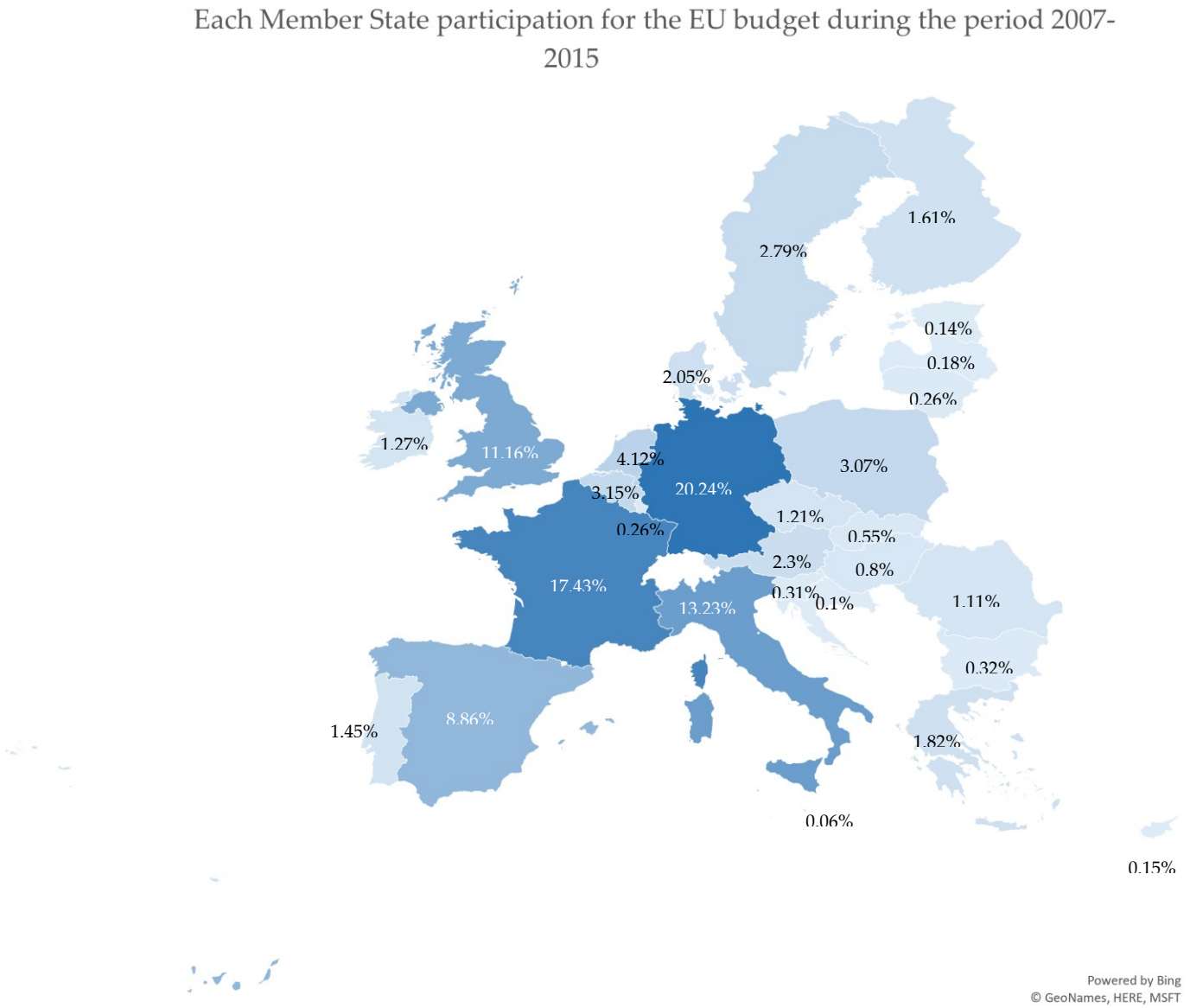


Figure 4 - Each Member State participation for the EU budget during the period 2007-2015;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

[11] https://ec.europa.eu/budget/graphs/revenue_expediture.html

Ideas Specific Program

The Ideas Specific program is the FP7 program in charge of funding high quality/break through research. These types of programs require, as we´ve seen earlier, tighter approval standards which can lead to a smaller amount of approved proposals. However, it is good to remind that this Specific Program was one of those who was able to get more funding than what the European Commission expected to. The fact is that the percentage of participations outside the top 5 economies plus the Netherlands is 18.93%.

This is a very specific program with a much more specific and narrower objective than the others. More detailed information in Appendix 7.

Table 4 - Ideas Specific Program Participations and EU Granted Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	Number of participants	Participations	Participations rate per participant	Ideas Specific program granted funding (€ in millions)	Ideas Specific program granted funding (%)
AT	26	139	5.35	187.116	2.83%
BE	16	182	11.38	249.501	3.77%
BG	3	4	1.33	3.160	0.05%
CY	4	12	3.00	13.660	0.21%
CZ	10	16	1.60	16.325	0.25%
DE	129	841	6.52	1,149.472	17.36%

DK	13	100	7.69	148.050	2.24%
EE	3	6	2.00	5.150	0.08%
ES	79	316	4.00	40.756	6.14%
FI	10	79	7.90	112.790	1.70%
FR	84	698	8.31	979.483	14.79%
GR	15	42	2.80	55.630	0.84%
HR	3	3	1.00	3.780	0.06%
HU	18	46	2.56	58.575	0.88%
IE	10	50	5.00	55.856	0.84%
IT	82	384	4.68	405.958	6.13%
LU	1	1	1.00	1.010	0.02%
LV	1	1	1.00	1.361	0.02%
MT	3	3	1.00	0.474	0.01%
NL	29	504	17.38	694.255	10.48%
PL	12	23	1.92	20.788	0.31%
PT	21	50	2.38	55.932	0.84%
RO	1	1	1.00	367	0.01%
SE	16	189	11.81	280.083	4.23%
SI	3	4	1.33	2.143	0.03%

SK	1	1	1.00	1.156	0.02%
UK	91	1334	14.66	1,713.491	25.87%

Regarding this Specific Program it is possible that the amount of funding received varies in such a degree that it would be unfair to make a variable based on such metric. Not only we already know that the FP7 funding is given based on a Person-month[12] system and, therefore, bigger economies end up claiming more funding in the same project than the others due to their more expensive cost of living[13], which, in turn, influences the wages[14] to which the Person-month[15] system is directly linked. In this case the discrepancies among granted funding can also be explained by the singularity of each project that gets approved meaning that for the same call not all the approved projects will have the same requested funding, entities, objectives or participants. For example, Romania, Luxembourg, Slovakia and Latvia have different costs of living[16]. We do know that out of these 4 Luxembourg has a much higher cost of living[17] and that Romania doesn´t use euro having a weaker currency. Therefore, Romania´s ability to request funding based on a stronger currency will bring their granted funding down. That could explain why with only 1 participation each, Luxembourg obtained almost 3 times the funding. The key factor is that Slovakia and Latvia, also with 1 participation only and a

[12] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967
[13] https://ec.europa.eu/eurostat/statistics-explained/index.php/Comparative_price_levels_of_consumer_goods_and_services
[14] https://www.eurofound.europa.eu/data/statutory-minimum-wages
[15] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967
[16] https://ec.europa.eu/eurostat/statistics-explained/index.php/Comparative_price_levels_of_consumer_goods_and_services
[17] https://ec.europa.eu/eurostat/statistics-explained/index.php/Comparative_price_levels_of_consumer_goods_and_services

lower cost of living than Luxembourg, obtained a bigger amount of funding than Luxembourg.

The best examples for such fact is that the Nordic and some central countries, can retrieve a substantially bigger sum per participant than some of the big countries. For example, Sweden, Belgium, Denmark and Finland can all retrieve similar amounts per participant as France or even bigger amounts when compared to Germany.

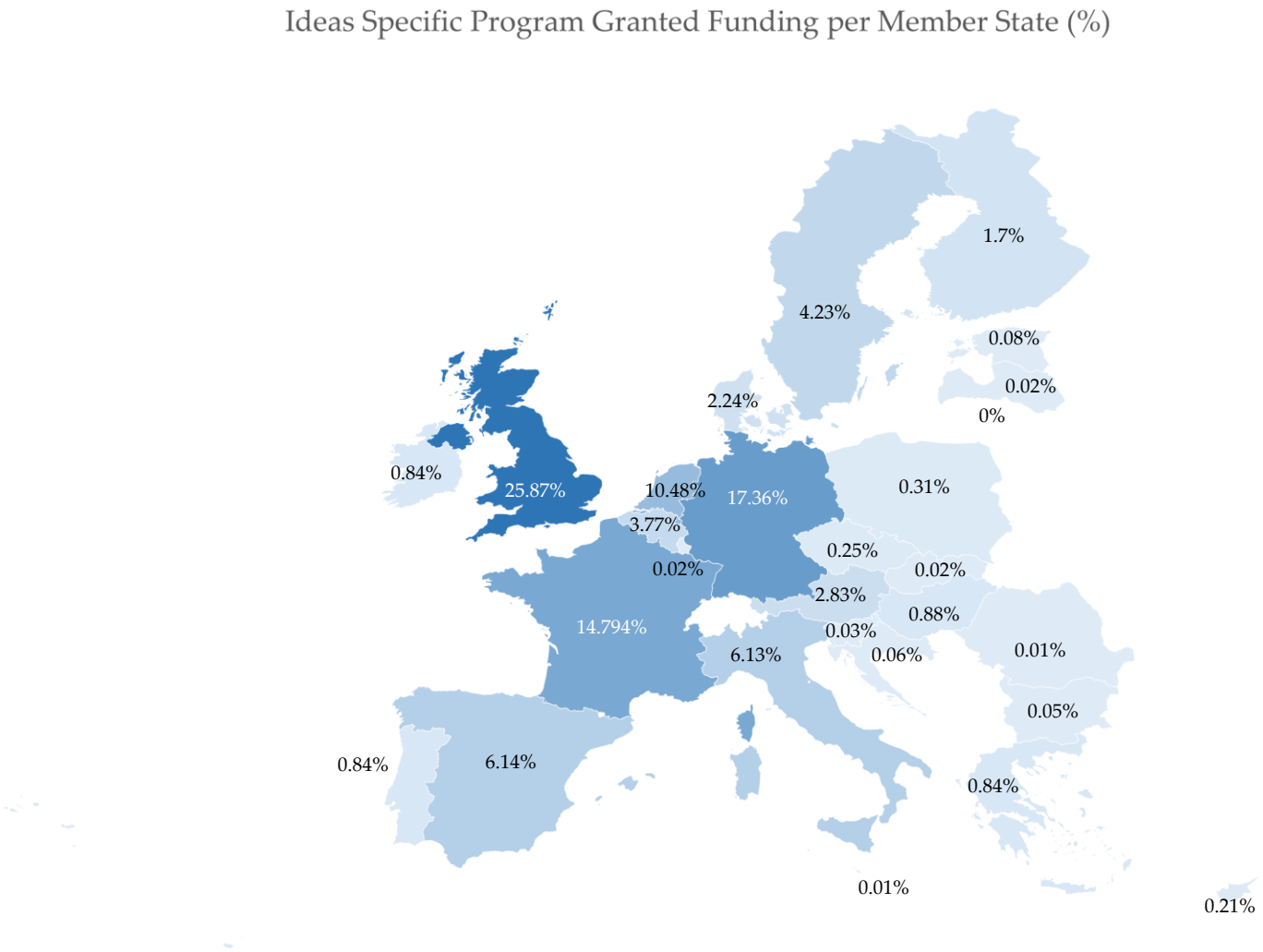


Figure 5 - Ideas Specific Program Granted Funding per member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

These countries have a cost of living[18] that can be compared to the German or the French one. Once again, there is an outstanding position performed by the UK. Being one of the biggest receivers of this Specific Program and exceeding, again, the percentage of direct participation to the EU budget in comparison to the percentage of funding received from this program. Although it was something, we could observe regarding the two previous Specific Programs, in this one the dichotomy centres of knowledge-periphery are greater than ever.

The major conclusion we can retrieve is that Europe is far from the possibility of having cohesion in an economy based on knowledge across the Union. The disparities in economic potential will most probably be exacerbated if no measure is taken.

People Specific Program

The People Specific Program of the FP7, has the name indicates, focus on funding projects that elevates the researcher's personal capacity and knowledge. This Specific Program mainly focus on increasing the EU human capital. As most of the economic theory defends, the existence of a highly trained, highly skilled human capital is beneficial to every economic aspect at both Micro and Macro level. The investment predicted by the European Commission when drafting available budget for the People Specific Program was under the effective needs of the market. That is a good sign since it is good to know that the EU Member States have researchers looking for programs dedicated to their enhancement.

Since this Specific Program is focused on enhancing researchers, the metric of participants regarding this pillar indicates the amount of entities that have researchers capable or that procure to participate in projects that require People Specific Program

[18] https://ec.europa.eu/eurostat/statistics-explained/index.php/Comparative_price_levels_of_consumer_goods_and_services

funding. Although, the number of interested entities in participating indicates relatively well how strong the research and innovation sector is in that Member States economy.

Table 5 - People Specific Program participants and average funding per participation;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	People Specific Program Participants	People Specific Program Participations	EU Contribution (€ in millions)	Average funding per participation (€)
AT	112	456	119.605	262,291.60
BE	114	632	187.098	296,040.65
BG	42	102	5.715	56,032.81
CY	18	77	13.023	169,131.50
CZ	65	197	29.769	151,108.90
DE	466	2195	569.917	259,643.18
DK	68	450	154.978	344,396.05
EE	21	67	10.305	153,797.80
GR	71	462	89.363	193,425.31
ES	298	1714	396.562	231,366.28
FI	60	251	51.385	204,722.12
FR	301	1997	460.859	230,775.73
HR	27	48	9.358	194,947.72
HU	55	291	32.428	111,437.87
IE	62	375	114.531	305,415.68
IT	310	1405	289.695	206,188.91
LT	19	67	4.593	68,556.80
LU	7	26	11.298	434,548.71
LV	18	88	2.866	32,570.25
MT	10	26	1.304	50,170.76
NL	149	1170	315.134	269,345.72
PL	115	367	45.095	122,873.95
PT	94	394	60.819	154,363.72
RO	48	95	9.408	99,026.97
SE	103	613	183.295	299,012.52
SI	28	92	14.662	159,374.40
SK	31	70	11.308	161,542.67

UK	359	4149	1,10.,604	265,510.67
EU	3071	17876	4,295.977	240,320.94

The average per participation having into account only EU Member States was €240,320. Once the People Specific Program focus on researcher's empowerment, the budget per participation on improving the EU human capital seems low.

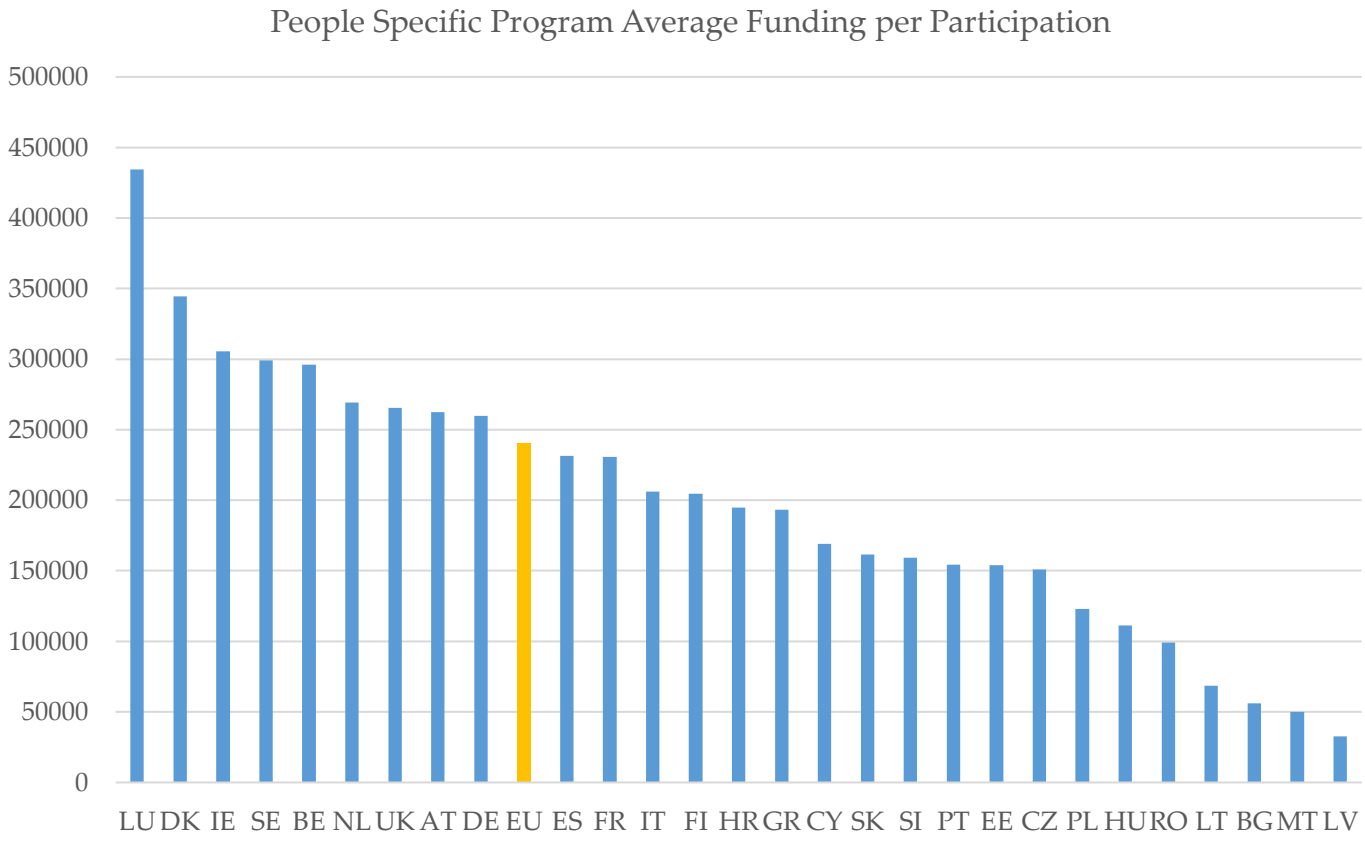


Figure 6 - People Specific Program Average Funding per Participation;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

This metric exemplifies the differences in the research field between European countries. It is extremely hard to create a knowledge-based economy when only a few Member States value researchers and their work. Although there are a few wealthy nations below the EU average, they aren´t as far away from it as the rest of the countries. The southern and the eastern countries claim a very small fraction of what the wealthier

nations claim per participation. Regarding the Peoples Specific Program, the differences, not only signal a huge difference between standard of living in most countries but it also indicates that the results and the impact of research in those countries aren´t has big has they should. The EU should try to increase the value and the dimension of the research sector in those countries. What this metric demonstrates is the potential flow of highly educated people from the periphery to the centre and the EU should adopt policies that could level the field

Global Balance of the FP7 Program

The FP7 program, as we analysed, presented several issues concerning the method of distribution of funds and the results of such method. It was possible to visualize where the research and economic capital in the EU lays. The concentration of the research and innovation potential has been an essential tool for the increased disparities between the peripheric Member States, composed by the eastern and southerner Member States and the central and more developed ones composed by the top 3 economies, the Nordic countries, Benelux and Austria. While the major economies in the EU are net negative in general budgetary terms, regarding the FP7 Program which is responsible for funding and promoting research and innovation across the Union, some of those same economies are having net negative percentual differences regarding all aspects of the FP7. The UK has a clear spot in the research European sector. Other countries such as France, Germany and Italy also have clear importance since they receive a lot of the funding although they have negative percentual differences when compared to their direct contribution to the EU budget. The major issue lays in the peripheric countries. The eastern economies, Portugal and Malta demonstrate to have net negative balances between their received funding from the FP7 Specific Programs and their direct contribution to the EU budget. All these countries have very small direct contributions to the EU budget with most of them not reaching the mark of 1%. If the European Commission intends to create a

knowledge-based economy for the future, it cannot neglect all these countries. They are the countries that provide secondary services and products to supply highly developed economies of the centre. If their capacity for retain and produce high quality research and innovation is not improved it will be very hard for them to level the technological field with the other Union Members. It is important to say that the only exception in the previous group of countries that were mentioned was Estonia. This country has been able to enjoy the success and the influence of its most developed neighbour Finland and the UK since Estonian researchers tend to travel to those countries in order to "receive" knowledge (Christensen, Thomas Alslev Freireich et al., 2012, page 54). Together with more open policies towards new business models they were able to create in their capital a small hub capable of capture much more funding in comparison to its neighbours and to its direct participation to the EU budget. Croatia only entered in the Union in 2013/4 and, therefore, presents better numbers compared to its most similar Member States so it might not be the best country for analysis due to its singularity. Its singularity resides in the fact that they have been receiving EU funding as a third party of the Union while not contributing to the EU budget making their numbers an exception to the rule.

Regarding the SMEs and the FP7 support to this important sector of the economy, it was not very high or, at least, not has high at it would be expected.

Table 6 - SME Participants, Participations and EU Granted Funding under FP7;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	SME Participants	SME Participations	SME EU Contribution (€ in millions)	Average EU funding per participant (€)	Average EU contribution per SME participation (€)
AT	349	777	206.008	511,185.66	265,132.33
BE	492	1256	350.370	620,124.19	278,957.14
BG	91	152	27.363	288,028.84	180,018.03

CY	71	147	30.583	355,611.86	208,045.03
CZ	180	320	57.011	287,934.84	178,159.68
DE	1834	3379	944.691	465,594.39	279,577.10
DK	311	496	169.041	495,720.19	340,807.63
EE	91	159	33.358	323,861.39	209,797.00
EL	331	772	161.366	422,423.79	209,023.17
ES	1408	2675	595.708	385,073.05	222,694.58
FI	249	400	95.894	352,550.01	239,734.01
FR	1136	2250	615.953	495,936.36	273,756.87
HR	38	84	17.135	407,964.64	203,982.32
HU	187	417	81.251	381,461.31	194,847.15
IE	271	492	132.954	435,913.69	270,231.05
IT	1295	2421	569.293	396,996.31	235,147.75
LT	64	90	17.084	251,241.73	189,827.08
LU	23	57	11.075	395,531.41	194,296.13
LV	30	47	5.977	181,133.07	127,178.54
MT	20	50	8.056	350,260.44	161,119.80
NL	810	1489	415.485	458,087.27	279,036.37
PL	217	348	63.434	268,788.63	182,281.95
PT	253	581	135.455	453,026.37	233,140.94
RO	126	230	33.256	234,193.74	144,589.18
SE	434	667	218.934	474,911.29	328,237.04
SI	113	214	42.160	337,276.51	197,007.31
SK	65	94	20.207	288,676.53	214,971.88
UK	1711	3041	899.579	475,716.22	295,816.96
EU	12200	23105	5,958.679	440,079.70	257,895.66

For the entire period of the FP7 Program, there was a total of 12,200 SME´s participating. The participation of this entities is very important since most of the economic tissue of the European Economies are constituted by SME´s. That importance is bigger in most peripheric economies of the EU. In the southern and eastern countries, small and medium enterprises compose almost the totality of all the businesses operating in the country. The amount of SME participations in the total of participations in the FP7

program (122186), as of March 2020, was 19%[19] while receiving 14.68% of the FP7 granted funding. Almost 1 in 5. That is a very positive mark for the FP7 program. It is known that SME´s, due to their size and structure cannot normally compete with the bigger ones and often have barriers that make their participation in this funding programs harder. However, having 1/5 of participations in the FP7 coming from SME´s it is a very interesting and promising result. The percentual funding amount they obtained, however, is not has big compared to the percentage total of participations they represent. Their total obtained funding, €5.974 billion, is only 14.68% of the total funding granted by the FP7. This drop can be explained by the fact that some the economies most dependent on SME´s are the ones that currently have, precisely, a lower cost of living (Schmiemann, 2008, page 4). That fact can help to ensure that the number of participations in comparison with the total amount will be bigger than the number of funding obtained relative towards the amount of funding granted in the total. Regarding the research and innovation economic sector, it is possible to see that even the biggest economies have high level of SME´s participations in the FP7 Program.

However, one of the most interesting data we found was that, although the SME´s comprised 19% of the participations in the FP7 Program, they represented 48.5% of the participant entities. The gap between 48.5% and 19% while receiving only 14.68% of the funding can only be explained by their size and their ability to be a part of more than one participation. According to the FP7 dashboard, without the JRC, 12200 SME´s made 23105 participations meaning that the number of participations isn´t close to double the number of participants.

[19] https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1/sheet/3d13a5cb-1ef0-4c26-ac4d-51346b7b3f2d/state/0

Table 7 - Percentage of SME Participants per FP7 Specific Program;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	Capacities Specific program	Cooperation Specific Program	Ideas Specific Program	People Specific Program
AT	48.76%	43.48%	-	31.25%
BE	44.27%	39.74%	6.25%	24.56%
BG	40.35%	25.57%	-	9.52%
CY	59.65%	53.75%	25.00%	44.44%
CZ	49.19%	40.58%	0.00%	15.38%
DE	53.52%	45.39%	2.33%	30.90%
DK	57.89%	46.99%	-	29.41%
EE	62.50%	49.46%	-	33.33%
EL	58.47%	48.91%	-	28.17%
ES	65.03%	43.63%	5.06%	22.15%
FI	54.01%	40.93%	-	36.67%
FR	51.61%	41.71%	-	26.58%
HR	25.00%	22.13%	-	3.70%
HU	51.48%	44.53%	16.67%	23.64%
IE	62.86%	56.35%	-	35.48%
IT	60.29%	45.09%	6.10%	24.52%
LT	53.85%	40.66%	-	15.79%
LU	42.86%	33.33%	-	0.00%
LV	36.59%	24.62%	-	11.11%
MT	59.26%	28.00%	-	0.00%
NL	54.21%	48.05%	-	41.61%
PL	38.68%	32.28%	-	9.57%
PT	54.63%	38.66%	4.76%	19.15%
RO	40.38%	28.20%	-	8.33%
SE	49.18%	44.08%	6.25%	33.98%
SI	48.31%	39.34%	-	35.71%
SK	35.71%	29.85%	-	16.13%
UK	63.47%	51.51%	1.10%	31.75%

Regarding the SME´s participants in the 4 Specific Programs, it is important to notice the lack of SME´s participating in the Ideas Specific Program. Due to its special focus on cutting edge research and innovation it is important to state that, according to

Table 17, there is a lack of SME´s from most of the countries in the EU able to participate in the Ideas Specific Program meaning that the market is dependent on big players for such innovation. The lack of SMEs, in this sector can be very risky since bigger players tend to be big international companies that operate in other highly technological advanced markets such as the USA or Japan. Being dependent on such companies can easily make the newest research and innovation flee from the European market.

There is a clear interest of the SME´s in participating in the FP7. This type of enterprises looks to the EU funding to evolve, increase and improve. This means that the European funding is a very important tool for the capacity of SME´s to adapt to newer products or services, seek to acquire better resources and even improve their human capital. The ratios of SME´s participations in the 4 Specific Programs analysed in detail shows that there is a huge number of these companies that, seek to expand, are courageous and look to be more competitive. These entities, in order to create a knowledge-based economy and a more competitive EU, are fundamental for our economic success. Therefore, the FP7 had success in reaching these entities although there was margin for improvements, namely, increasing their percentage of the funding in order to create incentives and lay the foundations for a more competitive and motivated economic tissue across the Union.

As it has been demonstrated across the analysis, the distribution of the FP7 granted funding has shown a deep divide between those with a higher cost of living and a big research and innovation sector and those, mostly peripheric and from the east or the south of the Union, who doesn´t have an established research and innovation sector and their participation in the program seems to be very incipient. It is also possible to state that the biggest research and innovation engine in the Union is the top 5 economies, especially the UK and Germany and some Nordic or central countries such as Sweden, Denmark, Netherlands and Austria.

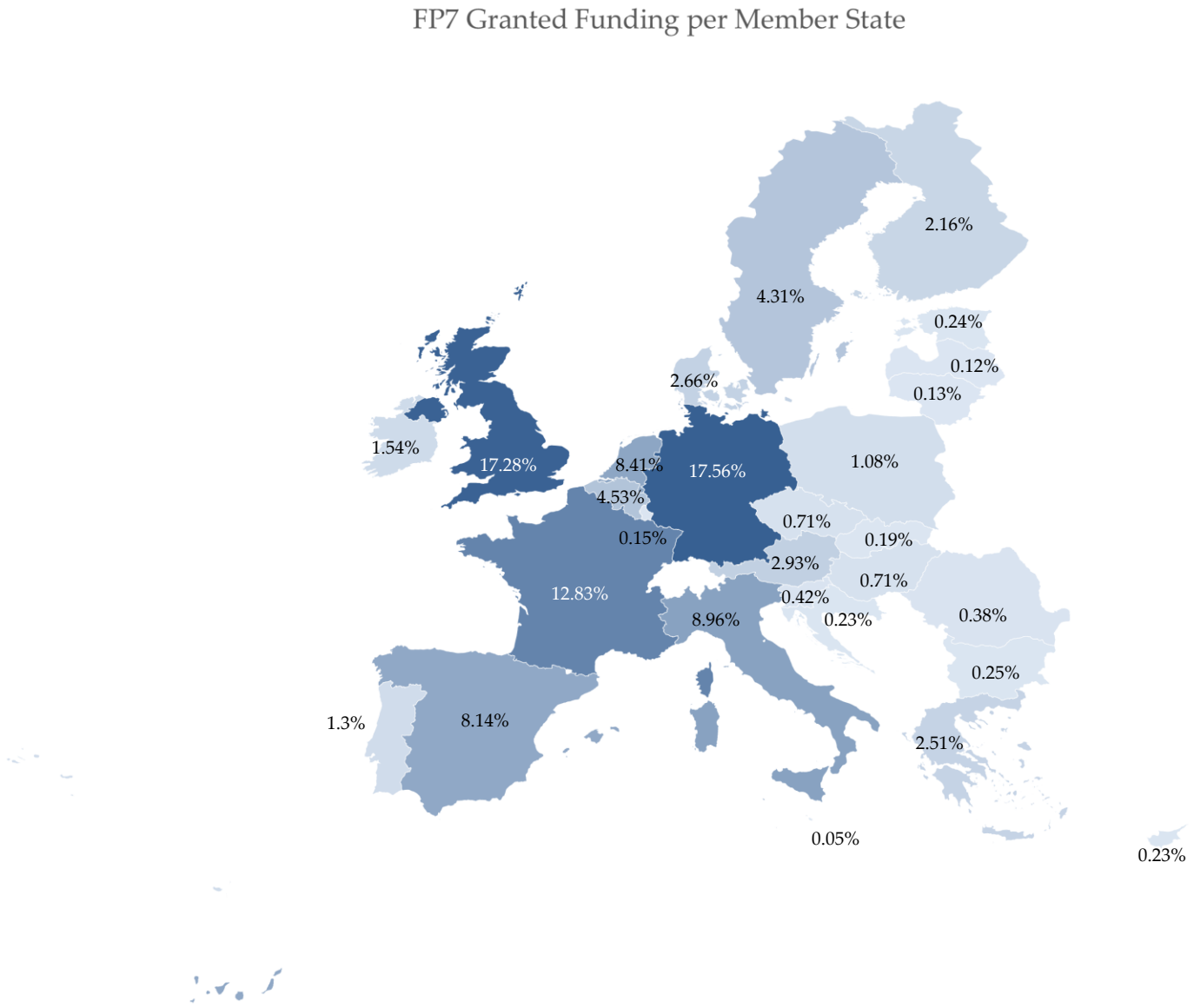


Figure 7 - FP7 Granted Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

An interesting aspect of this analysis is the demonstration of the similarity regarding granted funding between Italy, Spain and Netherlands. These 3 countries are very different regarding their economic and demographic structure. The fist aspect is that Italy and Spain have far more population and a much bigger economy than the Netherlands. However, all 3 nations receive funding between the 8% and 9% (ES-8.14%; NL-8.41%; IT-8.96%). This demonstrates that there is a big gap in this sector, and it is

geographic. Regarding the research and innovation potential, it is clear that the Netherlands have a much bigger sector comparative to their economy than the others. That shows a greater degree of development by the sector. This indicates that even countries as big as Spain and Italy require investment in order to increase and improve their research and development capacity.

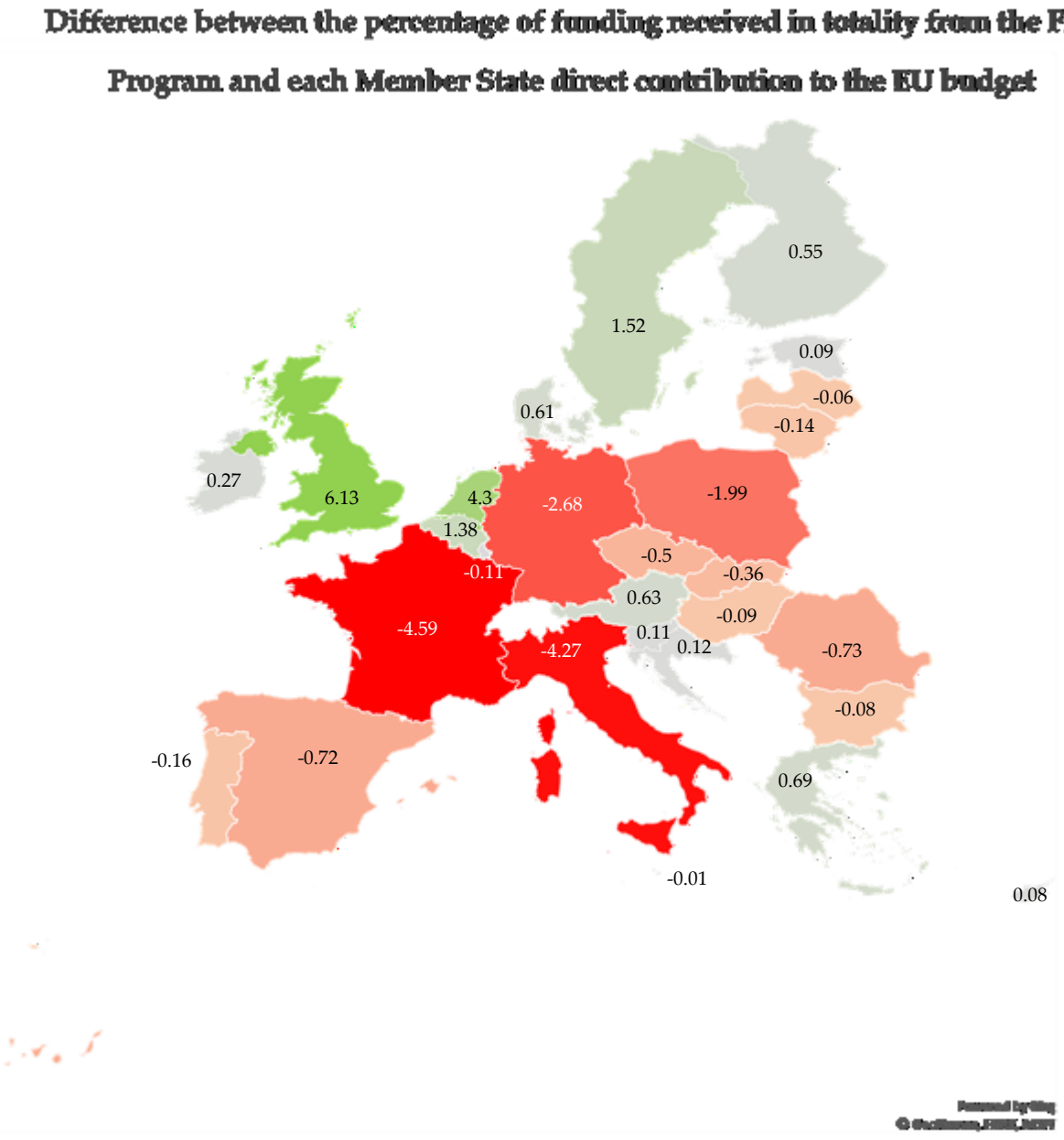


Figure 8 - Difference between the percentage of funding received in totality from the FP7 Program and each Member State direct contribution to the EU budget;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Regarding the amount of funding that each country has received compared to the amount of each Member State contribution to the EU direct budget there are also a certain number of countries that are very strong in the research and innovation sector and therefore they collect more funding from the FP7 compared to their contribution to the EU direct budget. The UK is clearly the biggest beneficiary while the Nordic Member States also have net positives although, has it has been previously analysed, their condition derives also from a combination between the system used for the allocation of the funding for each participant in any given proposal and their elevated cost of living.

What we can observe is a great contrast between the Nordic countries and the UK versus the rest of the Union. Most of the differences aren´t big enough to reach 1 percentage point meaning that its nominal value is quite reduced. However, even smaller percentages in the peripheric economies of the EU are unencouraged since those countries need much more the European help than their wealthier counterparts. The biggest losers, Germany, France and Italy suffer significantly big losses since that their percentual differences are bigger and their budgets are also much higher. A 1percentage point difference in, for example, Germany, on absolute terms, means a lot more money than a 1 percentage point difference in Portugal. The same happens for the net positive countries that have a big cost of living such as the UK and the Netherlands. What we can observe is that regarding research and innovation, there is a flux of money from the periphery and the centre of the Union to the Nordics. The exceptions to the rule are Austria and Greece and present significant net positive percentual differences. In conclusion, in order to develop and increase the research and development sector across the entire EU, the European Commission should revise the Person-month[20] system in order to improve the allocation method of funding.

[20] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

HORIZON 2020 Funding Program

H2020 – The basics

The Horizon 2020 Program (H2020) was created to succeed to the FP7 and is predicted to be operational for the period 2014-2020. Since the FP7 was created and designed before the financial crisis of 2008/2009, it didn´t had into account the proper macroeconomic situation during most of the time the program occurred. On the other hand, the Horizon 2020 was created during this period and has included in it a bigger focus on promoting the economic recovery of the European economies through investment in high value-added products and services. To achieve such objective, it focuses on technology development and research.

Because all the national governments during this period decreased their own budgets for public investment, the H2020 had a predicted budget of 80€ billion[21], that´s more 30 billion euros than its predecessor, the FP7. However, at the beginning of the program, only around 72€ billion were attributed.

Another thing that the H2020 brought was the compilation of 3 programs in one. The H2020 aimed at combining the previous FP7 with the Competitiveness and Innovation Framework Programme (CIP) and the EU contribution to the European Institute of Innovation and Technology (EIT).

[21] https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

The H2020 program is a part of the Europe 2020 Strategy created in 2010 to answer to the economic crisis that ensued. Inside the Europe 2020 Strategy, there are 3 priorities (European Commission, 2010):

1. Smart growth – developing an economy based on knowledge and innovation.
2. Sustainable growth – promoting a more resource efficient, greener and more competitive economy.
3. Inclusive growth – fostering a high-employment economy delivering economic, social and territorial cohesion.

These 3 priorities are mutually reinforcing and offer a glimpse to the vision of the European Commission regarding Europe´s social market economy for the XXI century. Due to the macroeconomic setting and context during which Europe 2020 strategy was created, the European Commission set some standards for the targets to be achieved by the aforementioned strategy (Appendix 7).

Due to our focus on the H2020 program, a detailed contextualization of all the Europe 2020 strategy priorities will not be made. Therefore, we will present a small introduction to the Smart Growth priority since it is the one that englobes the H2020 program.

The Smart Growth priority seeks "strengthening knowledge and innovation as drivers of our future growth" (European Commission, 2010). In order for this priority to materialize itself and achieve success, the European Commission believes that a full use of the newest information and communication technologies is essential in order to achieve quality of all European education systems, strength regarding the European research performance and the promotion of innovation and knowledge transfer. All this aims at ensuring that innovative ideas can be turned into brand new services and

products that hopefully can create value-added based economic growth, jobs and increase European competitive advantage.

The European Commission stated that Europe must have targeted:

- Innovation:
    - Regarding R&D investment, Europe falls behind its major competitors, the US and Japan. That´s why, according to the European Commission, Europe "needs to focus on the impact and composition of research spending and to improve the conditions for private sector R&D in the EU"
- Education, training and lifelong learning:
    - Improve the educational statistics is fundamental for an economy knowledge-based and of high added value. When elaborating Europe 2020 strategy, the European Commission stated that the EU should act on its educational performance as a all since, for example, less than a third of the people aged 25-34 had a university degree compared to 40% in the US and more than 50% in Japan.
- Digital Society:
    - For a knowledge-based and high-tech economy to take place, Europe needs a society that is not only familiarized with technology, it also must have access to technological infrastructure of high quality. As off 2010, the Information and communications technologies (IT) market was worth 2 000€ billion. However, only 25% of it was secured by European firms. Besides that, the European Commission reports that Europe was falling behind regarding high-speed internet. This highly affects the EU ability for innovation, on-

line dissemination of knowledge and on-line distribution of goods and services.

The European Commission, by promoting the Smart Growth priority, aims at unleashing "Europe's innovative capabilities, improving educational outcomes and the quality and outputs of education institutions, and exploiting the economic and societal benefits of a digital society".

The Smart Growth priority is divided into 3 Flagship initiatives:

a. Innovation: Innovation Union (Where H2020 is inserted)[22];
b. Education: Youth on the move;
c. Digital Society: A Digital Agenda for Europe;

The H2020 program is a part of the Innovation segment of the Smart Growth Priority and its main purpose is to secure Europe´s global competitiveness. The existence of the H2020 program is a testament of the European Commission to the notion that research and innovation are an "investment in our future" and for a smart, sustainable and inclusive European economy. By coupling Research and Innovation, this program intends to achieve its emphasis on excellent science, industrial leadership and tackling societal challenges. The main goal of the H2020 program is to empower Europe and its economy of world class science, removing of barriers to innovation and facilitate the public and private sectors cooperation at all levels.

Just like its predecessor FP7, the H2020 Program is all inclusive where everyone can apply in the same frame as previously. The only difference has been, according to the European Union and the H2020 website, a diminished red tape bureaucracy in order to simplify the application and implementation process. The major difference in the analysis

[22] https://ec.europa.eu/programmes/horizon2020/what-horizon-2020

of this program towards the FP7 is the major focus of H2020 in proposals that regard research and investigation as well as increased participation of SMEs in European projects.

Unlike the FP7, however, the H2020 program brings together research with innovation. This means that besides funding the research in every field, it also aims at bringing those findings into the economy as fast as possible. The 3 major types of actions with which the H2020 works are the Cooperation and Support Actions (CSA), the Research and Innovation Actions (RIA) and the Innovation Actions (IA). While the first one is already familiar from the FP7 program, the other 2 are new to the H2020. The RIA focus in funding actions that have the sole purpose of research. The IA focus on picking up the research left from an RIA and attempt to apply it to the market. This is, if there is research done for a new product or service, those who apply for an IA normally attempt to pick that product or service, and study how can they apply it to the market.

The H2020 program, in order to achieve its objectives has been divided into 3 complementary priorities. Inside those priorities lays a vast net of programs with variant specific purposes. H2020 also includes 2 Specific Objectives that are complementary to the program.

The three H2020 priorities with their respective variant's budgets (in millions) and the 2 Specific Objectives(European Commission, 2014)[23]:

1. Excellent science:
    a. European Research Council – 13 095€
    b. Future and Emerging Technologies – 2 696€
    c. Marie Sklodowska-Curie actions (MSCA) – 6 162€
    d. Research infrastructures – 2 488€

[23] https://ec.europa.eu/programmes/horizon2020/h2020-sections

2. Industrial Leadership:
    a. Leadership in enabling and industrial technologies (LEITs) – 13 557€
        i. Information and Communication Technologies
        ii. Space
        iii. Nanotechnologies, Advanced Materials, Advanced Manufacturing and Processing and Biotechnology
    b. Access to risk finance – 2 842€
    c. Innovation in SMEs – 616€
3. Societal Challenges:
    a. Health, demographic change and wellbeing – 7 472€
    b. Food security, sustainable agriculture and forestry, marine and maritime and inland water research and Bioeconomy – 3 851€
    c. Secure, clean and efficient energy – 5 931€
    d. Smart, green and integrated transport – 6 339€
    e. Climate action, environment, resource efficiency and raw materials – 3 081€
    f. Inclusive, innovative and reflective societies – 1 310€
    g. Secure societies – 1 695€
4. Specific Objectives:
    a. Science with and for society - 462€
    b. Spreading excellence and widening participation – 816€

As we can observe, the H2020 is broader than its predecessor and has a bigger focus on technological development, climate change fight and economic recovery in general. This makes the H2020 more complete and embracing which, according to the research and articles discussed previously, might make it a better tool for the purpose of cohesion and economic progress. Since the European Commission Intended to create an

economic recovery based on Research, Innovation and high-value products and services, the H2020 seems to be a fundamental tool for such purpose.

Because of the timing in which the H2020 program was created, the amount of funding covered is more generous than the FP7. In the H2020, the amount of funding is mostly 100% except for IAs where a 20% maximum will be applied for profit making entities (European Commission, 2014).

Also, the H2020 has simplification of participation rules (European Commission, 2014):

For example:

1. A single set of rules:
    a. Adapted for the whole research and innovation cycle;
    b. Covering all research programmes and funding bodies;
    c. Aligned to the Financial Regulation, coherent with other new EU Programmes;

2. One project – one funding rate:
    a. Maximum of 100% of the total eligible costs (except for innovation actions, where a 70% maximum will apply for profit making entities);
    b. Indirect eligible costs: a flat rate of 25% of direct eligible costs;

3. Simple evaluation criteria (structure of the proposal):
    a. Excellence – Impact – Implementation (Excellence only, for the ERC);

4. New forms of funding aimed at innovation:

a. pre-commercial procurement, inducement prizes, dedicated loan and equity instruments;

5. International participation:
    a. facilitated but better protecting EU interests;

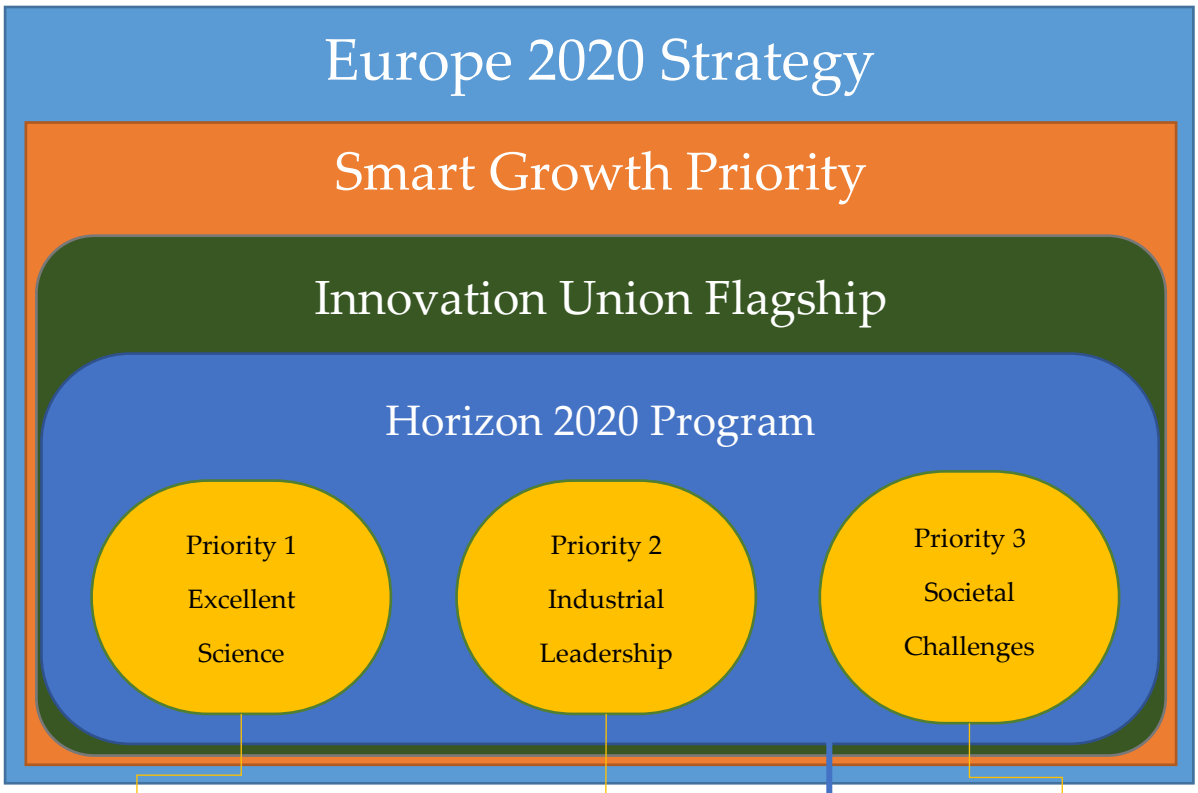
6. Simpler rules for grants:
    a. broader acceptance of participants accounting practices for direct costs, flat rate for indirect costs, no timesheets for personnel working full time on a project, possibility of output-based grants;

7. Fewer, better targeted controls and audits:
    a. Lowest possible level of requirements for submission of audit certificates without undermining sound financial management;
    b. Audit strategy focused on risk and fraud prevention;

8. Improved rules on intellectual property:
    a. Balance between legal security and flexibility;
    b. Tailor-made IPR provisions for new forms of funding;
    c. A new emphasis on open access to research publications;

The H2020 is bigger and more in-depth due to the financial crisis and the macro-economic context that affected the creation of the program. For such reason, the H2020 also allows for key partnerships to be built, having a dedicated funding packaged for them. The Innovation and Investment Package of €22 billion aims at funding partnerships Joint Technology Initiatives for areas such as medicine, aeronautics, and industry in general. These same Initiatives also have a Joint programme included. In order to better

visualize the Structure of the H2020 program it's possible to verify the following image that depicts were the program is inserted and, very basically, the H2020 main structure (European Commission, 2014):



- European Research Council – 13 095€
- Future and Emerging Technologies – 2 696€
- Marie Sklodowska-Curie actions (MSCA) – 6 162€
- Research infrastructures – 2 488€

- Leadership in enabling and industrial technologies (LEITs) – 13 557€
- Access to risk finance – 2 842€
- Innovation in SMEs – 616€

Specific Objectives

- Science with and for society – 462€
- Spreading excellence and widening participation – 816€
- Total budget of 1 278€ million

- Health, demographic change and wellbeing – 7 472€
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research and Bioeconomy – 3 851€
- Secure, clean and efficient energy – 5 931€
- Smart, green and integrated transport – 6 339€
- Climate action, environment, resource efficiency and raw materials – 3 081€
- Inclusive, innovative and reflective societies – 1 310€
- Secure societies – 1 695€
- Total budget of 29 679€ million

Figure 9 - H2020 simplified schematics

Constructed by Authors

A great deal of observed progress between the H2020 and the FP7 is the bigger focus in SME and in what was previously the People and the Ideas Specific Programs under FP7. The fact that the European Commission increased focus in the areas that went overbudget in the previous program demonstrates that the European Commission was paying attention to the demands and the needs of the European entities. For such reason, the Commission created the seal of excellence initiative regarding the SME instrument.

According to the H2020 dashboard regarding the info about the Seal of excellence[24], the SME Instrument "supports close-to market activities with the aim to give a strong boost to breakthrough innovation with a market-creating potential. Innovative SMEs with a clear commercial ambition and a potential for high growth and internationalization are the prime target. The SME instrument has 3 phases, including a coaching and mentoring service."

The Seal of Excellence is an award given to high quality proposals submitted to the SME Instrument that were unable to be financed for budgetary constraints.

The H2020 also contains the Enhanced European Innovation Council pilot (EIC)[25]. The EIC pilot supports developing high-risk research and innovation with potential to create new markets and boost jobs, growth and prosperity in Europe. This pilot was created amid the H2020 program and therefore its has not been operational for the full length of the program starting to fund projects only in 2018 and ending at the same time as the H2020 program.

The pilot will bring together four different support schemes into a single place and make them easier to understand and access for innovators. The schemes are the SME instrument, the Fast Track to Innovation, parts of Future and Emerging Technologies,

[24] https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b
[25] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/european-innovation-council-eic-pilot

and a set of six "crack the challenge" prizes, to be known as EIC Horizon Prizes (Moedas, 2018). The main purpose is to make, for the first time, the H2020 SME instrument fully "bottom up" in order to make any area of technology or business sector able to make innovative proposals. The great change introduced by the Commission is the existence of face to face interviews so that the evaluation will not be merely based on paper proposals.

The EIC pilots two new schemes:

i. The EIC Pathfinder pilot (grant only), comprising FET-Open and FET-Proactive.

    i. The EIC Pathfinder Pilot offers grants of up to €4 million to promote collaborative, inter-disciplinary research and innovation on science-inspired and radically new future technologies. These grants are for consortia of at least 3 entities from 3 different Members States and associated countries.[26] This Pilot has a focus for Artificial intelligence, implantable autonomous devices and materials and breakthrough zero-emissions energy generation for full decarbonisation. The promised budget for this pilot scheme was 660€ million for the period of 2019-2020.

ii. The EIC Accelerator pilot (grant only and blended finance), building upon the SME Instrument.

    i. The EIC Accelerator Pilot builds on the SME Instrument Phase II and provides grant-only support as well as support in the form of blended finance (combining grant and equity).[27] The scheme supports high-risk, high-potential small and medium-sized

[26] https://ec.europa.eu/research/eic/index.cfm?pg=funding
[27] https://ec.europa.eu/research/eic/index.cfm?pg=funding

innovative enterprises willing to develop and commercialise new products, services and business models that could drive economic growth and shape new markets or disrupt existing ones. The applicants must be established in a Member State or an H2020 Associated country. With a total of 1.3€ billion for the period 2019-2020 this is probably the most exclusive funding money of the entire H2020 program or associated pilot.

The Enhanced EIC pilot also includes other calls and actions such as Fast Track to Innovation (FTI) and the Horizon Prizes. This pilot will have a 2.7€ billion of committed budget from the already existing program, the H2020 and it is supposed to make the transition to a fully-fledged EIC. The Work Programme contains three main novelties:

1. Reformed and simplified funding instruments;

2. A more flexible and pro-active approach to management (needed for high-risk projects and fast evolving technologies and markets); and,

3. A revised governance in the form of an Advisory Board composed of high-level experts from across the European innovation community.

The FTI scheme is for relatively mature ground-breaking technologies, concepts and business models which are close to market. Proposals must come from consortia of 3 to 5 legal entities who want to see quick market uptake of new technologies. Grants are up to 3€ million and the scheme has a 300€ million budget for the period 2018-2020. Unlike the remaining pilots and associated schemes of the H2020, the for-profit entities will receive up to 70% of co-financing while not-for-profits will have 100% co-financing.

The EIC Horizon Prices are awarded to whoever can most effectively meet a defined challenge, without prescribing how that challenge should be solved. These will boost breakthrough innovation across sectors by fostering cutting-edge solutions which

bring major benefits to citizens and society. Individual prizes amount to 5 or 10 million euro. The total budget for EIC Horizon Prizes until 2020 is €40 million.

H2020 – A statistical analysis

The Horizon 2020 program, to this date, has not yet ended. Its submission deadlines and project appreciations are schedule to last all across 2020, and it is possible that only in a couple of years it would be possible to do a full analysis of the entire performance of the H2020. However, most of the program schedule time has passed and the European Commission has now started to unveil and design the program that will possibly replace, not only H2020 but also the Europe 2020 strategy.

Although some FP7 Specific Programs had only one single grant type, those types of grants also exist in the H2020, however they do not represent an exact copy of the previous Specific Program.

The analysis of the available H2020 dashboards[28]- will have 4 subdivisions:

1. H2020 Key Figures and Country Profiles (European Commission, 2020a)
2. SME Performance and Seal of Excellence (European Commission, 2020g)
3. H2020 Projects (European Commission, 2020f)
4. H2020 EIC Pilot (European Commission, 2020e)

H2020 Key Figures and Country Profiles

The first thing worthy of examination is the fact that, according to the Horizon dashboard[29], the amount of funding already granted over the last 6 years and a half is significantly lower than the total amount of budget that the Commission had available for the entire program. As we have explored before, in its totality, the H2020 had approximately 72€ billion in budget available, however, only 50.83€ billion have been

[28] https://webgate.ec.europa.eu/dashboard/hub/stream/aaec8d41-5201-43ab-809f-3063750dfafd
[29] https://webgate.ec.europa.eu/dashboard/sense/app/93297a69-09fd-4ef5-889f-b83c4e21d33e/sheet/a879124b-bfc3-493f-93a9-34f0e7fba124/state/analysis

granted for projects under the program. This means only 70.6% of the available budget, compared to the FP7s 90% meaning a reduction of nearly 20%. Even knowing the H2020 is still operational, the program is in its last year running through the last calls of the program. It is not realistic to assume that the European Commission is going to attribute 20 billion euros on the last year of the program alone or even a significant amount of that remaining budget.

This, once again, brings the question if the underfunding comes as a consequence of the lack of proposals or if the same points made towards the FP7 are also valid for the H2020 which is the existence of a certain amount of approved projects for a determined call or if once again is the subjectivity of the evaluators causing this anomaly. However, there is also another factor that might be interesting to explore in further research which is the fact that in the FP7 Program the amount of effective funding was around 45.5€ billion while in the H2020 program the amount of effective funding being around 50.83€ billion as of April 2020. As it is possible to observe, the values are very close, with only a 5€ billion gap (equivalent to 10% of the granted H2020 funding). This means that the research and Innovation sector in Europe over the years has not changed much regarding its nominal value. Over the last 2 programs, complying a period of nearly 15 years (2007 – 2022 since H2020 last projects might end solely around 2022) the amount of research and development that the European Commission has been able to fund has improved around 10% but clearly not hitting the higher marks that the European Commission would have hoped.

Of those 50.83€ billion, 46.26€ were distributed in Member States. Regarding total amount of participations, there was 117657 participations regarding H2020 projects done merely in the Member States. According to the H2020 dashboard regarding countries key figures[30] the number of participating entities (participants) was 29483.

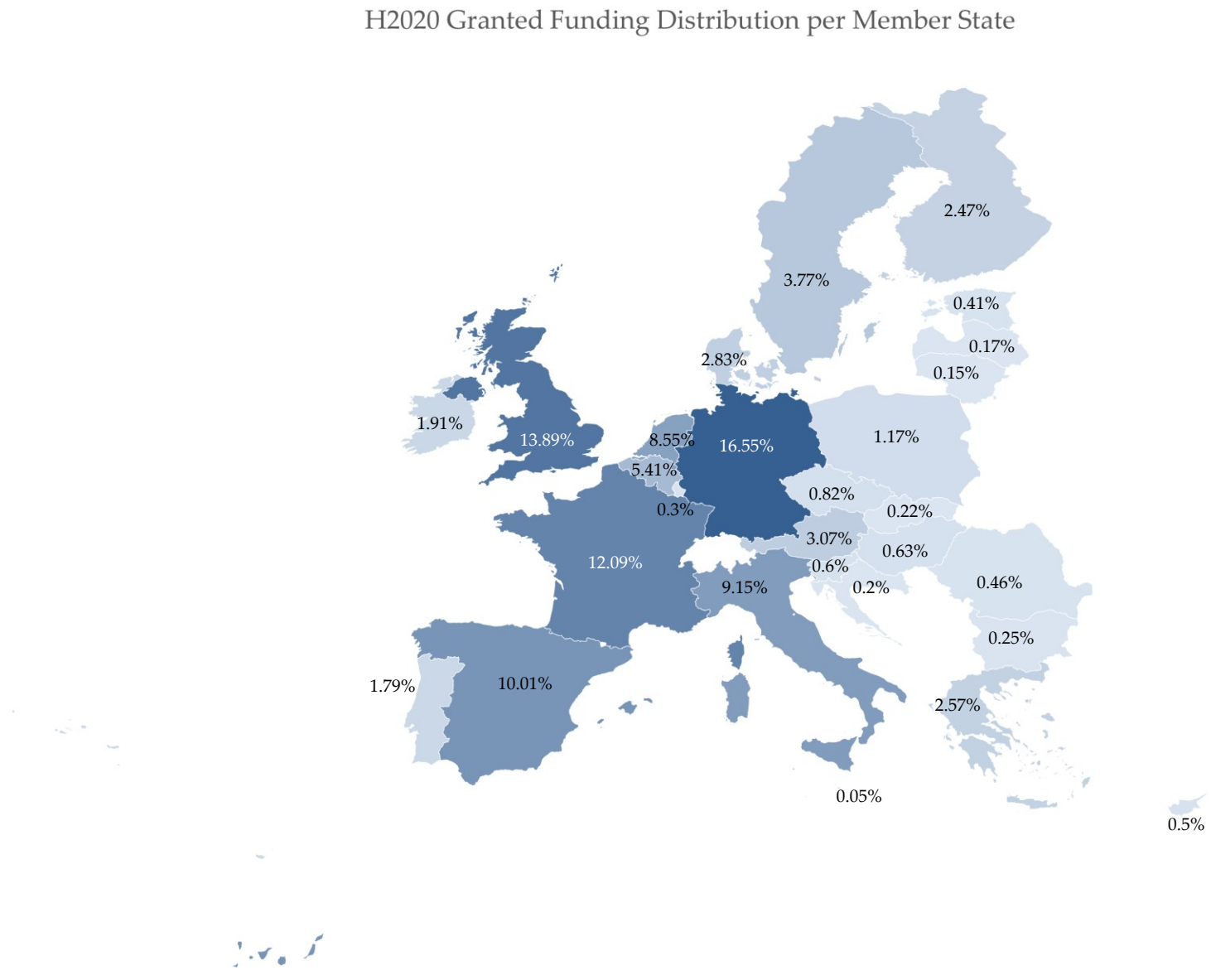


Figure 10 - H2020 Granted Funding Distribution per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

[30] https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/0c8af38b-b73c-4da2-ba41-73ea34ab7ac4/state/0

When comparing these numbers between each program and divided by Member States we obtain some mixed results. As stated before, the H2020 has distributed already more than the FP7 and it has not ended, meaning that the end value of granted funding will be superior than the FP7. This indicates a rise in the research and innovation sector value in the Unions economy which is positive having into account that the main purpose of the European Commission is to create a knowledge-based economy to drive the future of the EU.

It is also very important to mention that in 2016, the UK has passed a referendum in order to exit the EU commonly called Brexit. During the time in which the H2020 has been operational, most of it was spent with the uncertainty of a Brexit and the UK suffered a lot regarding the amount of granted funding received.

When we analyse the distribution of the H2020 funds we see a map quite similar to the FP7. It is a fact that this process is a slow one and financing and improving the research sector across the Union is a difficult task. It is also unrealistic to expect that all nations might receive equal amount of funding specially because these programs are for all 28 nations composing the Union and the euro is not the main coin on several of those Member States. However, it would be great if the peripheric countries would be able to access a bigger amount of the funding. That would indicate a bigger research and innovation sector and a better possibility for growth and enhanced economic performance. With our analysis we could verify a regression of the UK regarding the total amount of funding it was capable of capture. It is no surprise since, as explained previously, the Brexit made a big impact in the performance of the country across all the metrics and brought it to a much closer level to France and, to a lesser extent, Italy and Spain. Of all the top economies in the Union, the most stable regarding amount received was Italy. The country showed a percentual level very similar to the previous levels. In general, all Member States show improvements regarding their ability to increase their

percentage of received H2020 funds when compared to the FP7. The differences are small but, to the smallest economies, they are relevant to the research and innovation sector. The variance in percentage is so low that only a few countries register percentual differences worth pointing out. Of all the top 5 economies, the northern ones registered the biggest percentual losses regarding funds distribution. The UK, as expected, lost the most with -3.4 percentual points compared to its FP7 performance. It was followed by Germany (-1.01 percentual points difference) France (-0.74 percentual points) which demonstrates a shift of research and innovation potential between these countries which and the smaller and peripherical ones. To the weakest economies it is a good prospect because it indicates positive reactions to the investments and funding's already received while also indicating a better position to increase competitiveness and the general economic capacity to participate in the knowledge-based economy that the European Commission intents to create.

Regarding the Member States with net positives, the highest was Spain, the only Member State to have a percentual increase superior to 1. The positive fact is that the increase in the research and innovation potential has been spread across Europe and the valorisation of the European market has been made by all countries. This is the best positive scenario the European Commission could hope for. Although the increases were quite low regarding the percentage of H2020 funds captured by the Member States compared to the FP7 levels, indicates that the programs are creating a cohesion effect among the EU Members. This cohesion in such a key sector is fundamental. While a few countries might be at an already better position than others, an increase across the Union is fundamental for the economic competitiveness of the same. The better prepared the weak economies are to deal with the competition from other markets, the higher the chance of creating a strong knowledge-based economy that can work to the benefit of all the Member States. It is also important to notice that this increase in the peripherical

ability to capture more funding from the H2020 than from the FP7 is not due to Brexit. The research and innovation sectors of the peripheric and weaker economies cannot be compared to the UK research and innovation capability. It is very possible that the decrease of the UK helped countries with also strong research and innovation sectors to not decrease so much or even to not decrease at all. The countries that we most believe to have benefited from the Brexit was the remaining powers in the research and innovation sector such as Germany, France, Italy and other developed economies such as the Netherlands and Austria.

Table 8 - Net Difference between FP7 Granted Funding and H2020 Granted Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Country	FP7 Granted funding (€ in millions)	H2020 Granted Funding (€ in millions)	Net Difference (€ in millions)
AT	1,193.934	1,418.323	224.389
BE	1,844.236	2,502.692	658.457
BG	99.875	116.624	16,749,734.03
CY	93.175	230.372	137.197
CZ	287.841	377.527	89.686
DE	7,145.735	7,654.684	508.947
DK	1,080.980	1,311.122	230.142
EE	96.251	191.172	94.921
EL	1,021.671	1,189.445	167.774
ES	3,312.513	4,631.022	1,318.509
FI	879.007	1,143.086	264.078
FR	5,221.710	5,591.253	369.542
HR	91.691	94.003	2.312
HU	290.894	292.018	1.125
IE	627.928	884.130	256.202
IT	3,646.442	4,231.512	585.070
LT	51.966	70.280	18.314
LU	60.699	137.613	76.914
LV	48.821	79.676	30.855
MT	21.085	25.408	4.323

NL	3,423.776	3,954.870	531.093
PL	441.262	540.716	99.455
PT	527.792	828.897	301.106
RO	154.361	212.565	58.204
SE	1,752.186	1,743.860	-8.326
SI	171.238	278.683	107.444
SK	76.522	102.993	26.470
UK	7,033.756	6,423.779	-609.976
Total	40,697.347	46,258.326	5,560,979

The UK and Sweden were the only countries that lost granted funding when compared to the nominal values of received under the FP7. While Sweden suffered a loss of 8.326€ million, representing around 0.48% of the funding received during the FP7, the UK had a loss of almost 610€ million. This loss represented 8.67% of the total FP7 granted funding to the country. The massive loss in the received funds is just one of the visible marks and effects on the UK research and innovation sector. Meanwhile, most of the remaining 26 countries received significant increases to their received funds.

Table 9 - Percentual Difference between FP7 Granted Funding and H2020 Granted Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Country	Percentual Difference (percentual points)
AT	18.79%
BE	35.70%
BG	16.77%
CY	147.25%
CZ	31.16%
DE	7.12%
DK	21.29%
EE	98.62%
EL	16.42%
ES	39.80%

FI	30.04%
FR	7.08%
HR	2.52%
HU	0.39%
IE	40.80%
IT	16.04%
LT	35.24%
LU	126.72%
LV	63.20%
MT	20.50%
NL	15.51%
PL	22.54%
PT	57.05%
RO	37.71%
SE	-0.48%
SI	62.75%
SK	34.59%
UK	-8.67%
Total	13.66%

The total amount of increased granted funding between the FP7 and the H2020 was of 13.66%. What we can observe is that the majority of the countries have significantly larger increases between their previous FP7 received funding and the already received from the H2020. While the values are very irregular and do not seem to follow a pattern, the biggest economies in the EU seem to have smaller increases than most of the peripheric countries. As always, there are exceptions. Luxembourg has a 126.72% increase while being a country with a high cost of living. Countries such as Cyprus, Estonia, Latvia, Slovenia and Portugal are countries that have smaller per capita GDPs than Luxembourg, which is the EU country with the biggest per capita GDP[31], and yet also have really good percentual increases regarding the same metric being all of them above a 57% increase. This shows that the research and innovation sector in these

[31] https://ec.europa.eu/eurostat/databrowser/view/sdg_08_10/default/table?lang=en

countries is maturing and reaching an absorption and fund caption bigger than previous years. Regarding the 5 major economies, Spain is the one where the research and innovation sector increased the most. The bigger EU economy in this sector, the UK, on the other hand, had a fall of 8.67%. This demonstrates that the research and innovation sector of the country relies to a certain extent on its participation in the EU market and in the EU partners. The Brexit, despite all the delays that suffered, has caused along the life span of the program, enough doubt and hesitation regarding the UK capacity of complying with compromises leading to a loss of capacity to capture and attract H2020 funds. Although the remaining top 3 economies had still the capacity to increase their received funding during the H2020 in comparison to the FP7, Germany, France and Italy saw increases lower than most of the other Member States. This indicates a degree of maturity regarding the sector and their impossibility to increase much more their research and innovation capacity compared to the already existent levels.

What this demonstrates is that during the H2020 program several of the peripheric countries were able to make good progress regarding their research and innovation capacity. This indicates that this sector is appearing in such countries and becoming more evolved and mature and that the European funds are having a big part in such evolution.

Despite this positive fact, it is important to mention that there are still some peripheric countries that lag and don´t show signs of increasing and evolving as much. The H2020 received funding of Hungary compared to the FP7 is only a 0.39% increase, by far the lowest of all the Member States that showed a positive increase regarding this metric. This means that the investments made in the country are not taking effect or that the country is having problems in creating a competitive research and innovation sector capable of retaining and increasing its appeal and capacity to retain funding. The middle ground countries that are well developed economies and have reached a research and innovation capacity almost at its fullest such as the Netherlands, Austria or Belgium

present modest increases comparing to their FP7 values. That is what it would be to expect since they show a capacity to still improve in this field although they have reached a very high maturity level. This means these countries are most probably the most effectives in using the investments and funding granted to them.

Meanwhile, regarding the number of participants, there has been a significant increase in entities that participate in the H2020 program when compared to the amount of entities that participated in the FP7.

In total, the H2020 had more 17.21% of participants compared to the FP7 total amount. This indicates an increase in entities capable and interested in participating in the EU programs connected with research and innovation. Regardless of their purpose, this increase is substantial and very positive since it indicates that the research and innovation environment in Europe is increasing. If there is growth means it is becoming more attractive, more diversified and there are more opportunities for the sector in Europe. For the purpose of the Europe 2020 strategy this is very positive and important news. When comparing the performance of only the Member States, for the FP7 there were 23 724 signed grants while for the H2020 there were 25 134. This number is significantly higher and demonstrates that with more participants there is possibility for sustained growth.

Table 10 - Net and Percentual Difference between FP7 Participants and H2020 Participants;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Country	FP7 Participants	H2020 Participants	Net difference	Percentual Difference
AT	773	932	159	20.57%
BE	1209	1446	237	19.60%
BG	270	268	-2	-0.74%
CY	124	167	43	34.68%
CZ	411	393	-18	-4.38%

DE	3804	3828	24	0.63%
DK	599	762	163	27.21%
EE	158	219	61	38.61%
EL	604	808	204	33.77%
ES	2686	3614	928	34.55%
FI	549	707	158	28.78%
FR	2528	2903	375	14.83%
HR	163	222	59	36.20%
HU	376	421	45	11.97%
IE	449	543	94	20.94%
IT	2571	3330	759	29.52%
LT	135	158	23	17.04%
LU	71	115	44	61.97%
LV	96	141	45	46.88%
MT	52	61	9	17.31%
NL	1606	1982	376	23.41%
PL	597	748	151	25.29%
PT	563	749	186	33.04%
RO	379	451	72	19.00%
SE	901	1008	107	11.88%
SI	260	347	87	33.46%
SK	193	202	9	4.66%
UK	3026	2958	-68	-2.25%
Total	25153	29483	4330	17.21%

Regarding the increase in participants per Member State it is very positive to observe growth in most of the countries. It is also curious to notice that the growth of participants doesn´t seem to follow a geographical or economical pattern. For example, the top 5 economies present very different growth regarding the number of participants. The only consistent are the UK and Germany. The UK has a decrease in the number of participants which goes along with the expected result of the Brexit referendum and the complete exit from the Union, even with the possibility of an agreement and it also follows the fall of received funding by this country. It is however positive for the country that the reduction of the participants isn´t has high as the reduction of granted funding.

Germany also shows relative consistency. Its granted funding growth was quite low as well as its percentage of participants growth. This indicates that the UK and Germany have the most advanced research and innovation sectors in the Union and, most importantly, the EU funding is fundamental for this sector. The public funding, in this case coming from the EU, is, such has stated in the chapter about the importance of Structural funds and public investment, a key factor in the support and sustainability of a strong Research and innovation capability. The fact is that both countries showed research levels bigger and of more complexity than its Union counter parts. The main difference is that, while the H2020 was functioning, one of these countries, the UK, started the process to leave the EU and has a consequence the research and innovation sector responded with mistrust. This, we believe, indicates that in the future, several countries belonging to the Union and with an already high research and innovation capacity will take some of the UK role in this sector. The decrease in participants regarding the UK in the H2020 program also indicates that the public funding of the sector is of extreme importance.

In the metric regarding participations, our analysis showed an interesting result. Between the FP7 and the H2020 program, as of the beginning of 2020, the number of participations has fallen. Obviously, the amount of participations in the H2020 is going to increase over 2020 and 2021. However, achieving this maturity in the program and still have fewer participations while registering already more entities taking part of the program and more funding granted can only mean one thing: the amount of single participations has increased. This is quite good for the general picture because it indicates that there are much more entities participating and interested in the program. This helps for the cohesion of the Union because it allows for a bigger spreading of the funding making it influence more people and entities. It also demonstrates a bigger economic weight for the sector and a bigger creation of value by the Program. The capacity for the

program to be more attractive and to a bigger variety of entities adds value to the research and innovation of the European Member States and makes it much more attractive for investment which is a key factor and one of the aims of the Commission. Although the number of participations in the H2020 are predicted to be more than the present number since the year has not ended, at least there are already good indications that the European sector for research and innovation is responding positively to the programs created by the Commission and bringing new players to the sector.

Table 11 - Net and Percentual Difference between FP7 Participations and H2020 Participations;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Country	FP7 Participations	H2020 Participations	Net Difference	Percentual Difference
AT	3652	3740	88	2.41%
BE	5666	6167	501	8.84%
BG	716	692	-24	-3.35%
CY	471	669	198	42.04%
CZ	1460	1390	-70	-4.79%
DE	18763	15817	-2946	-15.70%
DK	2870	3044	174	6.06%
EE	560	636	76	13.57%
EL	3801	3891	90	2.37%
ES	11783	13825	2042	17.33%
FI	2948	2596	-352	-11.94%
FR	13129	12922	-207	-1.58%
HR	413	596	183	44.31%
HU	1669	1166	-503	-30.14%
IE	2019	2183	164	8.12%
IT	12318	12561	243	1.97%
LT	424	471	47	11.08%
LU	257	442	185	71.98%
LV	339	402	63	18.58%
MT	201	184	-17	-8.46%
NL	8546	8250	-296	-3.46%
PL	2240	2125	-115	-5.13%

PT	2462	2883	421	17.10%
RO	1092	1192	100	9.16%
SE	4643	3994	-649	-13.98%
SI	941	1097	156	16.58%
SK	499	523	24	4.81%
UK	18304	14199	-4105	-22.43%
Total	122186	117657	-4529	-3.71%

Most curiously, the UK isn´t the country that had the biggest shortfall of participations as of the time of our analysis. Those countries were Hungary and Germany. Germany shows a loss in the percentage of EU granted funding but not as big as the one showed by the UK. However, this opposite presentation regarding the data is intriguing. The UK is the country that shows the biggest fall in the percentage of granted funding received but Germany shows a bigger negative difference in the participations than the UK. This oddness can be explained by the difference in the average per participation. The UK has a bigger granted funding per participation than Germany. This gives us a very important indication which is the type of research and innovation done in the UK is, by all indications, more advanced and that the UK also has a bigger standard of living than in Germany. Has we´ve seen during the analysis in the FP7, these factors have an impact in the amount of funding that a country receives. Therefore, the fact that the UK has a better research and innovation sector, the higher cost of living and a more powerful coin creates the reasons for the difference we can observe. It also indicates that through the Brexit, the EU is losing one of its biggest assets regarding research and innovation. The European Commission should develop a plan to take advantage from the Brexit in order to minimize its impacts or even transform it into an opportunity.

Hungary is the country that, regarding this metric, demonstrates a path in the opposite direction of the remaining Member States, especially those that, in economic terms, are similar. While it is not the only country having, by the time of the analysis, a

lower percentage of participations between FP7 values and the H2020 ones, it is the country with the biggest negative difference of the entire Union making it an interesting case for analysis. Hungary is an eastern European country that joined to the EU in 2004 with more 9 fellow countries of which 6 of them were part of the former Soviet Union. A few of these countries also presented negative percentual differences but much smaller than the Hungarian. This leads us to a solid conclusion that the main difference, in comparison to its fellow member States, can lye solely in the country itself. The political decisions and the economic path that Hungary has chosen for the last 6 years had a clear impact in the direction that the research and innovation sector has taken. By all the metrics analysed before, Hungary had positive differences in all except in participations. Therefore, despite the fewer number of participations, the Hungarian research and innovation sector was able to capture more funding (increased 0.39%) and included more participants in the program (increased 11.97%). We conclude that the political decisions made by the Hungarian government are reducing the capability of the country to fully take advantage of the EU programs related to the research and innovation sector. Although this behaviour doesn´t change much the performance of the Program in general, it is advised more research regarding this particular country and its performance.

Regarding the H2020 3 priorities, due to the Programs different division and structure compared to the previous FP7, it is worth analysing the results divided by each of the three H2020 main Priorities. These Priorities had a combined budget of €71.135 billion the remaining budget was dedicated to 2 Specific Objectives that will also be analysed separately.

As explained previously, the three H2020 priorities were Excellent Science, Industrial Leadership and Societal Challenges. We assumed that the bigger the predicted budget, the bigger the importance of such priority for the European Commission. In the

H2020 the Societal Challenges Priority was given nearly €29.7 billion which was almost half of the entire available program budget indicating a very big commitment by the European Commission to the success of such priority. The Societal Challenges Priority, however, was the most subdivided of the three with seven variants. The Excellent Science also received a significant amount in predicted budget with €24.44 billion. This priority had a much narrow focus than the previous one. Its budget was only divided into 4 variants with one of those receiving €13.05 billion. This variant, the European Research Council, was solely responsible for the financing of the Ideas Specific Program of the FP7. Since the H2020 is a bigger program than the FP7 and it included in it the previous FP7 as well as several other singular programs, it is fair to assume that what previously composed the Ideas Specific Program has now been included in the H2020 under the Excellent Science priority. Therefore, it is possible to compare this variant of the Excellent Science with the Ideas Specific Program. Another variant of the Excellent Science priority is the Marie-Slowodoscka Curie Actions (MSCA). This variant, just as the ERC, was solely responsible for the financing of the previous People Specific Program in the FP7. Using the same line of thinking, we can also compare this variant of the Excellent Science priority with the People Specific Program.

The first point to notice in our analysis is that the existence of this variants in their unchanged forms is evidence that the European Commission took the same conclusions as we did and decided to maintain and increase the funding of the only two Specific FP7 Programs that were, in our analysis, underbudget at the beginning of the program. The increase of the funding for much bigger levels also indicates that the Commission intends to include in this program much more responsibilities and increase their impacts. However, the increase is quite substantial. For the ERC the increase is almost the double. It goes from €7.51 to €13.05 billion. In the MSCA the increase is less but still significant

going from €4.75 to €6.16 billion. Both these increases aren´t met since the EU granted contribution for both will be less that the H2020 predicted budget.

Table 12 - H2020 Priorities Respective Variants Predicted Budget;

Source (European Commission, 2014) - *others calculation*

H2020 Priorities	Respective Variants	Predicted Budget (€ millions)	Total Predicted Budget per Priority
Excellent Science	European Research Council (ERC)	€ 13,095.00	€ 24,441.00
	Future and Emerging Technologies (FET)	€ 2,696.00	
	Marie Curie Actions (MSCA)	€ 6,162.00	
	Research Infrastructures	€ 2,488.00	
Industrial Leaderchip	Leadership in enabling and industrial technologies (LEITs)	€ 13,557.00	€ 17,015.00
	Access to risk finance	€ 2,842.00	
	Innovation in SMEs	€ 616.00	
Societal Challenges	Health, demographic change and wellbeing	€ 7,472.00	€ 29,679.00
	Food security, sustainable agriculture and forestry, marine and maritime and inland water research and Bioeconomy	€ 3,851.00	
	Secure, clean and efficient energy	€ 5,931.00	
	Smart, green and integrated transport	€ 6,339.00	
	Climate action, environment, resource	€ 3,081.00	

efficiency and raw materials	
Inclusive, innovative and reflective societies	€ 1,310.00
Secure societies	€ 1,695.00

Table 13 - H2020 Priorities Variants Granted Funding;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Project Programme Part	Participant Net EU Contribution (€)
European Research Council (ERC)	€ 8,322,216,272.20
Information and Communication Technologies	€ 5,259,008,973.05
Marie-Sklodowska-Curie Actions	€ 4,610,927,383.90
Health, demographic change and wellbeing	€ 4,344,231,887.47
Smart, green and integrated transport	€ 4,308,450,161.75
Secure, clean and efficient energy	€ 3,418,772,560.42
Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy	€ 2,232,071,144.19
Research Infrastructures	€ 1,804,449,207.24
Climate action, environment, resource efficiency and raw materials	€ 1,746,931,002.75
Future and Emerging Technologies (FET)	€ 1,593,231,094.79
Others	€ 1,441,001,257.74
Advanced manufacturing and processing	€ 1,274,467,489.01

Innovation in SMEs	€ 968,474,167.31
Secure societies - Protecting freedom and security of Europe and its citizens	€ 960,195,725.53
Euratom	€ 919,268,578.15
Advanced materials	€ 751,067,971.26
Europe in a changing world - inclusive, innovative and reflective Societies	€ 728,486,542.08
Space	€ 701,666,697.63
Nanotechnologies	€ 499,153,469.32
Teaming of excellent research institutions and low performing RDI regions	€ 374,254,226.50

Table 14 - Participations per Variant of each H2020 Priority;

Sourcehttps://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Project Programme Part	Participation
Marie-Sklodowska-Curie Actions	21111
Information and Communication Technologies	13597
Smart, green and integrated transport	10832
Secure, clean and efficient energy	9509
Health, demographic change and wellbeing	9165
Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy	7681
European Research Council (ERC)	6244
Climate action, environment, resource efficiency and raw materials	5610
Research Infrastructures	5490
Innovation in SMEs	4468
Future and Emerging Technologies (FET)	3471
Others	3430
Advanced manufacturing and processing	3264
Secure societies - Protecting freedom and security of Europe and its citizens	3180

Europe in a changing world - inclusive, innovative and reflective Societies	2849
Space	2398
Advanced materials	1912
Euratom	1384
Nanotechnologies	1293
Cross-theme	769

According to the Tables 22, 23 and 24 it is possible to verify the difference between predicted and granted funding for each priority and respective variants. Regarding the ERC it's possible to conclude that, unlike for the FP7, this program was overbudgeted by a big margin. Of the nearly €13.1 billion only a bit more than €8.322 billion were attributed as of March 2020. Although it was the variant that more funding granted of all the H2020, it didn´t hit the expected budget by a margin of 36.45%. That´s more than a third of the budget not being attributed. The good sign is that the H2020 distributed amount for the ERC is still bigger than the one distributed by the FP7 which was €7.735 billion. This indicates that the research and innovation regarding top of the line research is increasing significantly. This is fundamental for the EU Knowledge-based economy that the European Commission wants to implement. Although it clearly missed the predicted budget by a significant margin, it still indicates growth and potential.

The MSCA didn´t behaved as positive as the ERC. This variant equivalent to the People Specific Program did not only missed the target budget, it actually received less funding than the previous People Specific Program. This variant of the Excellent Science priority received a total of €4.61 billion during the H2020 program as of March 2020. That is 25.17% of the available budget available for the variant. This value is also inferior by €212.477 million in comparison to the FP7. The MSCA also had approximately minus 9000 participations than the People Specific Program of the FP7. This decrease in the value is a bad sign for the European Commission since this specific variant has the aim of funding

human capital enhancement. This variant is of extreme importance for the European Commission and its main objective since the Knowledge-based economy in Europe requires investment in human capital. The reduction of the funding in comparison to FP7 numbers also indicates that the amount of human capital in the Union regarding the research and innovation sector has not, at least increased. The stabilization of the granted funding value around €4.8 billion for this variant indicates that the research and innovation sector isn´t being able to increase its dimension regarding its human capital valorisation. This matter should suffer more research since it is a key factor of the research and innovation sector.

After extensive analysis to the H2020 Participation in the Programs dashboard[32] we were able to detect interesting data. When we make a deeper division of the distributed funding by the H2020 program we can have a better picture of what sector of research and innovation a Member State is stronger.

The Excellent Science priority is the H2020 most specific and detailed priority. This section of the H2020 has only 4 variant programs and a €24.44 billion budget. However, the differences between the distribution of its budget among Member States is bigger than the total distribution of all the funding related to the H2020.

[32] https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/d23bba31-e385-4cc0-975e-a67059972142/state/0

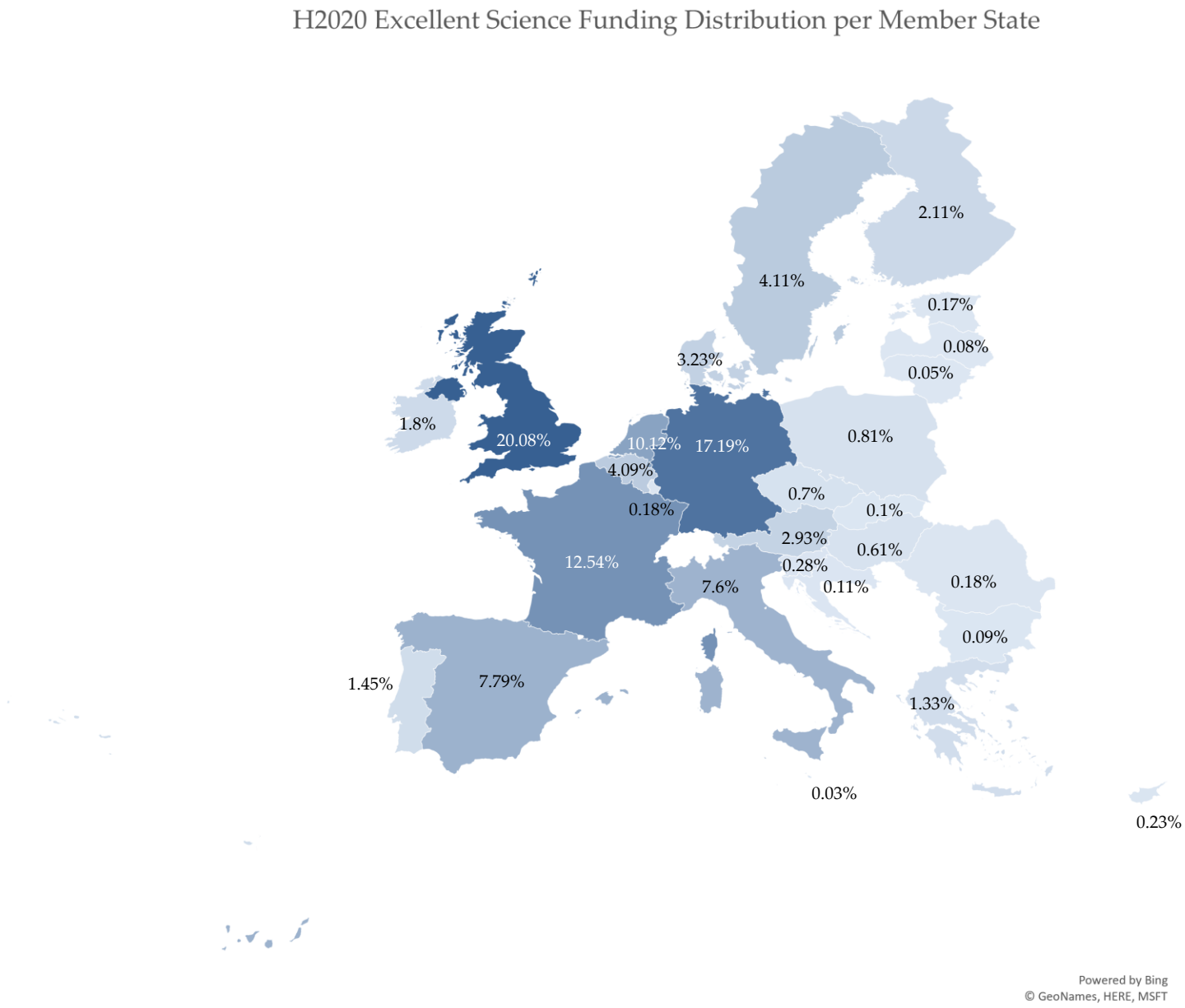


Figure 11 - H2020 Excellent Science Funding Distribution per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Once again, the UK is the country that stands the most since it receives 20.08% of the granted funding regarding this priority. It is possible to also observe that the distance between the previously identified as the countries with the bigger and better research and innovation sectors as intensified. The clear dominance of the Nordic countries, the top 5 economies plus the Netherlands, Austria and Belgium in this field is clear.

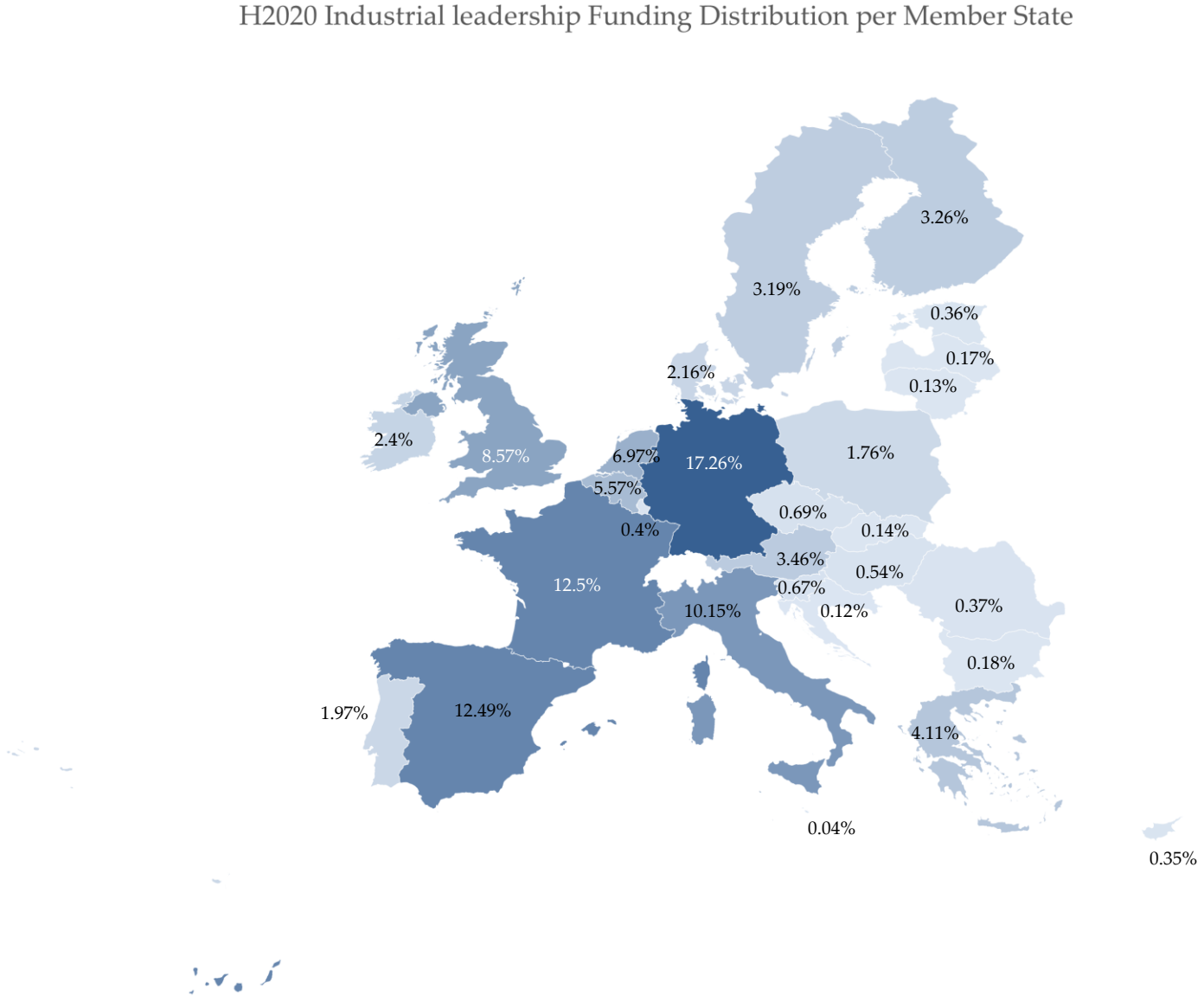


Figure 12 - H2020 Industrial leadership Funding Distribution per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

The Industrial Leadership priority gives us different and also interesting results. The UK, in this priority clearly doesn´t stand out so much. Meanwhile, Germany takes a clear position of leadership regarding this field of research and innovation. What it is surprising is the research and innovation capacity of southern countries such as Italy and Spain. Having results above the UK is positive and they would be expected to be similar

or close to France. France clearly demonstrates a research and innovation sector capable of accompanying its industrial sector. The Spanish research and innovation sector receive as much funding as the French and that demonstrates that the Spanish economy is also having good capability in improving its industrial sector.

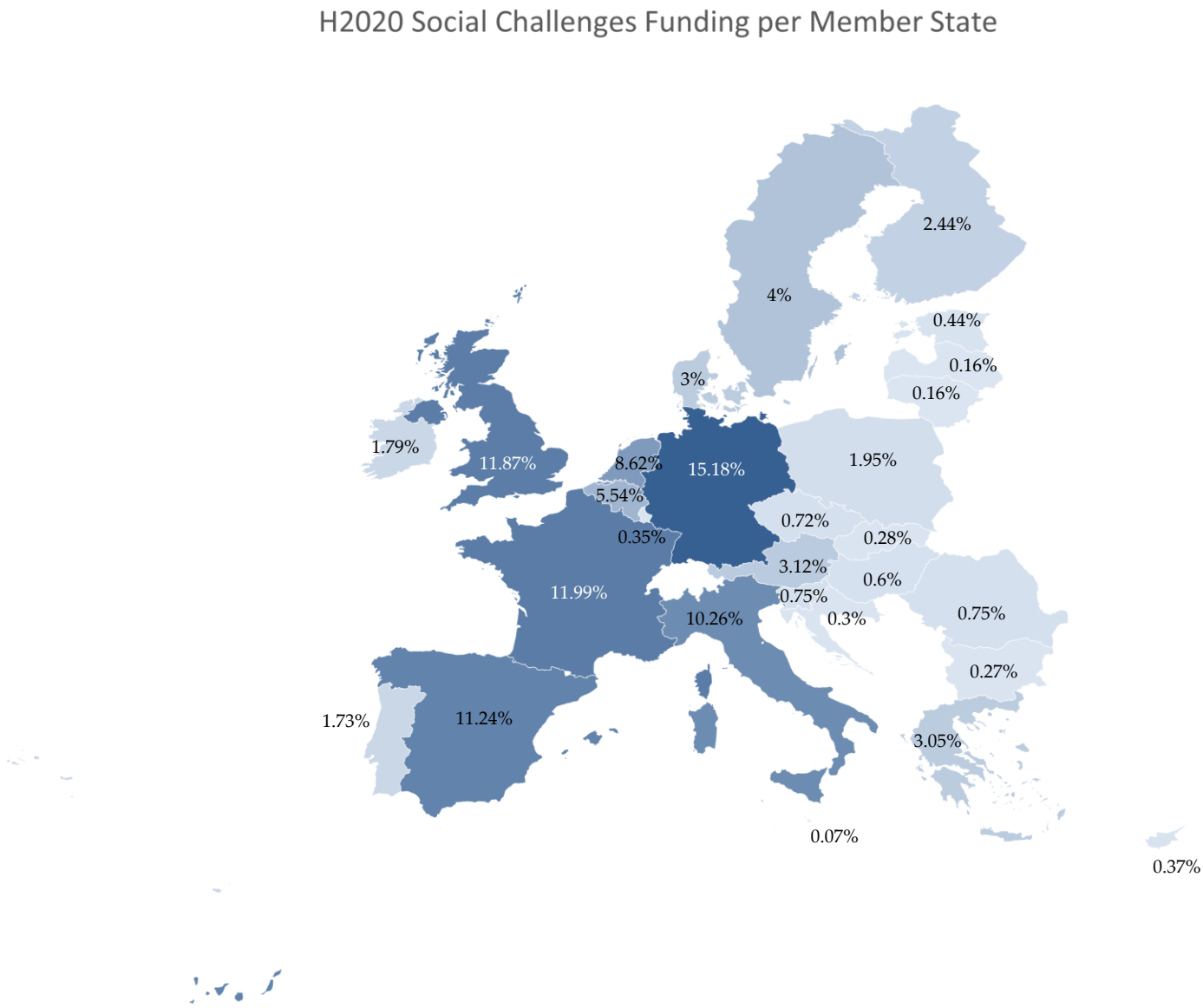


Figure 13 - H2020 Social Challenges Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

In the case of the Social Challenges priority, the presence of the peripheric economies is bigger and its possible to notice. The hegemony of the top 5 economies is still present. However, the increased presence of the Member States that normally show lower results demonstrate that the peripherical areas of the EU are able to present better results regarding the social aspects of the research and innovation sector. The Societal

Challenges priority is more open, broader and accessible leading to a bigger participation of the peripheric sectors and entities. Although the top 5 economies still take the lead on this priority, the fact of the biggest share, Germany, being of 15.18% of the granted funding demonstrates the higher level of dispersion of the funding.

Another very interesting result was regarding the H2020 Specific Objective Spreading Excellence and Widening Participation. This Specific Objective was created in order to increase cohesion regarding the research and innovation sector within the EU.

Although the attributed budget for this Specific Objective did not reach the available budget of €816 million, it had a much bigger rate of granted budget than all of the main priorities. The Spreading Excellence and Widening Participation Specific Objective had a 72.39% of the budget granted by March 2020 making it the most successful program in the H2020 regarding attributed Funding.

Table 15 - Percentage of Granted Funding per H2020 priority plus Specific Excellence and Widening Participation Specific Objective;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

Column1	Excellent Science Total Budget (€ in millions)	Industrial Leadership (€ in millions)	Societal Challenges (€ in millions)	Spreading excellence and widening participation (€in millions)
Granted Funding	16,330.824	9,809.768	17,739.139	590.693
Available Budget	24,441	17,015	29,679	816
Percentage of granted Funding	66.82%	57.65%	59.77%	72.39%

The distribution across the Member States of the funding of this Specific Objective was also quite positive. Countries such as Portugal and Cyprus had very good percentages of funding with both above 10%. It is also possible to see the eastern countries and the Baltics with very positive and encouraging results. Estonia, Poland and Czech Republic have good performances which also go along with the previous data.

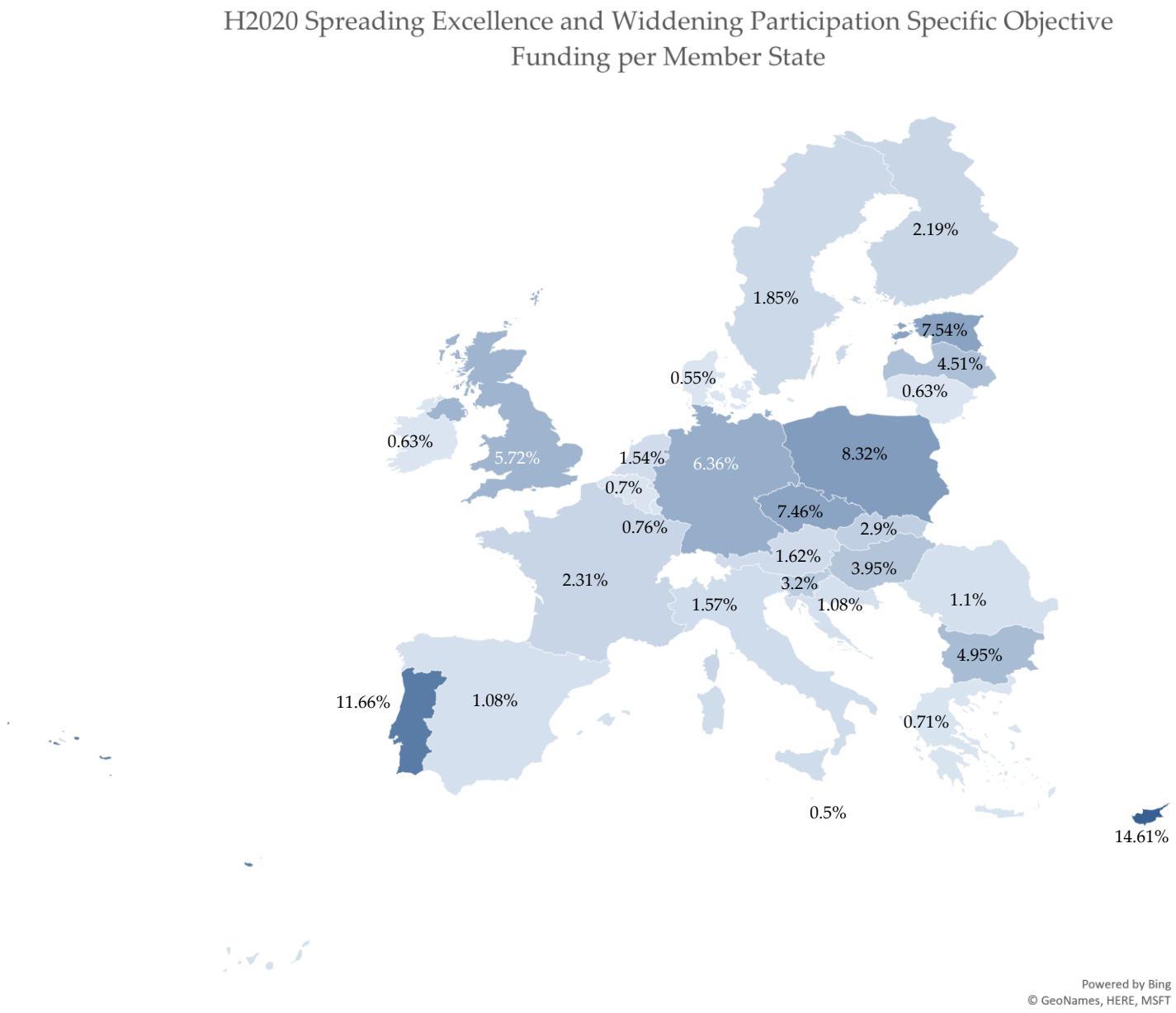


Figure 14 - H2020 Spreading Excellence and Widening Participation Specific Objective Funding per Member State; Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

The Funding received by Germany and UK is also bigger compared to the remaining top economies. This is a clear sign that the great centres of research and innovation in Europe are situated in both of these countries and to improve themselves, the peripheric one's look for entities situated in these Member States. The big presence of Portugal and Cyprus in this Specific Objective indicates that these Member States are

making big efforts in expanding, increasing and improving their research and innovation capability. It is probable the in the next program the metrics of these 2 Member States show an evident improvement. The success of this Specific Objective is however obscured by the fact that the UK, due to the Brexit, will no longer be as present in the EU research and innovation sector as before. This indicates that for future programs it is very likely that we might observe an increase, to a certain extent, of dependence on German research and innovation entities and sector in general.

Table 16 - Direct EU Budget Participation per Member State;

Source https://europa.eu/european-union/about-eu/eu-budget/revenue-income_en – others calculation

Country	Direct EU Budget Participation per Member State
AT	2.41%
BE	3.69%
BG	0.38%
CY	0.14%
CZ	1.26%
DE	20.69%
DK	1.93%
EE	0.17%
GR	1.25%
ES	8.33%
FI	1.55%
FR	16.29%
HR	0.34%
HU	0.85%
IE	1.64%
IT	12.13%
LT	0.30%
LU	0.27%
LV	0.19%
MT	0.08%
NL	4.61%
PL	3.27%

PT	1.36%
RO	1.25%
SE	2.82%
SI	0.31%
SK	0.58%
UK	11.88%

Using the same formula used in the previous section, we calculated the EU direct budget participation of each Member State (Table 26). We found that the distribution of the EU funds regarding the research and innovation programs follows the same pattern as in the FP7 with the peripheric countries having worse performances than the central ones regarding the percentual difference between the amount of direct budget participation and the received funding per priority.

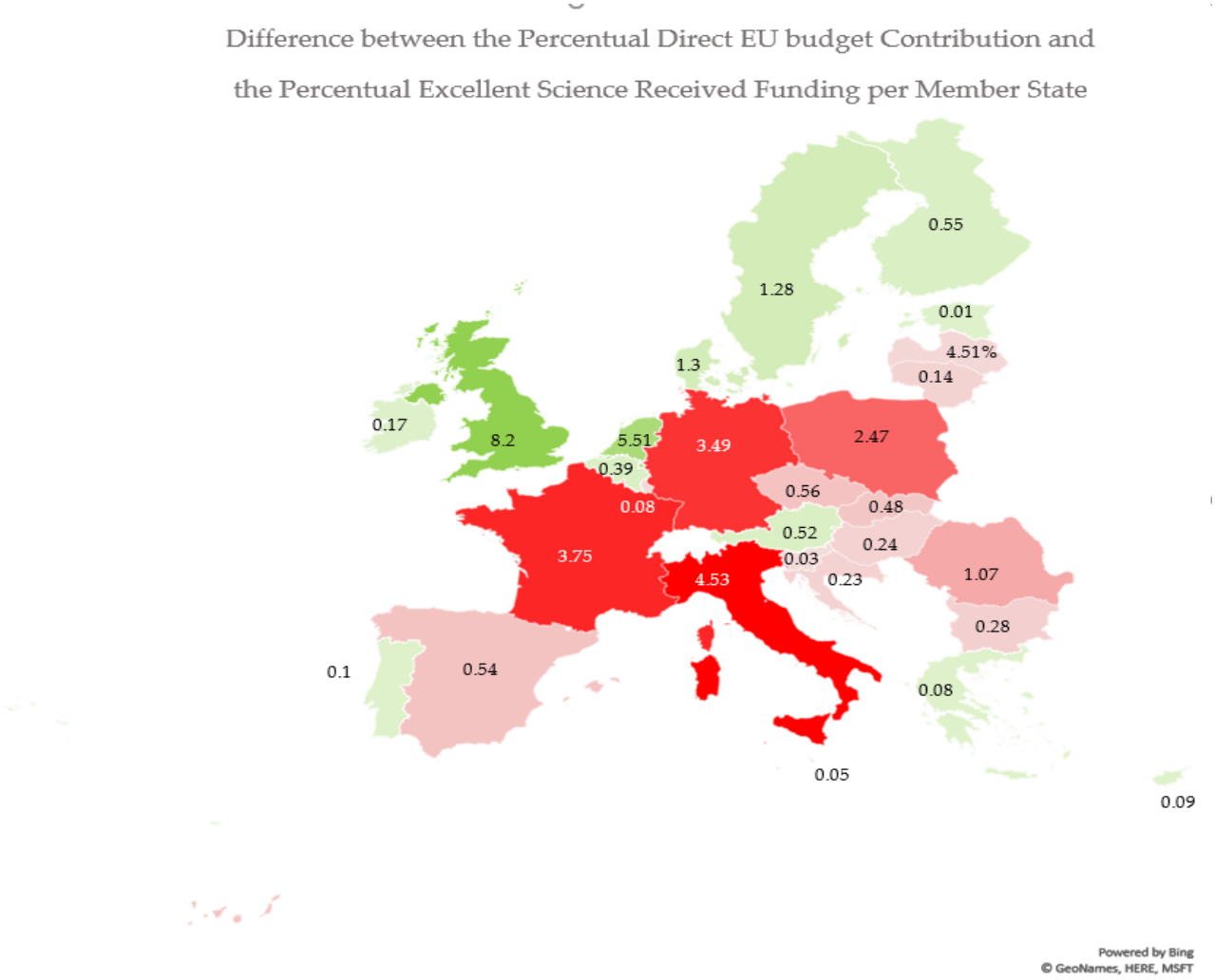


Figure 15 - Difference between the Percentual Direct EU budget Contribution and the Percentual Excellent Science Received Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726 – others calculation

The results of the percentual difference regarding the Excellent Science priority demonstrate the great difference there is regarding the top research that is done in the EU. Just as in the FP7, the UK and the Netherlands achieve the greatest net positive results regarding this metric. Although the UK has not managed to have a net positive in the whole of the Excellent Science priority as it obtained in the Ideas Specific Program, the 8.2 percentual points of positive difference towards the countries direct budget participation in the EU budget still indicates that the research and innovation sector

regarding top research hasn´t suffered a significant difference regarding which countries still have more presence in this area of the research and innovation sector. Even the Netherlands didn´t achieved as much of a positive difference compared to the Ideas Specific Program. It is an indication that the sector for high-end research and innovation is starting to expand and more countries are starting to receive funds. However, the Ideas Specific Program is not directly comparable to the Excellent Science priority since this priority englobes more variants and is a bit more complex than the Ideas Program. However, the difference is quite significant.

A great deal of surprise is the net positive presented by Portugal, Estonia, Greece and Cyprus. Compared to the Ideas Specific Program, Cyprus had already been able to achieve a percentual points positive difference, but it managed to increase it by 0.01 percentual point. It doesn´t seem much but the country is the second to last direct contributor to the EU budget so even and 0.01 percentual point difference can be significant. The other 3 managed to pass from net negative to net positive during the H2020. Estonia is almost breakeven but still suggest that it´s reinforcing the position of leader in research and innovation among the Baltic States. Portugal and Greece were two of the economies that were most affected by the financial crisis in 2008/9 and passing from a negative difference to a positive one over the course of the FP7 and the H2020 demonstrates that these countries are investing and capturing funding to improve, develop and expand their research and innovation sector. This indicates an investment in the strategy that the European Commission aims to achieve and that these countries might be able to participate in the knowledge-based economy the Commission has planned. The eastern economies keep having net negative differences with every country presenting similar differences. Germany increases its net difference while France and Italy reduce it. This indicates that these big economies are starting to improve their research and innovation sectors. Of the top 5 economies the one that has the best

behaviour is Spain. While still maintaining a net negative position, it managed to reduce that difference by around 2 percentage points.

In a more general picture, our analysis indicates that regarding the high-end research, the UK has reduced its lead in the field leaving it open for other countries to seize the opportunity. It is also possible to see that, since Germany maintained a relative stable position, the gains were made especially by the all the southern countries and Estonia, while the eastern economies maintained their percentual differences. The mechanism for funding the research and innovation sector is suffering a small transformation, not only due to the Brexit effect, but also due to the economic recover of the past years. The southern economies have bigger and better research and innovation sectors than before and it is visible in their ability to capture European funding.

SME Performance and Seal of Excellence

The SME Performance dashboard[33] and the Seal of Excellence dashboard[34] gives us a good notion of the SME landscape in the EU and the one that intends, can or has the ability to participate in the H2020 and be a part of the research and innovation landscape but it wasn´t able to participate in the H2020 program for lack of funding. As stated before, the SME proposals and SME entities awarded with the seal of excellence were proposals or entities that had good and viable proposals for projects but they weren´t able to move forward for lack of funding.

In our previous analysis we were able to verify that the Innovation in SMEs program, a variant in the Industrial Leadership priority had attributed a total budget of €968.47 million when it had only a predicted budget of €616 million. This represents an overbudget situation of 57.22%. Individually, this variant of the Industrial Leadership

[33] https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/62509062-153c-48c2-9716-afdc498336c8/state/0

[34] https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b

priority goes against the outcome of the general H2020 picture. During the FP7 analysis we also conclude that the amount of granted funding towards the SME sector was under predicted and that the companies that compose this sector are fundamental for the research and innovation sector. This results in the H2020 program further establish our conclusion that the SMEs are fundamental for the success of the research and innovation sector and for the economic future of the EU.

The EIC and the SME instruments are specially focused programs for the funding of projects focused in this type of entities. The EIC, due to its pilot characteristics, will be analysed further in detail in another section.

Table 17 - Percentual Difference between SMEs Total H2020 Contribution and the SMEs Total FP7 Contribution;

Sourcehttps://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/62509062-153c-48c2-9716-afdc498336c8/state/0 – others calculation

Country	SMEs Total H2020 Contribution (€ in millions)	SMEs Total FP7 Contribution (€ in millions)	Net Difference (€ in millions)	Percentual Difference (%)
AT	281.889	206.008	75.881	36.83%
BE	391.150	350.370	40.779	11.64%
BG	26.703	27.363	-0.659	-2.41%
CY	72.332	30.581	41.750	136.51%
CZ	60.045	57.011	3.034	5.32%
DE	1,008.036	944.691	63.345	6.71%
DK	266.003	169.041	96.963	57.36%
EE	47.439	33.358	14.082	42.21%
EL	233.114	161.366	71.748	44.46%
ES	996.997	595.708	401.289	67.36%
FI	227.168	95.894	131.274	136.90%
FR	799.546	615.953	183.593	29.81%
HR	15.700	17.135	-1.434	-8.37%
HU	83.733	81.251	2.482	3.05%
IE	215.760	132.954	82.807	62.28%
IT	756.890	569.293	187.597	32.95%
LT	21.964	17.084	4.880	28.56%

LU	25.465	11.075	14.390	129.94%
LV	10.948	5.977	4.970	83.15%
MT	5.966	8.056	-2,090	-25.94%
NL	741.810	415.485	326.325	78.54%
PL	157.213	63.434	93.779	147.84%
PT	171.558	135.455	36.103	26.65%
RO	24.244	33.256	-9.012	-27.10%
SE	262.849	218.934	43.915	20.06%
SI	73.156	42.160	30.996	73.52%
SK	21.011	20.207	0.804	3.98%
UK	842.661	899.579	-56.919	-6.33%
EU	7,841.350	5,958.679	1,882.671	31.60%

Our analysis indicates that only 5 Member States lost granted funding in the H2020 program compared to the FP7. The bad sign of this is that 4 (Bulgaria, Croatia, Malta and Romania) of those 5 Member States are peripheric and have weaker economies. Further information in Appendix 8.

Table 18 - Percentual Difference between SMEs H2020 Total Participations and SMEs FP7 Total Participations;

Sourcehttps://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/62509062-153c-48c2-9716-afdc498336c8/state/0 – others calculation

Country	SMEs H2020 Total Participations	SMEs FP7 Total Participations	Net Difference	Percentual Difference
AT	895	777	118	15.19%
BE	1309	1256	53	4.22%
BG	154	152	2	1.32%
CY	247	147	100	68.03%
CZ	282	320	-38	-11.88%
DE	2974	3379	-405	-11.99%
DK	645	496	149	30.04%
EE	188	159	29	18.24%
EL	859	772	87	11.27%
ES	3476	2675	801	29.94%
FI	497	400	97	24.25%
FR	2289	2250	39	1.73%

HR	79	84	-5	-5.95%
HU	337	417	-80	-19.18%
IE	565	492	73	14.84%
IT	2956	2421	535	22.10%
LT	102	90	12	13.33%
LU	99	57	42	73.68%
LV	57	47	10	21.28%
MT	33	50	-17	-34.00%
NL	1837	1489	348	23.37%
PL	393	348	45	12.93%
PT	667	581	86	14.80%
RO	170	230	-60	-26.09%
SE	703	667	36	5.40%
SI	268	214	54	25.23%
SK	127	94	33	35.11%
UK	2549	3041	-492	-16.18%
EU	24757	23105	1652	7.15%

The first interesting aspect when analysing the difference between the participation numbers of the H2020 program with the FP7 ones is that Bulgaria was a country that registered a decrease in the received funding regarding SMEs but obtained an 1.32% increase in participations. Although it is not a significant difference since the nominal difference was an increase of 2 participations, it is still worth to explore the reasons for such paradoxal results. The main factor that we point out is that the type of participations that Bulgarian SMEs did weren´t capable of capturing as much funding as previously. The main issue that the European Commission should look deeper is the capability of the system to create situations were such results are possible. The country of Malta also registers a big reduction in the participations. As stated as before the research and innovation sector of the country isn´t being able to attract or to incentivize the participation of SMEs in H2020 projects indicating an inability of the sector to be competitive.

Meanwhile, in the opposite direction of Bulgaria, the Czech Republic, Germany and Hungary were able to receive more funding for their SME sector while having a reduction in the number of participations by the same sector. This can be happening due to the fact that the research and innovation sector of these 2 countries are able to participate in projects with a higher added-value and that can captivate more funding per project.

Table 19 - Net Difference between Average H2020 and FP7 EU contribution per SME participation;

Sourcehttps://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/62509062-153c-48c2-9716-afdc498336c8/state/0 – others calculation

Country	Average H2020 EU contribution per SME (€)	Average FP7 EU contribution per SME (€)	Difference (€)
AT	314,959.28	265,132.33	49,826.95
BE	298,815.56	278,957.14	19,858.42
BG	173,398.80	180,018.03	-6,619.23
CY	292,843.60	208,045.03	84,798.57
CZ	212,925.59	178,159.68	34,765.90
DE	338,949.43	279,577.10	59,372.33
DK	412,407.88	340,807.63	71,600.25
EE	252,336.58	209,797.00	42,539.58
EL	271,378.62	209,023.17	62,355.45
ES	286,823.18	222,694.58	64,128.60
FI	457,078.07	239,734.01	217,344.06
FR	349,299.10	273,756.87	75,542.23
HR	198,735.09	203,982.32	-5,247.22
HU	248,465.86	194,847.15	53,618.72
IE	381,876.49	270,231.05	111,645.43
IT	256,051.93	235,147.75	20,904.18
LT	215,335.97	189,827.08	25,508.89
LU	257,223.09	194,296.13	62,926.96
LV	192,065.25	127,178.54	64,886.71
MT	180,794.17	161,119.80	19,674.37
NL	403,815.95	279,036.37	124,779.59
PL	400,034.13	182,281.95	217,752.19
PT	257,208.09	233,140.94	24,067.15

RO	142,611.21	144,589.18	-1,977.97
SE	373,896.35	328,237.04	45,659.31
SI	272,970.11	197,007.31	75,962.81
SK	165,442.78	214,971.88	-49,529.11
UK	330,584.90	295,816.96	34,767.94
EU	316,732.65	257,895.66	58,837.00

When analysing the differences between average funding received per SME participation it is possible to understand the situation that caused such previous results. The negative difference in these averages correspond mostly to the countries that achieved also a reduction in funding granted. The only two exceptions are the UK which was able to receive more per participation which indicates that its elevated reduction in the participation is the main cause for the reduction in received funding. The case of Malta is similar since the averages have increased but the reduction in the number of participations has a big impact.

The interesting aspect of the H2020 is that the Commission created a specific instrument to help SMEs expand their activities and developing new market or growth strategies. The SME Instrument was exclusively for SME entities and it was part of the Commission effort to increase competitiveness of SMEs across the Union.

Table 20 - SME Instrument Granted Funding and Participations per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b– others calculation

Country	SME Instrument Granted Funding - Percentage of Total SME Granted Funding	SME Instrument Participations - Percentage of Total SME Participations
AT	20.00%	16.20%
BE	8.23%	6.34%
BG	13.39%	10.39%
CY	1.54%	4.45%
CZ	17.68%	10.64%

DE	18.73%	13.42%
DK	46.08%	36.90%
EE	54.94%	37.23%
EL	5.07%	4.42%
ES	35.37%	30.38%
FI	53.35%	35.61%
FR	23.62%	15.51%
HR	13.87%	10.13%
HU	37.56%	29.08%
IE	48.22%	25.84%
IT	23.94%	25.85%
LT	24.85%	32.35%
LU	4.49%	11.11%
LV	18.71%	29.82%
MT	10.17%	18.18%
NL	18.73%	14.26%
PL	24.96%	27.23%
PT	20.99%	19.94%
RO	5.33%	7.06%
SE	49.75%	38.12%
SI	24.90%	26.87%
SK	10.34%	18.90%
UK	19.80%	19.18%

As it is possible to observe, the SME instrument was able to fund a good portion of the amounts that each Member State received for the SME sector. However, it is possible to verify that there is a big gap between some Member States. Some of the Member States SME sector received more than 30% of their funding through the SME Instrument while others, such as Romania for example, only received a fraction of the total funding through the SME Instrument. Because the SME Instrument purpose is to fund close-to-market projects this indicates that the countries with a higher SME Instrument percentage have a SME sector that is much more active, attractive, competitive and dynamic than some of its Union counter parts (see Appendix 10). We

advise the European Commission to proceed with further research since this type of situations, where the amount of received funding and the amount of participations appear to have no correlation between themselves, are unusual.

Table 21 - Global Seal of Excellence Performance;

Source https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b – others calculation

Call Deadline Year	Proposals	Proposals with the Seal	Requested EU Contribution for Proposals with the Seal (€ in millions)	Requested EU Contribution (€ in millions)
2014	8030	460	371.077	2,313.860
2015	11008	1912	2,391.881	6,540.806
2016	11863	2429	2,731.104	6,588.270
2017	15151	3980	4,923.569	11,025.928
2018	14324	3277	3,604.852	10,057.343
2019	16119	4094	4,883.509	13,285.256
2020	1826	573	1,067.427	3,294.578
Total	78321	16725	19,973.419	53,106.041

Regarding our analysis of the Seal of excellence it is possible to verify that the SME sector is big and between 2014 and March 2020 has requested €53 billion in EU funding. The SME sector is dynamic and willing to risk and to innovate and the numbers presented by the Seal of Excellence dashboard[35] prove it. The amount of proposals awarded with the Seal was 21.35% which indicates that one fifth of all the presented proposals were only rejected for lack of funding capability see Appendix 11).

[35] https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b/sheet/0514f307-0cff-484a-bfce-e7730337bdd1/state/0

Table 22 - Percentage of Proposals awarded with Seal of Excellence;

Source https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b – others calculation

2014	2015	2016	2017	2018	2019	2020
5.73%	17.37%	20.48%	26.27%	22.88%	25.40%	31.38%

The amount of proposals awarded with the seal has increased over the period of the program and it means that the SMEs concurring with proposals are creating very interesting proposals and that the sector is starting to deliver proposals that go along towards the European Commission goals. We can conclude that this increase in rejected proposals awarded with the seal is due to quality and not to existent budget constraints since the first two years, much likely, there was not an overall budget constraint but due to the fact that might be a maximum number of proposals awarded with funding to each call. It is also positive to see that since 2016, at least one fifth of the proposals were awarded with the seal meaning that the proposal quality and the projects quality have been constantly high. The conclusion is that the proposals that were approved were of high quality and that gives reassurances to the European Commission that the programs that support the SME sector need to be expanded and that it promotes high quality projects.

Table 23 - Seal of Excellence EU Member States Performance;

Source https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b – others calculation

Country	Applicants	Applicants in Proposals with the Seal	Funded Applicants	Requested EU Contribution (€ in millions)	Requested EU Contribution for Proposals with the Seal	Granted EU Contribution (€ in millions)

					(€ in millions)	
AT	1,295	394	143	921	432	58
BE	1,284	295	91	939	377	46
BG	1,291	99	16	542	63	4
CY	277	38	12	169	46	1
CZ	829	100	29	279	71	11
DE	5,240	1,305	407	3,798	1,536	208
DK	2,238	700	241	1,949	893	133
EE	1,015	198	71	525	211	27
EL	1,220	125	38	513	73	12
ES	12,825	3,127	1,052	6,354	2,653	371
FI	2,535	690	176	2,338	976	129
FR	4,735	1,187	367	4,299	1,619	219
HR	462	36	8	145	38	2
HU	2,439	411	98	1,211	357	30
IE	1,572	383	150	1,285	512	112
IT	13,908	2,390	754	6,085	1,798	188
LT	508	75	33	124	35	6
LU	162	25	11	86	21	1
LV	656	92	17	306	84	2
MT	121	19	6	42	11	2
NL	3,307	823	259	2,524	1,079	142
PL	2,355	275	107	830	278	40
PT	1,652	344	134	967	362	39
RO	728	44	12	147	14	0.6
SE	3,117	935	273	2,948	1,299	143
SI	1,599	214	72	577	162	19
SK	763	92	25	453	111	5
UK	6,524	1,490	490	4,376	1,573	186
EU	**74,657**	**15,906**	**5,092**	**44,733**	**16,679**	**2,137**

The amount of granted funding of €2.13 billion is also promising. Beyond the already analysed €919 million distributed under the Industrial Leadership priority, the total amount to help SMEs under the SME Instrument is a significant boost to the sector. The funding of the cooperation between the research and innovation sector and the SMEs

is fundamental for the development of competitiveness and technological development in the economy.

It is also interesting to see that the countries with more SMEs applying are Spain and Italy. The difference between both countries and the third, Germany is very big. The SMEs in these countries demonstrate willingness to participate in these programs and projects more than the others. Spain is the only country that has more than a thousand applicants both with awarded seal and with granted funding. For more details see Appendix 12.

H2020 Projects

The H2020 projects analysis was made to give us a perspective of the type of projects, actions and the amount of grants that have been funded until April 2020.

Table 24 - Excellent science Priority Projects General Metrics;

Theme	Number of Projects	Number of participations	EU Contribution (€ in millions)	Participations per projects	EU contribution per project (€ in millions)	EU contribution per participation (€ in millions)
ERC	5473	6732	8,953.554	1.23	1.636	1.330
MSCA	8450	21789	4,763.690	2.58	0.564	0.219
Research Infrastructure	290	5589	1,831.617	19.27	6.316	0.328
FET	404	3475	1,593.467	8.60	3.944	0.459
Totals	14617	37585	17,142.328	2.57	1.173	0.456

Source https://webgate.ec.europa.eu/dashboard/sense/app/93297a69-09fd-4ef5-889f-b83c4e21d33e – others calculation

The Excellent science priority can be considered, because of the variants it contains, their purposes and their focused objectives the priority that aims to fund the

high-end research and innovation in order to create new knowledge as well as new products and services. This priority is the one that registers the least dispersion of funds and participations. In the Excellent science priority 91.9% of the Funding is presented in eleven of 28 Member States. The same Member States also have 86.9% of all participations. All these eleven Member States are countries that have been mentioned across this analysis has being the ones with better economies. In the research and innovation sector, which is represented very well by this priority, the Netherlands even present better metrics than Spain and Italy. The amount of participations regarding this type of programs should be more dispersed in order to spread the funding as well as the research and innovation capability. This is a sign that the EU and the European Union are failing in their capacity to increase the peripherical and weaker economies research and innovation potential of high-end technology. The European Commission should attempt to make further research and bolder steps in order to increase cohesion in this sector. It is also notable that the countries that follow the eleven bigger economies in the Union are the southern countries of Portugal, Greece and the country of Ireland. This indicates that the Eastern Member States, Cyprus, Malta and the Baltics are being left behind in a crucial sector for the economic success of any major economy, especially in a knowledge-based economy such as the one the European Union intends to create. For more information see Appendix 13.

Table 25 - Industrial Leadership Priority Projects General Metrics;

Source https://webgate.ec.europa.eu/dashboard/sense/app/93297a69-09fd-4ef5-889f-b83c4e21d33e – others calculation

Theme	Number of Projects	Number of participations	EU Contribution (€ in millions)	Participations per projects	EU contribution per project	EU contribution per participation (€)

					(€ in millions)	
Information and Communication Technologies	1626	13610	5,260.732	8.37	3.235	386,534.32
Advanced manufacturing and processing	246	3295	1,288.223	13.39	5.237	390,963.02
Innovation in SMEs	2372	4518	1,011.604	1.90	0.427	223,905.23
Advanced materials	147	2139	853.802	14.55	5.808	399,159.27
Space	388	2398	702.004	6.18	1.809	292,745.72
Nanotechnologies, Advanced Materials and Production	346	1293	499.023	3.74	1.442	385,941.80
Biotechnology	116	749	350.082	6.46	3.018	467,399.27
Access to risk finance	12	48	9.371	4.00	0.781	195,223.61
Industrial Leadership - Cross Theme	2	30	3.976	15.00	1.988	132,515.82
Totals	5255	28080	9,978.816	5.34	1.899	355,370.94

In this priority, due to its major focus on the Industrial sector, we observe a difference compared to the Excellent Science priority. The major four Member States both in participations and EU contribution are the four biggest industrial players in the EU which are Germany, France, Spain and Italy. Curiously, these four Member States combined have 52.4% of all participations and EU contributions. However, a curious effect can be observed. Germany and France have higher percentages of EU received funding than they have of percentage of participations. Meanwhile, both Spain and Italy

have higher participation percentages then they have of received funding. This leads us to conclude that the effect of the Person-month[36] system to attribute funding, which is indexed to each country cost of living, is making countries receiving more in percentage more funding than the participations they do and vice-versa. This can lead to an inequality between Member States that can deepen the lack of cohesion and not the other way. Countries that have cheaper human capital, according to our analysis, tend to need to make a much bigger number of participations in order to receive as much as their wealthier counterparts. This can create an unbalanced situation inside the same project. This type of situation should be explored by the European Commission and the system should also be rethink, redesigned or even changed completely. For more information see Appendix 14.

Table 26 - Societal Challenges Projects General Metrics;

Source https://webgate.ec.europa.eu/dashboard/sense/app/93297a69-09fd-4ef5-889f-b83c4e21d33e – others calculation

Theme	Number of Projects	Number of participations	EU Contribution (€ in millions)	Participations per projects	EU contribution per project (€)	EU contribution per participation (€)
Smart, green and integrated transport	1467	11128	4,538.305	7.59	3,093,595.55	407,827.52
Health, demographic change and wellbeing	999	9176	4,347.349	9.19	4,351,700.65	473,773.86
Secure, clean and efficient energy	1171	9628	3,491.486	8.22	2,981,627.26	362,638.71
Food security, sustainable agriculture and	713	7702	2,239.809	10.80	3,141,386.99	290,808.74

[36] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

forestry, marine and maritime and inland water research						
Climate action, environment, resource efficiency and raw materials	578	5610	1,747.490	9.71	3,023,338.90	311,495.52
Secure societies - Protecting freedom and security of Europe and its citizens	319	3186	960.529	9.99	3,011,063.79	301,484.42
Europe in a changing world - inclusive, innovative and reflective Societies	389	2880	737.806	7.40	1,896,674.18	256,182.73
Societal Challenges - Cross-theme	2	4	0.280	2.00	140,000.00	70,000.00
Totals	5638	49314	18,063.054	8.75	3,203,805.17	366,286.52

The Societal Challenges priority presents distribution and participation levels more favourable even if only in comparison to the other priorities. This priority top eleven Member States present an 88% of the granted funding. It is still very close to the 90% mark but still lower. It also shows more favourable numbers regarding the number of participations which is 82.7%. This indicates that, despite having a more dispersion of funds and participations, this priority still shows quite big inequality levels. Although the top eleven Member States are not the ones mentioned in the Excellent Science priority. This is a sign of improvement. Among the top eleven nations in the Societal Challenges priority there is Greece breaking the pattern. These eleven countries are followed by Finland, Ireland and Portugal of which Portugal presents the lowest percentage of

funding and the higher percentage of participations while Finland is the exact opposite demonstrating again that the funding distribution system is quite ineffective regarding the procurement of cohesion in the research and innovation sector. For more information see Appendix 15.

H2020 EIC Pilot

The EIC Pilot is a recently created program that was introduced in the H2020 through a reformulation of the program and entered in action with calls and granted funding in January 2018. The purpose of this Pilot, as stated previously, is to support "top-class innovators, entrepreneurs, small companies and scientists with bright ideas and the ambition to scale up internationally. It brings together the parts of Horizon 2020 that provide funding, advice and networking opportunities for those at cutting edge of innovation"[37] according to the official European Commission website. The EIC Pilot started to fund projects from specific variants of the priorities of the H2020. The proposals destined to the Future and Emerging Technologies (FET), Fast Track to Innovation (FTI) and Innovation in SMEs (SME Instrument) could be applied to the EIC funding if they had some of the previously mentioned characteristics.

The EIC Pilot aims at verifying if such a program would be viable and would have acceptance across the sector and especially in the EU.

The first positive fact we found was that in the Member States, every single proposal was accepted. With an 100% acceptance rate for a Pilot program it is a very good sign to the European Commission that the EIC might be a very requested program regarding proposals. It also indicates a willingness of the European entities to rick and to innovate which is very good as well. Especially when having into account that the EIC Pilot aims at funding projects for scale up businesses and for cutting edge and high-end

[37] https://ec.europa.eu/research/eic/index.cfm

technology. From all the 2006 eligible proposals all of them became a signed grant and it received funding.

Another curious fact we discover was the fact that the amount of requested budget is inferior to the amount of granted funding. This is very unusual for such a program, however, since the EIC has a role in help a certain entity to expand and to innovate, it connects the companies to private funding as well. This means that a lot of the EU contribution we verify is acquired through private investment mechanisms that help this type of entities scaling up.

Table 27 - EIC General Metrics;

Source https://webgate.ec.europa.eu/dashboard/sense/app/5046bacd-e195-4efe-9161-942854c7393c – others calculation

Budget Topic	Indicative Budget (€ in millions)	Requested EU Contribution (€ in millions)	EU Contribution (€ in millions)	Average of Participants per Project
Future and Emerging Technologies (FET)	351.7	295.898	260.177	3.91
Fast Track to Innovation (FTI)	200	189.858	330.316	5.02
SME Instrument	1,131.998	830.936	2,476.913	1.03

The Budget that the EU had planned for the three topic areas was superior than the requested budget, even with all the projects being accepted showing a good sign from the side of the sector that it can pursue its expansion objectives and that the EU has available budget to allow them to do it. The SME Instrument projects have received more than three times the requested value. Assuming that a good amount of such money has come from the private sector willing to finance and invest in these projects and these companies, it is an amazing sign that the EU programs and the EIC in particular can generate confidence and willingness to invest and finance projects that aim at the creation

of new value, the modernization of the economy and high-end research and innovation. Such result is very satisfactory to the European Commission objective of creating a knowledge-based economy. The EIC Pilot, in terms of funding granted and caption of private interest is a success (see Appendix 16).

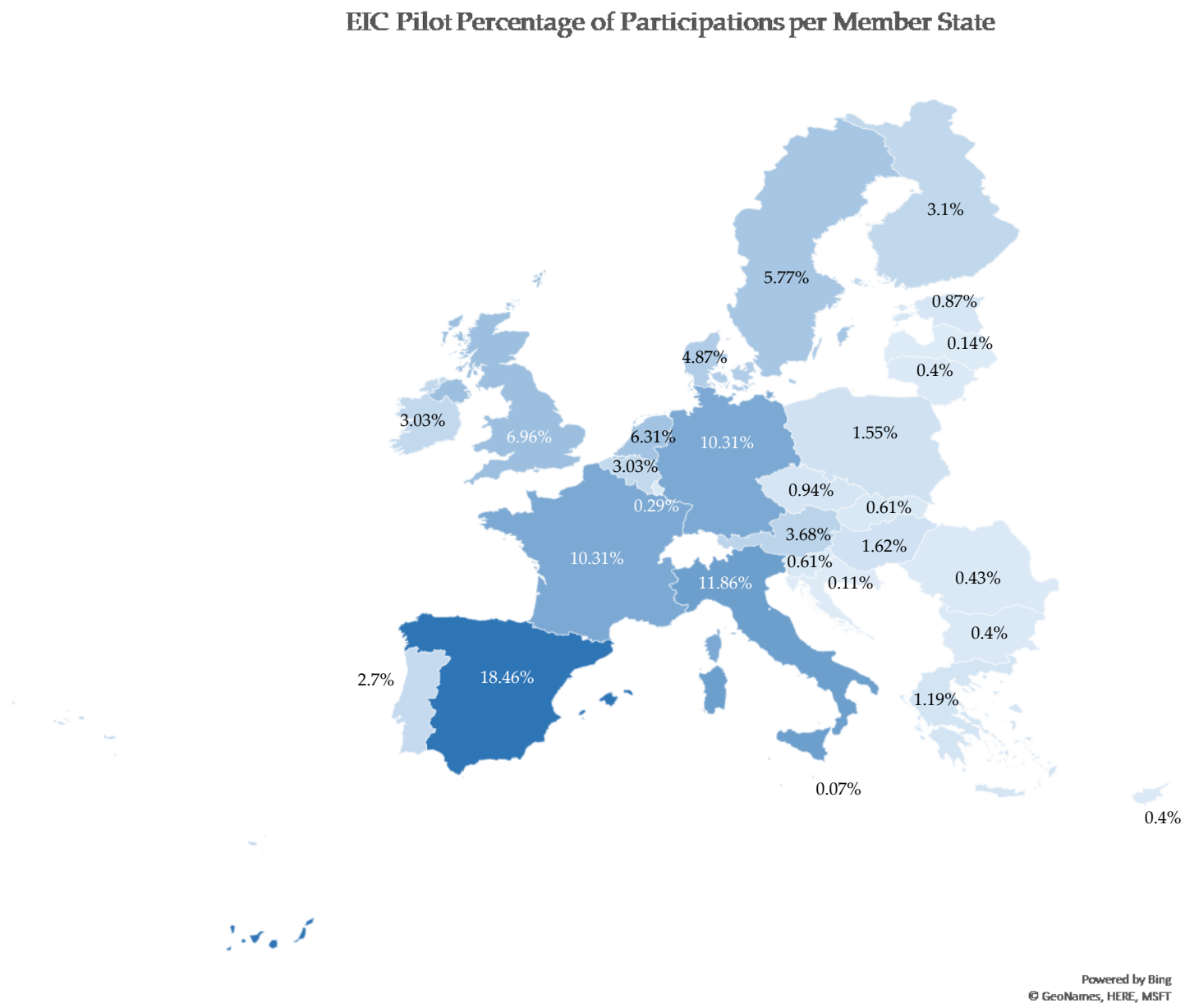


Figure 16 - EIC Pilot Percentage of Participations per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/5046bacd-e195-4efe-9161-942854c7393c – others calculation

Regarding the dispersion of the participations among the Member States we found interesting results. The EIC Pilot was the only analysed program of the H2020 where Spain and Italy managed to equivalent an equal or even better performance regarding participations. Since this program is versed on funding dynamic and high-end technological projects and scale-up of SMEs it is very positive to observe Spain and Italy capable of obtaining such good metrics. This means that the research and innovation sectors as well as the market and economic dynamism of these countries is increasing their capabilities and being able to participate in more restricted and demanding EU programs. This is a clear sign of the maturity of the research and innovation sector and of economic recovery since the H2020 program started in 2014 after the financial crisis in 2008/9. The maturity shown by these two countries demonstrates that both have made positive progress regarding their research and innovation sectors. It also goes along with the fact that the SMEs are a big and important part of the economic tissue of the weaker and peripherical economies. The fact that most of the EIC funding and the huge majority of participations were for the SME Instrument it demonstrates once again that the SME sector in these countries has a major importance in their economy, their economic development and the research and innovation capacity.

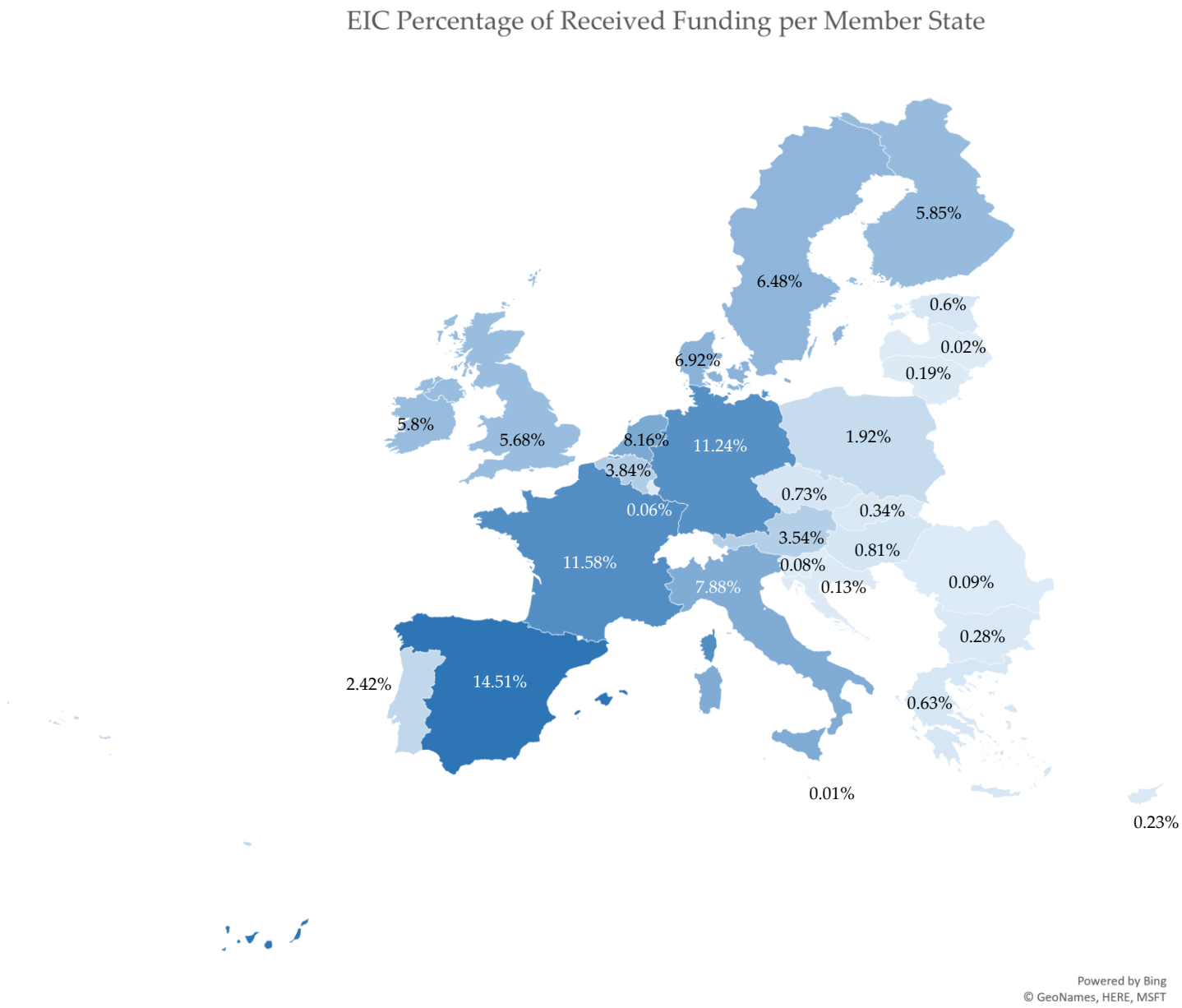


Figure 17 - EIC Percentage of Received Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/5046bacd-e195-4efe-9161-942854c7393c – others calculation

Regarding Funding it is possible to observe in what concerns the EIC Pilot the same issue that appeared across the H2020 and the FP7. A group of countries manage to have bigger percentages of funding received than the same countries percentage of participations. In the EIC program it is noticeable the better performance of countries such as Germany and France regarding their ability to receive a bigger percentage of

funding than the one they obtained in the metric of participations. The Nordic countries once again have the ability benefit from this effect. However, since the southern countries of Spain and Italy have shown a capacity to increase their participations in programs that are created specifically to fund more complex and demanding projects it is possibly that these countries at least might be able to come to a similar situation as the most developed countries. The EIC still uses the same system to distribute funding as the H2020 does. Therefore, the European Commission should reconsider changing the systems since the EIC is a program designed to fund high-end research and aid companies, especially SMEs, to expand, improve or scale-up. A program with these objectives and purposes is fundamental for the research and innovation sector across the EU and it can be a fundamental program regarding the achievement of cohesion in the research sector and for economic wellbeing in general.

A good result coming from this pilot is the possibility of participation by all the Member States. This is quite positive since the EIC is available only for the last three years of the H2020 program while the last one is still ongoing. If all the Member States were able to participate in this pilot means that the research and innovation sector is evolving and maturing across the Union. We conclude that the EIC Pilot regarding participations and funding distribution had good results and that the European Commission has good results to justify the creation of a program solely with the purpose of funding scale-up, close to market and application of high-end research.

Chapter II - FP7 and H2020 Reported Intellectual Property Rights and Scientific Publications Results

The FP7 and the H2020 programs have a joint dashboard (European Commission, 2020c) that gives detailed information about all the Intellectual Property Rights (IPRs) and Scientific Publications (SP) that has been reported aa a result of a signed research project (grant agreements). The analysed dashboard[38] presented us with very interesting results regarding the outcome of the FP7 and the H2020 programs.

When we analysed the global picture of the SP outcome regarding both programs, we found that the country with most Publishers of the peer review publications was the United States. This is a very positive aspect. Although it might surprise at first that the country that publishes the most SPs from EU funded projects is not a Member State, it is important that the USA, the biggest research and innovation sector in the world and the biggest market as well, have its publishers taking notice of the research and innovation that is made across the EU. Since the USA has some of the most prestige publishers in the scientific field, it is good for the EU research and innovation to be mentioned and credited in such publishers. The second country is the UK. This is also positive since the country is home of several of the most prestigious universities in the world and has one of the biggest research and innovation sectors in Europe as we´ve seen across our analysis. These two countries have additionally some of the most prestigious scientific publishers. For the SPs that are coming from EU funded projects to be published in the most prestigious scientific publishers it indicates that the research and innovation that the EU programs, both FP7 and H2020, have been financing, are creating value and good results.

[38] https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f

This is fundamental for the capacity of Europe and the EU to compete in all levels with the biggest research and innovation creators which are the US and Japan (Kokko et al., 2015).

Globally, there were 25863 projects creating 416594 publications. Almost three fourths of these were peer reviewed articles. This is the standard procedure for the scientific method. This indicates that most of the research and innovation driven by the EU programs is positively validated across their fields demonstrating once again that the EU research and innovation sector has recognised quality.

The H2020 program started only in 2014 and it hasn´t ended. Assuming that the program will follow the trend of the FP7, we expect that most of its results will be published or reported after it has ended. Therefore, we can only analyse and compare these results of the H2020 along the same period of the FP7. Since the H2020 has been going for over 6 years, period of 2014-2019, we will compare its results with the ones obtained by the FP7 in the period 2008-2013.

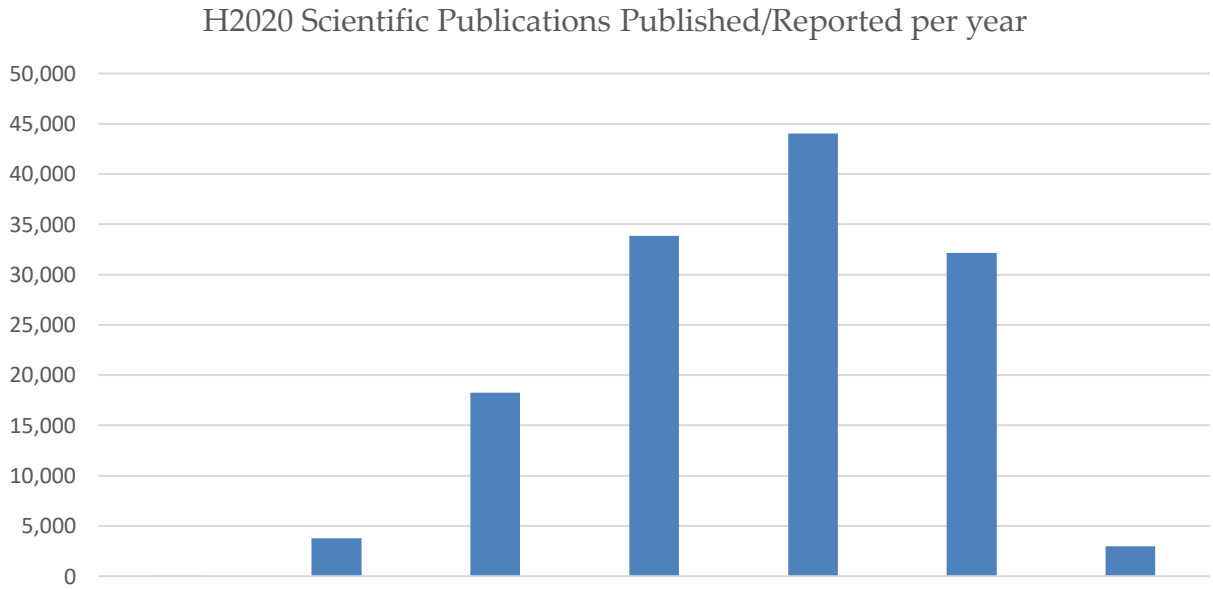


Figure 18 - H2020 Scientific Publications Published/Reported per year;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

As of April of 2020, the H2020 program has 11033 projects that have seen its SPs published or reported. These projects have already an accomplished 135142 SPs published leading to an average of SPs per project of 12.25. The FP7, in the corresponding period, achieved 54256 SPs regarding only 4725 projects. This metrics achieved for FP7 corresponding period an average of 11.48 publications per project. Although the publication per project has improved slightly, the best and most positive sign is the big gap between the reported SPs by the end year of the FP7 and the same results regarding the H2020. Although the year hasn´t ended yet, the H2020 already presents more than the double of SPs than its predecessor program. This is indication that the number of SPs published and reported in the H2020 Program will be much higher than the FP7. This indicates that the H2020 will have, at least, more quantity of SPs than the FP7. We still don´t have available information to verify if there will also be an improvement in SP quality but that is also to be expected. Since the H2020 average of SPs per project is slightly higher than the FP7 one for the corresponding period, this makes us believe that the number of SPs will start to increase until reaching its maximum around 2024. We are assuming that the H2020 will follow a similar trajectory regarding SPs published or reported similar to the FP7, therefore, it would have the year with most published SPs four years after the end of the program. For more information on the FP7 see Appendix 16.

Table 28 -Difference in percentual points between FP7 and H2020 Scientific Publications type;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Publication Type	FP7 SPs type (%)	H2020 SPs type (%)	Difference in Percentual Points
Peer Reviewed Article	65.27%	55.98%	-9.29
Conference Proceeding	18.03%	28.83%	10.8
Other	0.04%	8.19%	8.15

Book Chapter	4.66%	3.88%	-0.79
Article	11.43%	1.30%	-10.14
Thesis Dissertation	0.0018%	1.04%	1.039
Monographic Book	-	0.79%	-
Book Series	0.55%	-	-

Regarding the type of publication, it is possible to observe a significant shift. The biggest negative differences are in both article categories. The H2020 had a reduction of 9.29 percentual points in the published or reported peer reviewed articles and a reduction of 10.14 percentual points in published or reported articles. Meanwhile the conference proceeding increased 10.8 percentual points and the other category 8.15. This shows that there has been a shift regarding the method that the European projects have chosen to publish their results. This is indicative of a changing research and innovation sector and a diversification of the typology of projects. Since the H2020 has managed to increase the number of projects funded by the EU it is also positive since it is giving more space for other types of areas and methods of research to be explored.

Due to the fact that the H2020 is broader than the FP7, the comparison between both programs will be made based on the previous assumption that only the Ideas and the People Specific Program were composed of one single thematic topic, namely the ERC and the MSCA respectively. We will make a brief comparative analysis between these two Specific Programs and their respective variants inside the H2020 Excellent Science priority.

Regarding the FP7 Specific program and its comparison to the H2020 MSCA variant, it is possible to verify that for the corresponding periods, the H2020 managed to obtain much more SPs than the FP7. The Funding increased is a reflection of such increase

since for this analysis is only entering funding that was granted to projects that have already reported or published SPs.

Table 29 - Scientific Publications Results Comparison of FP7 Peoples Specific Program and H2020 MSCA variant; Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Specific Program	SPs during the respective analysed period	Projects received funding during the respective analysed period (€ in millions)	Average Funding per SP (€)
FP7 People Specific Program	9389	332.941	35,460.73
H2020 MSCA variant	29236	2,650.392	90,655.08

Therefore, it is more relevant to observe and analyse the substantial increase that the average of funding per SP has registered. Since that during our previous analysis we verified that there was in fact a reduction of average funding per participation, it is possible that due to the fact that the H2020 program is still an ongoing program, several of the projects under the MSCA variant have SPs that have been analysed and already published while waiting for the evaluation of the remaining SPs making the average of funding per SP higher than it really is. However, it is surprising the huge difference between the amount of the SPs released compared to the FP7 in the corresponding period. In the SPs that have been already published or reported, the H2020 variant observed a little more than 2 time the value. Regarding funding granted to the respective projects, the H2020 variant obtained almost seven times the FP7 value for the corresponding period. With more than two times the already published or reported SPs it is to be expected a much higher number of total SPs across the board from the H2020 compared to the FP7.

Regarding the FP7 Ideas Specific Program and its comparison to the H2020 ERC variant, we observe similar changes. The number of SPs already published or reported and the amount of funding regarding the respective projects is by far superior then the values regarding the corresponding period for the FP7 program. In the case of the H2020 ERC variant, the difference is much bigger than the MSCA towards the People Specific Program.

Table 30 - Table 43 - Scientific Publications Results Comparison between FP7 Ideas Specific Program and H2020 ERC variant;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Specific Program	SPs during the respective analysed period	Projects received funding during the respective analysed period (€ in millions)	Average Funding per SP (€)
FP7 Ideas Specific program	3,538	146.155	41,309.96
H2020 ERC variant	36,224	5,843.784	161,323.54

Regarding the number of SPs already published or reported, the H2020 ERC variant registered for the corresponding period a result 9.23 times higher than the FP7 counterpart. Regarding the funding granted to the respective projects, the increase was almost 39 times. However, the average funding per SP published or reported only doubled. This is an indication that in both of the situations, the H2020 program managed to accelerate its SPs publication or reporting while increase less the amount of funding per SP published or reported. The values of the increased SPs are lower than the amount of funding granted for the respective projects. This has happened because, as we have analysed, in these programs there was a small increase in the amount of the funding going to the peripherical and weaker economies that are less efficient and have research

and innovation sectors in lower stages of development. However, the fact that the average funding per SP is the metric that least increase when comparing both Programs. This is very positive because it indicates that if the European Commission manages to make a more equal distribution of the funds, it will make possible for the peripherical and weaker economies to develop faster their research and innovation sectors leading to a better performance in this metric after some time. That will be a fundamental turning point for the creation of the knowledge-based economy that the European Commission aims to achieve.

Table 31 - H2020 Priorities Average Funding per Scientific Publication;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

H2020 Priority and Special Objective	Publications	EU Contribution (€ in millions)	Average Funding per SP (€)
Excellent Science	77318	10,681.860	138,154.90
Industrial Leadership	23484	5,865.363	249,759.97
Societal Challenges	26162	9,417.215	359,957.77
Spreading Excellence and widening participation	4656	285.716	61,365.15
Science with and for society	481	159.442	331,480.07

Of all the 3 main H2020 priorities, the Societal Challenges have the biggest average of funding per SP of all the three priorities. There are three main factors explaining this result. Our previous analysis as shown that the Societal challenges priority was the broader of all the 3 priorities and for that reason managed to have more participations from the peripheric research and innovation sectors since those sectors were able to participate more in this priority rather than the more complex and demanding Excellent Science or, to a lesser degree, the Industrial Leadership priority. The combination of these two factors might result in the average of funding per SP of the Societal Challenges

priority being the highest. The bigger participation of less matured research and innovation sector might lead to a reduction in efficiency. The fact that this priority is also much broader also facilitates to increase this average. The variety of projects that can be funded under the Societal Challenges priority increase the discrepancies between the value of each project and their ability to produce SPs. Therefore, the average of funding per SP published or reported might have been inflated by more complex projects or different field of research might produce more or less SPs with the same amount of funding.

The Industrial leadership has a significant funding amount per SP since the main focus of this priority is the research and innovation in industries and it is inside it that there is the SME Instrument variant. Due to the more practical approach of the priority it is expected that the cost of each SP might be increased due to the necessity of the participation of industrial entities to aid those that intend to do the research and innovation part of the project. It is also possible that inside this priority there are projects that aim at implementing or discovering new services or products in the form of pilots. These type of projects also need industrial entities to help to the adaptation of the product. Another aspect is that, as mentioned before, in our analysis, the Industrial Leadership priority contains the SME Instrument variant. That variant has a much stronger presence in Spain, Italy and the weaker and peripherical economies than the Excellent Science variant have. However, the majority of the variants of the Industrial Leadership priority still focus on high-end research and innovation and application. This can also contribute to the fact that the priority has better results that the Societal Challenges but is not as efficient as the Excellent Science priority. Therefore, it is very positive that the Industrial Leadership priority can present results that are quite good regarding the other two H2020 priorities. It also indicates that there is space for serious improvement since several countries of the periphery of the Union with less matured

research and innovation sectors are showing positive signs regarding the research and innovation sector in general and regarding their SME sector as well.

The Excellent Science priority is the one that mostly focus on high-end research and, with the MSCA variant, in human capital enhancement. This variant has the purpose of funding the most complex and difficult research and innovation projects in the EU. This priority presents great results despite the previous analysis where the ERC and the MSCA were, comparatively to the FP7 equivalent period results, a bit worse regarding this same metric. The fact that in the H2020 there was a bigger percentage of the funding and of the entities participating in the high-end research projects funded by this priority from the peripheric and weaker economies might have contributed to a slight increase of the average funding per SP published or reported. This also presents a positive sign for those same peripheric countries since they are capable of attracting funding for high-end research and are capable of producing high quality SPs while not bringing the cost of such research and innovation outcomes to high. This indicates maturity in the research and innovation sector.

Since the H2020 is not over yet and following the FP7 historical precedent, most of the results of the H2020 projects will only be known in a few years, it is possible that these metrics might change for the better. If such scenario succeed it indicates that the European research and innovation sector is growing in term of size, productivity and efficiency which is a positive sign showing that the research and innovation sector across the EU is become more mature and with more cohesion being a great sign for the European Commission in order to implement the knowledge-based economy that they intend to create in order to make the EU more competitive.

One very positive sign is that the Special Objective Spreading Excellence and Widening Participation presented the lowest average funding per SP. This Special Objective was made to help developing the peripherical research and innovation sectors

more precisely and with greater efficacy. The fact that the SPs coming from the projects regarding this Special Objective were the cheapest indicates that this Special Objective might have been a great improvement between the H2020 and the FP7 and that it was a success. Although, since these are projects destined to help the peripherical countries to develop a research and innovation sector, they were simpler and less complex than the projects funded by the H2020 priorities themselves. Nevertheless, it is a very positive sign and good news for the peripheric and weaker economies and their research and innovation sectors. We widely recommend the continuation of this Special Objective and even maybe a reinforcement of it since several of the peripheric and weaker economies demonstrate some difficulty in lifting off their research and innovation sectors.

Table 32 - Comparison per H2020 Priority between Scientific Publications per project and Average Funding per Scientific Publication;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

H2020 Priority and Special Objective	SPs per Project	Average Funding per SP (€)
Excellent Science	10.28	138,154.90
Industrial Leadership	17.87	249,759.97
Societal Challenges	13.82	359,957.77
Spreading Excellence and widening participation	35.82	61,365.15
Science with and for society	7.29	331,480.07

When analysing the possible correlation between the average SPs per project and the average funding received per SP published or reported, we verified that, in the H2020 program, there is a light negative correlation of -0.69. Since the variables are related this metric can show us now a better picture of the efficiency of each H2020 priority. While in the FP7 the correlation was too close to zero to be an helpful metric, in the H2020, because the correlation is negative, it creates a situation where it is possible to state more securely

that the priorities and objectives that presented more SPs per project, automatically presented a lower average funding per SP and , therefore, were more efficient. This fact helps us understand that in the H2020, the funding granted to each priority and Objective was more linked to the ability of producing more or less SPs creating a situation where the analysis of the quality of a program and of its funding distribution was better or worse than the FP7. This fact also helps stating that the Spreading Excellence and widening participation was the most efficient of all the programs in the H2020. Since this Special Objective mainly focused on supporting improvement in the peripherical and weakest economies research and innovation sector, it is very good that it presented such good results.

Regarding the IPRs produced by the FP7 and the H2020 programs, until April 2020, 73.2% were made under the FP7 program, while only 26.8% were made under the H2020 program. Therefore, the comparisons between he H2020 and the FP7 program will be made according to the time frame equivalent to both programs, therefore, our analysis will only compare the FP7 data with the H2020 data for the period between 2008 and 2013. For more information regarding the FP7 see Appendix 18.

Regarding the H2020 numbers analysed, the program started in 2014 and is still ongoing and, therefore, the H2020 IPR applications numbers will only be analysed from the 2014 until 2019. In order to make a comparison between the H2020 data and the FP7 data we will be using the FP7 equivalent time period. Since the FP7 only presented IPR applications in the year 2009, the period from the FP7 to be analysed will be the 2009-2012 period since the program ended in 2013.

In the period 2014-2019, the H2020 program presented 1962 since the program started. This value is considerably higher than the FP7 result since this one has registered only 952 IPR application from the moment the program began until the second last year (2012) of its operation. It is important to state that the H2020 demonstrated the ability to

register or report IPR applications since it began in 2014 while the FP7 only presented results in 2009, 2 years after it began operating in 2007. This is an important difference between both programs. It shows that some of the projects funded by the H2020 were

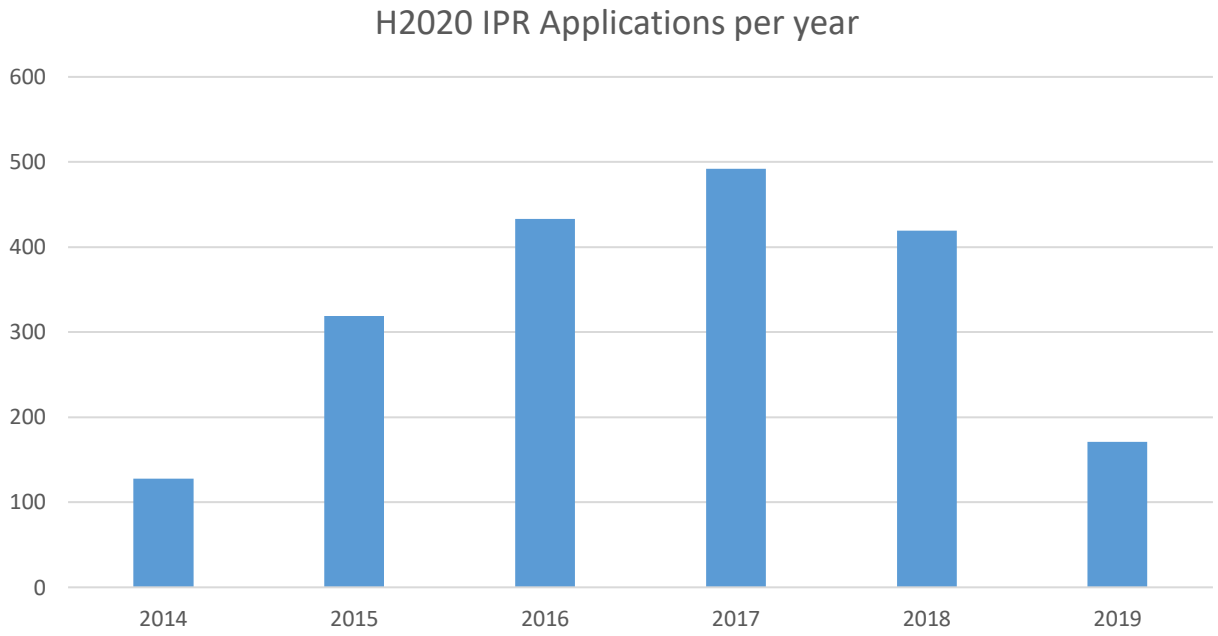


Figure 19 - H2020 Intellectual Property Rights (IPR) Applications per year;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

able to produce results faster than the FP7 ones. This is an indication that, most likely, the structural division of the H2020 and its broader constitution also had an effect in the ability of the projects to be faster and productive. The H2020 results doubled compared to the FP7 also shows that the research and innovation sector capacity to achieve results have increased which indicates a bigger degree of maturity and cohesion across the sector itself.

There is however a bad sign presented by the data. The FP7 program had a stable period between 2012 and 2017 where IPR applications being registered or reported was around 600 per year. The H2020 shows a different trend which is a reduction of the IPR applications in the years of 2018 and 2019. The reason for this behaviour is that the IPR applications registration or reporting require soundproof of its viability. We believe that

our analysis of the effectiveness of the H2020 remains. Since the program presents better results in its first years compared to the FP7, there is no reason to suspect that the situation would be different in the following years. The reason is that, since the H2020 has not ended its operation yet, several of the IPR applications related to the year of the project will still be done in the following years. The FP7 IPR registrations only ended last year not registering an IPR application since it began only in the year of 2020 meaning that from 2013 until 2019 the FP7 program wasn´t operational but still had IPR applications being registered regarding projects funded through the Program. Although there were signs that the research and innovation sector has evolved, the H2020 might follow a similar pattern and it is very much likely that the numbers presented by the program of IPR applications regarding projects for the years of 2018 and 2019 will increase significantly.

Table 33 - Difference in percentual points between FP7 and H2020 Intellectual Property Rights Registration type; Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Reported IPR Type	H2020 percentage of IPR per type	FP7 percentage of IPR per type	Difference in percentual points between types of IPR registered
Patent	82.57%	90.02%	-7.45
Trademark	11.11%	2.42%	8.70
Other	2.65%	4.94%	-2.29
Registered Design	2.14%	1.58%	0.57
Utility Model	1.48%	1.05%	0.43

Regarding the type of IPR applications there are also significant differences. Such as with the SPs, the most usual type of registered IPR applications has a decrease between

the H2020 and the FP7 of 7.45 percentual points passing from a 90.02% significance to 82.57%. This is a significant reduction, but it is counterbalanced by smaller increases in the registration of other types of IPR applications with a slightly higher increase in the Trademark type of IPR that increases 8.7 percentual points in the H2020 when compared to the FP7. This percentages and this differences might suffer some variations since the amount of IPR applications registered for the years of 2018 and 2019 regarding the H2020 program are not completed figures. This change will most likely affect those types with bigger percentages since they are the ones that have more IPRs still unreported because they tend to be preferential types of registration.

More diversification of IPR registration types indicates also a bigger diversification in funded projects. This diversification might be one of the reasons for the fact that the H2020 registered IPR applications already in its first 2 years of operation contrary to what happened in the FP7. However, we recommend more research from the European Commission in order to access the apparent increase in efficiency between the H2020 and the FP7 program. This diversification can also indicate an increase in the maturity degree of the research and innovation sector across the Union since it shows the ability to produce more research and innovation and with a bigger efficiency than the previous program.

Due to the dashboard[39] regarding the IPR applications information inability to supply the Ideas Specific Program data only for the FP7 period under analysis (2007-2012) we will be making an analysis with the FP7 final values for this Specific Program and an analysis with the temporal restraint for the People Specific Program since the dashboard is able to provide such information.

[39] https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f/sheet/2d7c529c-3e4c-4e67-b40a-0e6d5fb30cba/state/0

Table 34 – Intellectual Property Rights Results Comparison between FP7 Peoples Specific Program and H2020 MSCA variant;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Specific Program	IPR applications	Projects received funding during the respective analysed period (€ in millions)	Average Funding per IPR application (€)
FP7 - People Specific program	113	52.920	468,321.51
H2020 - MSCA variant	141	89.462	634,483.70

When comparing the FP7 People Specific Program and the H2020 MSCA variant the results for the similar periods give results with small variations. The increased in the funding granted for projects that provided with IPR applications so far in the H2020 program was disproportionately bigger compared to the increase in the IPR applications provided by the H2020 for the comparative period in relation to the FP7 results. This resulted in a higher average funding per IPR in the H2020 program. However, it is important to notice that the reported IPR applications for the 2018 and 2019 years aren´t, as of April of 2020, the full amount. Therefore, it is expected that these values come closer. Not only because the MSCA variant of the H2020 has not all the IPR applications for the last 2 years but also because, as analysed previously, the People Specific Program average funding per IPR will also increase. This combination of factor will bring the values together. This is a very positive sign for the H2020 program because we know that the H2020 has funded far more projects and distributed far more funding regarding this variant than the previous FP7 program as for the People Specific Program since the H2020 is broader and presented more available funding. Even if the value of the average per IPR regarding the H2020 MSCA variant stays close but higher than the FP7 result, it is a sign

that the H2020 was able to maintain a certain level of efficiency and increase the amount of IPR applications produced. It also demonstrated that there is availability for the production of such IPRs since the average per IPR would be similar, which means that if the European Commission intends to increase the amount of IPR applications produced by this type of projects knows the level of efficiency it can count with. This is good in order to give a view of the efficiency of this project when creating the next generation of EU research and innovation programs.

Table 35 – Intellectual Property Rights Results Comparison between FP7 Ideas Specific Program and H2020 ERC variant;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Specific Program	IPR applications	Projects received funding during the respective analysed period (€ in millions)	Average Funding per IPR application (€)
FP7 Ideas Specific Program	1,736	1,200	691,244.24
H2020 - ERC variant	285	180.468	633,222.40

Regarding the Ideas Specific Program from the FP7 and the H2020 ERC variant we observed a slight improvement in the average funding per IPR application from the FP7 result to the H2020 ones. Since the FP7 results we are analysing are the global ones there a few details we need to have in mind. The first is that the ERC variant results regarding IPR applications for the 2018 and 2019 are, most likely, not fully measured as of April 2020. Therefore, it is most likely that this value changes. There is also the fact that the amount of funding per participation in this variant had a quite small positive change. We must also have into account that the distribution of the funding of the priority where the ERC variant is inserted was less concentrated in the Member States that have the most

matured research and innovation sectors. Even by being a small difference in the redistribution of funding indicating more participation of the peripheric Member States it will most likely have an impact in the average funding per IPR application and in the efficiency demonstrated by the variant itself. Therefore, we conclude that, despite the apparent improvement, since we are comparing with final FP7 values, the previously mentioned factors of the lack of final IPR applications results regarding the years of 2018 and 2019 and the fact of the bigger presence of less matures research and innovation sectors for in the project participations both combined with the average funding per participation being practically the same we expect that the average value of funding per IPR application to increase and even to surpass the FP7 value. However, we also believe it will not be a significant increase since even the peripherical research and innovation sectors have presented improvements and maturity growth making it more likely that the ERC variant will remain with a very positive average funding per IPR when compared to the overall H2020 behaviour.

Table 36 - H2020 Priorities Average Funding per IPR;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

H2020 Priority and Special Objective	IPR applications	EU Contribution (€ in millions)	Average Funding per IPR application (€)
Excellent Science	515	662.607	1,286,614.88
Industrial Leadership	624	838.546	1,343,823.33
Societal Challenges	777	1,138.444	1,465,178.58
Spreading Excellence and widening participation	16	11.213	700,796.31

The average funding per IPR applications regarding each H2020 priorities are quite high. Our analysis gives the Societal Challenges the highest of the average funding per IPR application. This goes along the obtained result previously regarding the average

funding per SP published or reported where the Societal Challenges priority also reached the highest average among the H2020 priorities. This is due to the fact that this priority is the broader of them all, contains more participants from the more peripherical research and innovation sectors and its projects are those with the highest average of participations. This metrics combined give us a priority that distributes its funding more widely and involves more complex projects and making the results obtained more expansive.

The surprising fact that every H2020 priority has average funding per IPR application above the one million euros is most probably due to the lack of the full numbers regarding the IPRs of the 2018 and 2019 years. In fact, these IPR applications will most likely bring down most of the values of the priorities especially the Excellent Science. This H2020 program includes the MSCA which is a variant that tends to have one of the lowest averages per IPR since most of the program is based on enhancing the human capital of the European and research sector and having a huge majority of unique participations. It is also important to mention that this priority distributes most of its funding to Member States that already have matured research and innovation sectors as previously mentioned. These are factors that contribute for the Excellent Science priority to have the lowest average funding pre IPR application.

What seems very positive is the result obtained by the Spreading Excellence and widening participation Specific Objective. The results are very promising since it demonstrates to be the most efficient of the H2020 programs. It is, however, important to state that these Specific Objective main focus is in the peripherical and weaker economies and that its main purpose is to help those countries to reinforce and improve their research and innovation sector. The result obtained is clearly a result of a good work by those Member States in using the funding in projects that allowed them to have these results. They are simpler projects and do not have the complexities of high-end research

and innovation of the Excellent Science priority or the industrial focus of the Industrial Leadership priority or the huge number of participants of the Societal Challenges priority making these projects more able to have better metrics.

This is an important aspect to have in mind when analysing these results. The complexity and the amount of entities participating in each type of project of each priority influences largely these metric results. This makes the achievement of the Excellent Science priority and Industrial Leadership priority even more positive. The creation of Industrially focused IPR applications is fundamental for the economic progress of the Union. The achievement of such good metrics is very positive for the development of the SME sector since the Industrial Leadership priority as a special role regarding this sector.

In general, the averages obtained by the H2020 priorities show that there was a positive progress regarding the outcomes achieved when comparing to the previous FP7 program and that the research and innovation sector has been developing and maturing across the EU and some other countries are able to also participate in the process and create value for the Union as a hole.

Table 37 - Comparison per H2020 Priority between Scientific Publications per project and Average Funding per Scientific Publication;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

H2020 Priority and Special Objective	Average IPR application per project	Average Funding per IPR application (€ in millions)
Excellent Science	1.92	1.287
Industrial Leadership	3.06	1.344
Societal Challenges	3.44	1.465,
Spreading Excellence and widening participation	2.29	0.701

The first aspect to notice is the increase in the interval between the biggest and the lowest average of IPR application per project between the FP7 Specific Programs and the H2020 priorities. The lowest average of IPR per project in the H2020 was obtained by the Excellent Science priority with 1.92 IPR per project. As of April 2020, this value is the lowest but, such as the other values, it is expected to increase. The highest average in the same metric belongs to the Societal Challenges priority with 3.44 IPR applications per project. This is a shift between the FP7 results and the H2020. The Fp7 results regarding correlation showed a negative correlation regarding the average funding per IPR application and the average IPR application per project which indicated that the lower IPR per project was indicated to a bigger average funding per IPR. The H2020 metric shows a correlation of 0.545. This is not a strong correlation, but it indicates that there at slight positive correlation. This indicates that, as of April 2020, in the H2020 program, the higher the average funding per IPR application, the more IPR the project will register. Unlike the correlation obtained between the same metrics but regarding the SPs, it is safe to say that the research and innovation sector of the EU regarding the production of IPR applications demonstrate to be less efficient than the research and innovation sector that produces SPs. This is a problem for the EU. The IPR applications production mechanism is highly dependent on the public funding, including the EU funding and the more funding it receives the expensive the research and innovation of IPR applications gets. This is a problem that must be battled by the European Commission. We recommend further research on which factor is causing this lack of efficiency regarding the research and innovation of IPRs in the EU.

In conclusion, the H2020 brought better results in general than its predecessor, the FP7. The H2020 brought a better dispersion of the EU funding regarding the research and innovation sectors and expanded and increased the amount and the quality of the results obtained by the sector at large. However, it is possible to improve, especially regarding

the research and innovation of the IPR applications and improvement of the SPs metrics, especially regarding those programs that are more complex but involve a bigger amount of entities from the peripheric research and innovation sectors such as the Societal Challenges priority.

Chapter III - What can be expected?

In June 2018 the proposal for the creation of a new "European Union Framework Programme for Research and Innovation 2021 – 2027 (Horizon Europe) was adopted by the European Commission"(European Commission, 2019b). On March 2019, the Junker Commission made a press release stating that the Horizon Europe (HE) "will build on the achievements and the success" (European Commission, 2020b) of the current H2020.

The political agreement reached by the European Parliament, Council and Commission on March 2019 allowed the European Commissions to start HE implementation. The European Commission intends to have the programme´s launch on January 1st 2021 "(European Commission, 2020b).

The HE has a proposed budget of €100 billion and is planned to run through 2021 – 2027 and, to happen, will represent the "largest multinational collaborative research and innovation investment in Europe" (European Commission, 2019b) and, such has the H2020, it will be open to participants worldwide. The focus still remains the investment in research and innovation sector since it will be fundamental to "create new opportunities, tackle climate change, support sustainable economic growth and the competitiveness of our businesses and industries, and to enable better welfare and public services for all Europeans" (European Commission, 2019b).

The HE, such as H2020, will focus on supporting and help reaching the 6 priorities adopted by the European Council on June 2019 which targets similar overarching objective (European Commission, 2019b).

1. European Green Deal

The European Green Deal has the bold challenge of turning Europe is the first climate-neutral continent. According to the European Commission, making Europe the world's first climate-neutral continent by 2050 requires changing the way we produce, trade and consume, and spurring on unprecedented technological, economic and societal transformations". The EU, in the area of climate change, is at the vanguard of the implementation of the Paris agreement and it leads the global community in developing and implementing a new approach to protect biodiversity and planetary boundaries. Key efforts in achieving climate neutrality creates opportunities, jobs, economic growth and low carbon industry which is identified as a "key strategic value chain" (see Appendix 20).

2. An economy that works for People

Climate-neutral and healthy planet must be built on a strong and resilient social market economy. However, there is a need to prepare our technological and industrial future in a more strategic way, including incentivising and steering innovation, including social innovation, and facilitating the uptake of new technologies and innovative solutions. The promotion of social cohesion and inclusiveness and the health and well-being of its people are central aims of the European Union's policies and programmes. With the European Pillar of Social Rights, the EU set the direction towards a fairer, inclusive and more social Europe for all European citizens based on a European social model that is fit for the challenges of the 21st century, also providing people with equal opportunities through access to education, training and life-long learning (see Appendix 21).

3. Europe fit for the Digital Age

Digital technologies are transforming the world at an unprecedented rate, and Europe has the potential to become a world leader in the ongoing digital and industrial transformation. The EU needs to achieve technological sovereignty in critical technology areas such as high-performance computing, quantum computing, and the key technologies enabling them, by setting next generation standards and better coordinating and prioritising European investments in breakthrough technologies, in particular towards cybersecurity and human-centric and ethical artificial intelligence (AI). To succeed in the digital transformation the EU should build on its strengths and values and empower people through education, life-long learning and the development of new skills, which drive Europe's competitiveness and innovation (see Appendix 22).

4. Promoting the European way of life

There are a number of EU policy responses to current security challenges. As regards disasters, these include the Union Civil Protection Mechanism, the EU Adaptation Strategy and the Sendai Framework for Disaster Risk Reduction (2015-2030). In the framework of the European Agenda on Security and as part of the development of a Security Union, the EU has adopted policies and instruments on integrated border management, on protection of public spaces, on security (including cybersecurity) of infrastructure and on fighting crime, including cybercrime and terrorism. Research and innovation activities can support these policies in various ways (see Appendix 23).

5. A stronger Europe in the World

In an increasingly fractured and multipolar world threatened by global challenges, the EU will need to ensure its future prosperity and to seek a leading role in driving global efforts towards sustainability. The EU approach to research and

innovation has long been one of openness to the world to maximise our access to the latest scientific knowledge and international value chains, and to tackle global challenges together. The EU needs to build upon and further intensify this to fully benefit from new global opportunities, by pursuing strategic partnerships with key partner countries, and by promoting international cooperation based on common research and innovation principles, mutual benefits, EU interests, international commitments and, where appropriate, reciprocity. The expanding scope and interconnectivity of these challenges require the EU to strengthen its role in multilateral and bilateral setups while also asserting EU values and interests more pro-actively, including in strategic alliances and networks such as global environmental conventions on climate, desertification and biodiversity, biodiversity, the Belmont Forum, the Group on Earth Observations, the Mission Innovation initiative, the International Bioeconomy Forum and a range of Global Health initiatives (see Appendix 24).

6. A new push for European Democracy

Democracies have come under pressure in recent times. Action is therefore needed to re-invigorate and modernise democratic governance. The aim is to contribute to the development of policies, innovations and institutions that expand political participation and civic engagement, enhance accountability and legitimacy, protect rights and the rule of law and help restore trust in democratic institutions (see Appendix 25).

The HE also has Specific issues. The impact and added value in the research and innovation investments will depend on the capacity to attract private investment while leverage cross-cutting factors ranging from core EU values to legal and operational provisions. Therefore, the HE has certain Specific issues that will attempt to improve its

application and the research and innovation sector in general (European Commission, 2019b).

Gender equality is a core policy objective for all the EU activities. It is also a "crucial factor in the achievement of sustainable development and inclusive economic growth that works for all" (European Commission, 2019b). The HE is programming that Activities will aim at eliminating gender inequalities throughout research and innovation systems, including by addressing unconscious bias, and the gender dimension will be adequately integrated in research and innovation content across the whole programme.

The inclusion of Social Sciences and Humanities (SSH) is key since they lead to understanding the relationships between human behaviour and major global challenges, but also to the effectiveness of the solutions we propose to address them. SSH are key to understanding the relationships between human behaviour and major global challenges, but also to the effectiveness of the solutions we propose to address them.

Open science practices will be mainstreamed as the new standard for EU research and innovation. Particular focus will be placed on open access to scientific publications and research data, management of research data along the FAIR principles, development and consolidation of the European Open Science Cloud (EOSC) to provide a trusted and open common interoperable framework for federating infrastructures, platforms and associated services for data-driven research for all researchers and innovators, and responsibility and openness of science towards society and vice versa. Open science promises to give Europe a global lead in research data management. Engaging and involving citizens, civil society organisations and end-users in co-design and co-creation processes and promoting responsible research and innovation will improve trust between science and society, as well as the uptake of scientific evidence-based public policies and innovative solutions.

Another issue is the attention that specific actions will be launched for promoting ethics and research integrity and continuing to develop a coherent framework of adherence to the highest ethics standards and to the principles embedded in the European Code of Conduct for Research Integrity. Further developing cooperation between the research ethics and integrity actors involved at regional and national levels will also be a focus.

The HE will also have activities to disseminate and exploit results from research and innovation as an integral part of Horizon Europe. One of the most efficient ways of furthering dissemination and exploitation of research results is through education and training. When new discoveries and knowledge are integrated in education activities, students at all levels are able to bring state-of-the-art knowledge with them to workplaces across society. In addition to the initiatives towards open science mentioned above, Horizon Europe introduces novelties in the way research and innovation results are disseminated and exploited, giving more emphasis to third party uptake with private investments and to the knowledge and impact these results create after the end of research and innovation projects.

The dissemination of the knowledge will also be promoted between all types of economic sectors in order to create **e**ffective circulation of knowledge between research, industry, education and training. This is a pre-requisite for maximising the impact of European research and innovation sector funding. Integrating research and innovation activities with education and training, and supporting activities for knowledge exchange and transfer across sectors, for instance via Marie Skłodowska-Curie Actions and Knowledge and Innovation Communities, is a powerful method to ensure research and innovation activities are informed by and directed towards citizens' and society's needs and the results are widely disseminated, for instance through a well-educated work-force.

Key Enabling Technologies (KETs), for instance biotechnologies and advanced materials, are crucial for Europe's competitiveness in strategic value chains. Developing and mastering KETs can contribute towards giving EU industries the competitive edge they need for industrial leadership in global markets and promise breakthroughs to solving global challenges and achieving a circular, resource efficient and climate-neutral EU economy. Some ongoing investments in science under the FET Flagships with breakthrough potential for Europe will keep being supported under Horizon Europe. First, Quantum Technologies through the development of a quantum web, where quantum computers, simulators and sensors are interconnected via quantum communication networks. Second, Graphene, aiming at scientific breakthroughs in graphene and other 2D materials, while further advancing components based on these materials for applications in areas such as energy, electronics, sensors and biomedical technologies. Finally, the Human Brain Project will aim at achieving a comprehensive understanding of the human brain and its diseases by combining neuroscience with advanced ICT, enhancing and operating a sustainable and open European Research Infrastructure.

The Horizon Europe projected structured seems to be based on the H2020 structure while bringing back the idea of Program pillars such as in the FP7. The division will be made in 3 structural pillars (European Commission et al., 2016)where the distribution of roles will be similar to the H2020.

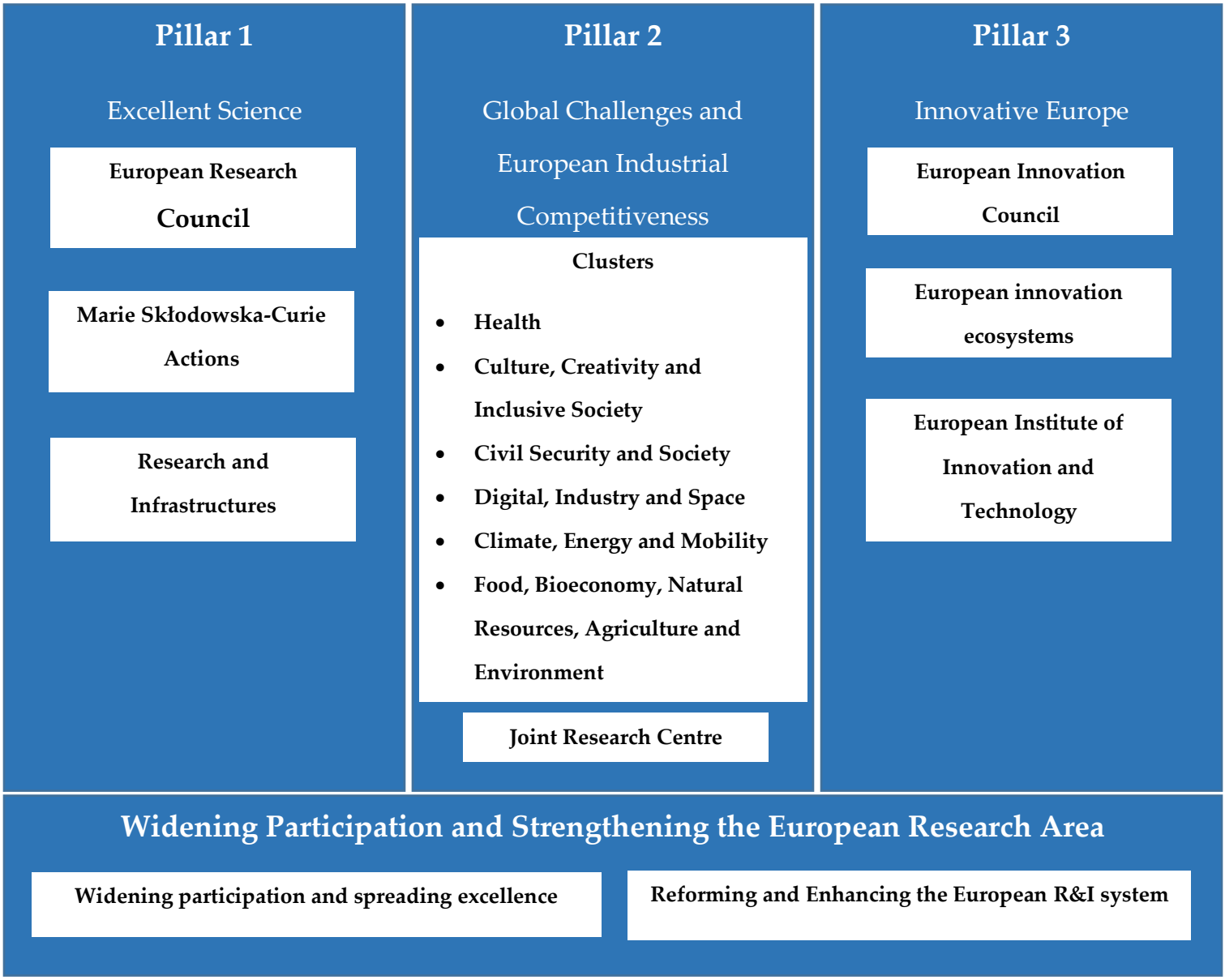


Figure 20 – Horizon Europe´s representative scheme; Made by Author

The previous image (Figure 30) was a proposed preliminary structure of HE (European Commission, 2019a). This proposal also comes with a predicted budget of €100 billion which would make it the biggest research and innovation program ever attempted by the European Union. The Euratom, not presented in the preliminary sketch, is also included in the plan.

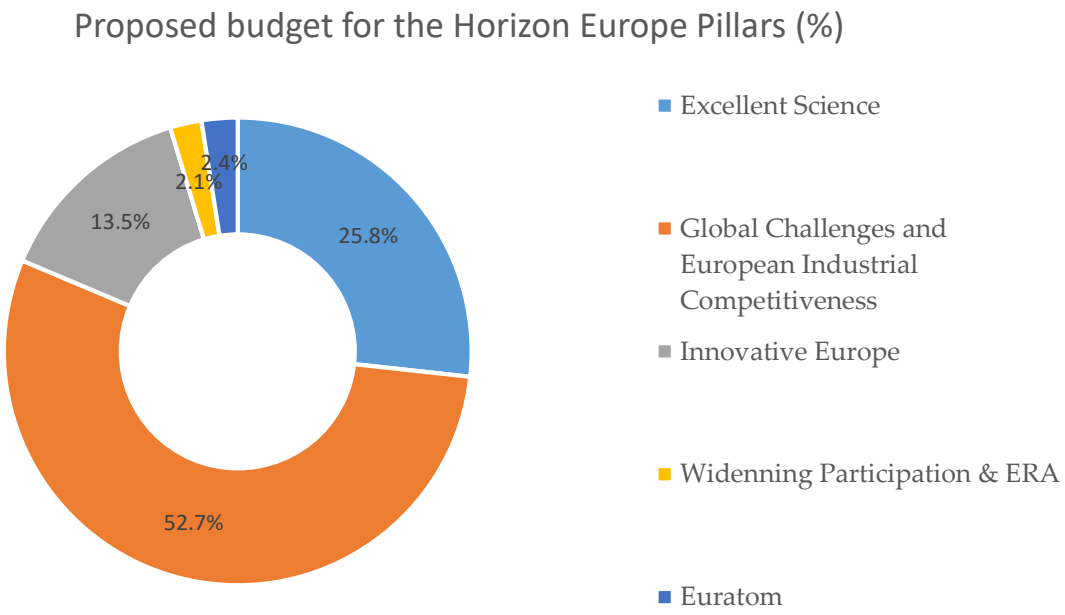


Figure 21 - Proposed Budget for the Horizon Europe Pillars;

Source (European Commission, 2019a) – *Made by Author*

In comparison to the H2020 there are some new elements that have been already explored, such as the EIC that will pass from the pilot test to an active, fully funded program and others who are completely new.

The support for breakthrough and disruptive innovations and the scale-up potential will be supported by the EIC that has 70% of its predicted budget, which is €10.5 billion together with European innovation ecosystems, market for SMEs. The HE will also look for R&I Missions where EUs research and innovation will attempt to have a bold and inspirational and measurable goal with impact for society and policy making. The HE defines 5 mission areas: adaptation to climate change, including societal

transformation, Cancer, soil health and food, climate neutral and smart cities and healthy oceans, seas, coastal and inland waters. The HE will also look for new generation of objective-driven and more ambitious partnerships in support of agreed EU policy objectives through Co-programmed (based on Memoranda of Understanding / contractual arrangements, etc…) Co-funded (based on a joint programme agreed and implemented by partners) and Institutionalised (long-term dimension and need of high integration) key partnership elements. Areas that the Commission point as possible for such institutionalised European partnerships are Health innovations, sustainable bio-based solutions, hydrogen and sustainable energy storage, key digital and enabling technologies, metrology, clean and connected mobility, EU air traffic, aviation and rail and innovative SMEs. The HE aims at a bigger international cooperation element since it is needed in order to tackle global societal challenges**.** For that it supports the openness and association to world´s best talents, expertise and resources as well as enhanced supply and demand of innovative solutions. One aspect that the HE will promote that the previous programs only recommended will be open science and better dissemination and exploitation of R&I results by making Mandatory open access to publications while ensuring intellectual property rights to authors and open access to research and data ensured through Mandatory Data Management Plan for FAIR (Findable, Accessible, Interoperable, Re-usable) and Open Research Data. The HE will maintain the Widening participation and spreading excellence Specific Objectives of the H2020 since a bigger cooperation is expected and recommended by the European Commission (European Commission, 2019a).

Considering the expected cooperation by the European Commission, it is important to mention that the HE is designed to maximize added value through a coordinated approach between all the three pillars of the program.

Pillar I – Excellent Science

The Excellent Science pillar will have three variants instead of the four previous during the H2020.

The ERC will continue to be the main variant in the Excellent Science pillar and will see an increase in budget passing from the previous €13.1 billion to a total of €16.6 (European Commission, 2019b). It is understandable since the ERC pursues ground-breaking, high-gain/high-risk research in order to advance the frontiers of knowledge.

The Marie Skłodowska-Curie Actions (MSCA) will also continue to be a part of the Excellent Science pillar. The purpose of the MSCA is to "fund, support and train the people and institutions behind research and innovation, strengthening excellent doctoral and postdoctoral training programmes, as well as researcher training and career development systems across the ERA, in a fully bottom-up and competition- for-excellence-based manner" (European Commission, 2019b). The MSCA budget also increases from €6.162 towards €6.8 billion.

The Research Infrastructures variant will remain supporting the "provision of state of the art services, knowledge, and tools to address societal challenges, ensure evidence-based policy making and help industry to strengthen its base of knowledge and technical know-how" (European Commission, 2019b) and will remain with €2.4 billion in available budget.

Pillar II - Global Challenges and European Industrial Competitiveness

The Pillar II is the equivalent to the H2020 Societal Challenges priority and was divided in 6 major clusters. The total amount of the pillar budget, according to the Commission will be €52.7 billion indicating a major reinforcement of budget into the research and innovation related sector. The Pillar II will have more areas and will be more abrasive than the previous Social Challenges priority and therefore, it is expected that the

increased budget will help funding the necessary research and innovation (European Commission, 2019b). For further information see Appendix 25

The JRC will be funded by the Euratom research and training programme for the period 2021-2025 with an available proposed budget of €2.4 billion. The objective is to research and innovate as well as training activities to reduce nuclear risks regarding, safety, security and radiation protection. The HE will "increased focus on non-power applications of radiation (medical, industrial, space), opening mobility opportunities for nuclear researchers through inclusion in Marie Skłodowska-Curie Actions" (European Commission, 2019a).

Pillar III – Innovative Europe

Pillar III aims to reinforce the innovative capacities of Europe, through supporting the development and deployment of disruptive and market-creating innovations, enhancing the overall European research and innovation sector by linking together European ecosystems, and reinforcing the synergies between academia, entrepreneurs, not least SMEs, and market operators (European Commission, 2019b). It is in this Pillar that there will be the programs focusing on SMEs.

The European Innovation Council (EIC) will enhance Europe's capabilities at the forefront of the next wave of disruptive, market-creating innovation. It will be the one-stop shop for enabling inventors, innovators and investors to bring the most promising ideas to real world application and will support the scaling-up of innovative start-ups and companies. The EIC will pass from the Pilot faze towards the fully open program. The EIC and the European innovation ecosystems will have a total of €10.5 billion proposed budget (European Commission, 2019a). The EIC's *Pathfinder* will actively support the development of breakthrough technologies, which are key to disruptive innovations while the EIC's *Accelerator* will bring any market creating innovation,

including social innovation, closer to market operators and investors and support the scaling-up of companies, on a bottom-up basis.

The European Innovation Ecosystem will strive to enhance the overall European innovation landscape, complementing the targeted support delivered by the EIC. It will connect all actors - public and private, national and local - of the innovation ecosystems in Europe, including EIC actors, to share best practices and resources and enhance opportunities. Activities will include the support to joint programmes supporting innovation activities, from training to projects and scale-ups, implemented by national or local actors.

The European Institute of Innovation and Technology will take a challenge-driven. Its "portfolio of activities, ranging from entrepreneurial education and training to innovation projects, business creation activities and support services for start-ups, scaleups and SMEs, can contribute to the objectives of the Pillar II and complement its relevant activities to address the key cross-cutting priorities beneficial for society such as addressing climate change, supporting the digital economy, innovative energy, health or sustainable development of cities" (European Commission, 2019b). The European Commission intends to attribute to this variant a total of €3 billion in budget (European Commission, 2019a).

Widening Participation and Strengthening the European Research Area

Measures supported under this part of the HE will over time underpin and amplify the impact of Horizon Europe by helping countries that are lagging behind, including the EU outermost regions, to contribute to actions under other parts of Horizon Europe. Measure will range from "creating new or upgrading existing centres of excellence (Teaming) and significantly improving the research and innovation capacity of universities and research organisations (Twinning) to attracting and maintaining high

quality human resources in research organisations ('ERA Chair holder') and ensuring scientific networking, capacity building and career development support to researchers at all career stages (COST actions)" (European Commission, 2019b). Most of this actions are the same as in the previous H2020 and mostly benefited in funding the peripheric Member States. The European Commission doesn´t propose a clear number but states that there is a "common understanding" of at least 2.1 billion (European Commission, 2019a). For more information see Appendix 27.

According to the analyses we have made across this work of the H2020 program, there are a few points where we believe the HE is good in supporting and in reinforcing them and other where we might believe the HE will not be so good.

Regarding the ERC, the increased budget it has been proposed might not be necessary. The gap between the ERC used budget as of March 2020 is quite significative (36.5%) and the amount of funding per participation combined with the number of participants per project does not provide confidence enough to establish that the funding granted for the ERC will reach the predicted budget. The MSCA also had a gap between its H2020 proposed budget and its effective granted budget by around 25%. However, the budget increase in this variant is lower compared to the budget increase of the ERC and its variant might end up with a gap between the H2020 proposed budget and its granted funding quite lower therefore its increase in the budget might be necessary since the program retains its importance. Regarding the Research Infrastructures, there was no increase in proposed budget which seems reasonable since it was the Excellent Science priority variant with the biggest gap between the granted budget and the proposed budget.

The proposed budget for the Global Challenges & European Industrial Competitiveness might be controversial. In the H2020 structure, the research and innovation sector, assuming the rules for approving projects remain with the same

variants regarding a total number of approved projects per call, this budget will not be fully granted. In the H2020, as of April 2020, most of the increases that might happen in the last year will not be enough for the granted budget to reach the proposed total budget for the H2020. The research and innovation sector has grown over the last 6 years thanks to the efforts of the FP7 and the H2020 but it's not big enough for such a big amount. Therefore, it is probable that the number of projects per call might rise. It is also advisable that the European Commission should attempt a more flexible type of budgeting and for granting funding. The use of the Person-month[40] system will make that most of this value will go to the already matured research and innovation sectors. The European Commission should, not only attempt to reformulate this system but also to create a more flexible way for distribution of funding. The proposed budgets are mere predictions and, therefore, the European Commission should attempt to create in the program the possibility of transferring available budget from programs with less demand towards programs with more demand. The EIC Pilot together with the Investment in SMEs variant of the Industrial Leadership priority in the H2020 have proved that the research and innovation funding's regarding SMEs create opportunities, good projects and positive effects regarding the distribution of the funding's across the Union. In this field, with the creation of the EIC, we believe the European Commission has made a very good decision for the research and innovation sector of the Union. The 3rd pillar of Innovative Europe and the Widening Participation and ERA Programmes are also great choices regarding the research and innovation existent potential. However, with the lack of capacity for the FP7 and the H2020 to absorb the entirety of each programmes and with the H2020 having a larger gap than the FP7 we believe that all evidence indicates that the HE will also have, by the end of the program, a bigger gap than then the H2020.

[40] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

It is also important to state that, as of April 2020, the World is currently fighting a pandemic due to a virus called Coronavirus-19 (Covid-19). The current pandemic has paralysed most of the EU countries and most of the economy has been shut down in order to help reducing the transmission of the virus. Several sectors of the economy will have to be rescued in totality while the economy in general will have to need fundamental and deep rescue from the central governments. This indicates that a new recession and economic crises will come, and its repercussions will be something new and will demand brand new European mechanisms and responses in order to fight the economic crisis.

The focus of the HE in the European Green Deal and the response of the European Commission towards the Covid-19 crisis is positive since both have an underlining focus in the environmental policy and the reconstruction of the European economy after the Covid-19 crisis end it will be heavily state financed. We believe that the HE will be a tool capable of helping in this recovery. However, its focus areas were not counting with the present virus crisis and the programme will have to be reformulated. It is also expected that the Covid-19 crisis will affect the last year of the H2020 as well in terms of its performance.

Conclusion

With the present analysis we could see that both programs had difficulty in attributing all their available funding although there were enough proposals and requested funding. We indicated two possible scenarios for such results to happened since the definition of a maximum amount of proposals per call, we assumed, is already defined by the European Commission to optimize the available funding, and we indicated that the EU evaluation system depended on the subjectivity of its evaluators and, across our analysis, the use of the Person-month[41] system to distribute the funding among participants. We believe that a combination of both factors to a certain degree is responsible for the gap between available budget in the Programs and effective granted funding. We believe that the subjectivity regarding evaluation influences the amount of funding it is distributed however it is important to keep a level of that same flexibility in the evaluation since with very standard evaluation methods it would be harder to differentiate proposals making it harder to decide and less diverse the type of projects and its results. The Person-month[42] system is, according to our analysis, an issue regarding the distribution of funding. The Person-month[43] system is inherently indexed to the cost of the human capital that will participate in the approved projects for a certain defined period. A system as this indicates that the participation of entities from countries with a higher cost of living will inevitably receive more funding in order to support that same cost. However, what we found, was that the Member States that have a higher cost of living were able to receive, in percentage, significantly more funding than their corresponding percentage in participations. This leads to a bigger benefit of those

[41] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967
[42] "Idem"
[43] "Idem"

countries that already have a better economy and a more matured research and innovation sector than the weaker economies in the EU.

Across the FP7, our analysis has demonstrated that the major beneficiary of the research and innovation programs in the EU was the UK. This country was the biggest receiver of funding in all the FP7 Specific Programs analysed. In the Capacities Specific Program, which granted funding for the improvement of research and innovation capacity it was possible to measure those Member States that had matured research and innovation sectors. The top 5 economies in the EU have the biggest research and innovation sectors followed by the Nordic countries and some central European countries that have matured sectors such as the Netherlands, Belgium and Austria. It was also possible to verify that the southern countries of Portugal and Greece plus Ireland have better performances than the remaining Member States. Across our analysis we were able to verify the percentual difference between the percentual amount of funding that each Member States received from each FP7 Specific Program and H2020 priority and the percentual direct participation of each Member State to the EU budget for the respective program's periods. This analysis gave us interesting results. In the Capacities Specific Program, of the top 5 economies in the EU, only the UK had a significant net positive difference between these two metrics cementing the idea that the country has a strong research and innovation sector. Spain also had a net positive difference showing a growing research and innovation sector. However, regarding this Specific Program, many other smaller Member States had positive net differences demonstrating that the FP7 Capacities Specific Program was a success regarding the ability of distributing more effectively its available funds and, as our analysis showed, being an exception in this metric. In the Cooperation, Ideas and People Specific programs our analysis has shown a pattern regarding the difference between the percentual amount of funding that each Member States and the percentual direct participation of each Member State to the EU

budget for the FP7 period. In all these three Specific Programs, there was a group of member States that always registered net positive differences which is composed of the UK, the Netherlands, Belgium, Austria, Denmark and Sweden since Finland always present small net positive or net negative differences. This demonstrates the ability for these Member States research and innovation sectors to be captors of funding and shows their maturity.

The analysis of this metric also shows the existence of 3 member States that are always the ones with the biggest net negative differences. Germany, France and Italy have always net negative differences despite being part of the Member States that also receive the most. The other group composed by the weakest and most peripherical economies have mixed results depending on the Specific Program being analysed demonstrating that their research and innovation sectors are still developing and are unable to have strong participations and capture of funding in all types of research.

Other interesting factor that our analysis has shown was the fact that those countries that tend to have net positive differences in the previous metric tend to also have a bigger percentage in received funding compared to their percentage of participations. However, regarding the difference between this two metrics, both Germany and France tend to also have a net positive difference. This happens because all the mentioned countries have higher cost of living leading to, because of the Person-month[44] system, to a higher amount of funding per participation. In the weaker and peripherical economies the average per participation varies according to the Specific program being analysed, however, most of those Member States tend to have bigger participation percentages then funding percentages. With these metrics our analysis has shown the inability of the Person-month[45] system to distribute funding in a more

[44] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967
[45] "Idem"

democratically way where, in the current system, the peripherical economies need to make more participations in order to receive the same amount of funding than the wealthier member States.

In the H2020 program, our analysis has shown similar results regarding similar metrics. However, the positive performance of the UK has slowed down significantly. The major cause for it might have been the Brexit feeling since the referendum in 2016. Most of the EU funded projects regarding the research and innovation sector involves an entity participation for a long period of time. The inability for the UK authorities to agree on the exit and the lack of an agreement created uncertainty and we were able to verify a lower percentage of UK entities participating across the H2020 program. However, the same patterns have appeared regarding the H2020 major priorities. In the Excellent Science priority and the Industrial Leadership Priorities the dominance of the same countries in the research and innovation sector was again demonstrated. The bigger differences happened in the worst performance of the UK and the better performance of countries such as Portugal, Greece, Spain, Poland, Estonia and Ireland. All these countries showed better results when compared to the FP7. This gives a very strong argument that these countries have been able to develop their research and innovation sectors with the EU funding they have been receiving. Of all the three H2020 priorities, the Societal Challenges priority showed a better distribution of the funding then the other 2. The predominance of the high-end research and innovation in the already mentioned matured research and innovation sectors is bad sign for the European Commission that has been trying to create a knowledge-based economy across the EU. For such we recommend more research on a better method for funding distribution in order to create better conditions for the research and innovation sectors of the more peripherical countries to develop.

The H2020 was a wider program than the FP7 and that allowed us to analyse the behaviour of the EU funds regarding research and innovation in the SME sector. Our analysis has showed that the SME sector in the EU is dynamic, looking for opportunities to grow and to scale-up. The Innovation in SMEs variant of the Industrial Leadership priority distributed more funding than the predicted initial budget as of March of 2020 showing a strong demand from the sector for scale up opportunities and going against the entire H2020 program tendency. The EIC pilot was also a good success. Its ability to have very good proposals in quantity showed potential. The Seal of excellence had a lot of proposals that were granted with the seal demonstrating a good amount of interest and quality in the EU SME sector. The Member State with the best behaviour regarding participations was Spain demonstrating a SME sector capable and willing to participate in the EU programs. However, once again, the country had a much bigger participation rate compared to the received funding rate while the Member States with the most matured research and innovation sectors were able to invert that situation. This demonstrated that even in a small environment of a Pilot Program, the Person-month[46] system is able to influence the ability of funding distribution.

Regarding the FP7 and H2020 ability to produce Scientific Publications (SP) and Intellectual Property Rights applications (IPR) the H2020 showed a better performance as of April of 2020 than the FP7. Since the majority of the results of the FP7 were achieved after 2013 which was the year the program ended, our analysis made a comparison of a comparative period (FP7 2007-2012; H2020 20014-2019). For the comparative period, the H2020 showed a better performance both at creating SPs and IPRs. H2020 was able to have IPR application registered in both of its first 2 years while the FP7 only had IPRs registered from 2009 forward. The fact that the H2020 is a broader program allows it to fund research from all types of fields creating more diversity in results as well. One

[46] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

important metric we analysed was the funding per SP/IPR and the H2020 Program showed a growth of the funding per SP/IPR when compared to the FP7 in the comparative period. This also happened because the amount of entities from the more peripherical research and innovation sectors increased leading to a bigger share of the more inefficient sectors to participate. However, the growth in the quantity of SP and IPRs is still very encouraging and we believe our analysis shows that the H2020 was able to show a better performance than the FP7.

To conclude, our analysis shows that both Programs were good regarding results obtained, especially when verifying the H2020 has obtained better results than the FP7 demonstrating a higher degree of maturity and value creation by the research and innovation sector as an all. However, we recommend more research regarding the Person-month[47] system since, according to our analysis, creates a better situation for countries that already have their research and innovation sectors established and where countries with more participations are unable to receive as much funding as some Member States that have fewer participations leading to a gap between the amount a country needs to participate in order to receive a certain amount of funding.

Our analysis also showed that the UK, a big and important participant in the research and innovation sector of the Union will leave a hole in the sector and that should be seen as an opportunity. Many Member States will capture the possibilities that the Brexit will leave and, according to our analysis, Portugal, Spain, Greece, Estonia, Poland and Ireland are strong candidates for such accomplishment.

We should also leave the note that, as of the writing of the document, the European Union, as well as the huge majority of the countries in the world, are currently in forced

[47] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

lockdown or strong social distancing measures due to a pandemic caused by the virus Coronavirus-19 (Covid-19).

The presented FP9 (Horizon Europe) has a strong focus on the European Green Deal and, due to Covid-19 and the economic crisis it will follow, it will be paramount to the success of the recovery of the economy after the pandemic. The FP9 has a proposed budget of €100 billion being the biggest research and innovation program ever created by the Union. Due to the current Covid-19 crisis and the Brexit, we believe the Horizon Europe will be fundamental for the research and innovation sector recovery.

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Appendices

Appendix 1

Source: (European Commission et al., 2016)

FP7 had 6 Funding Schemes:

1. Collaborative projects (CP)
    a. These projects are focused research projects with clearly defined scientific and technological objectives and specific expected results. The major objective is developing new knowledge or technology that improves European competitiveness in all fields. These projects tend to have a mixed of industry and academia entities in the consortium.

2. Networks of excellence (NOE)
    a. This category of projects is designed for research institutions that wish to combine and functionally integrate their activities and capacities in a given field, in order to create a European "virtual research centre" in set field.

       For such result to be possible a "Joint Programme of Activities" is created based on the integrated and complementary use of resources from entire research units, departments, laboratories or large teams. The implementation of this Joint Programme of Activities will require a formal commitment from the organisations integrating part of their resources and activities.

3. Coordination and support actions (CSA)

a. These actions aren´t for research itself. Their main objective is for coordination and networking of projects, programmes and policies. This includes, for example:
    i. coordination and networking activities, dissemination and use of knowledge
    ii. studies or expert groups assisting the implementation of the FP
    iii. support for transnational access to major research infrastructures
    iv. actions to stimulate the participation of SMEs, civil society and their networks
    v. support for cooperation with other European research schemes (e.g. "frontier research")

4. Individual projects (IP)
    a. Projects that, has the name indicates, carried out by individual national or multinational research teams and lead by a main researcher (principal investigator). These projects are funded by the European Research Council.

5. Support for training and career development of researchers ()
    a. These projects are the so-called Marie Curie support actions. They intend to help in the training and career development for researchers from across the EU (and its research partners).

6. Research for the Benefit of Specific Groups – in particular SMEs (BSG)
    a. These projects are research and technological developments, carried out by universities, research centres or other legal entities, where the main objective is to benefit specific groups, in particular SMEs (great focus of

the Commission and the Cohesion programme) or for civil society organisations and their networks.

b. This BSGs can be for SMEs or SME associations/groupings (BSG-SME or BSG-SME-AG respectively)

Appendix 2

Regarding percentual values, the Program that got furthest away of reaching the proposed budget was the Nuclear Research Specific Program. This Program didn´t use around 79% of the available budget. By far, this was the Specific Program that was further away from the initial budget. The reason does not appear to be a lack of participation initiative. In the overall FP7 project, for the period 2007- June 2014, there was a total of 487 concluded calls. For these calls, there was 135 716 proposals submitted of which 19% were retained for budget negotiations and 18.5% ended in a signed Grant Agreement (European Commission, 2015). Regarding the Nuclear Research Specific Program, the amount of proposals was 288 for the period 2007 – June 2014. Until June 2014, only 140 ended up in a signed Grant Agreement. This means a success rate of 46% (European Commission, 2015). As it is possible to verify, the Nuclear Research Specific Program was the one which got further away from the budget goal (-79% of the predicted budget) and yet it got a much bigger success rate regarding all the proposals presented for its related calls. Unfortunately, we weren´t able to find information to justify this apparent paradox regarding this program and, therefore, it can be assumed that due to its characteristics, the JRC is an outlier.

Appendix 3

The JRC Specific Program only granted funding to 140 grants focusing heavily in the Nuclear Fission and Radiation Protection thematic priority (136 of those 140 grants) with 353.92€ millions. This means an average of 2.6 million per project. However, there

are several types of projects. For example: Collaborative Projects (CP) represent almost half (69) of the funded projects in this thematic priority, Coordination and Support Action (CSA) projects which represent the other significant portion of the projects (59), Collaborative Projects with a CSA component (CP-CSA) with 9 approved projects and Networks of Excellence (NOE) with 3 approved projects.

The average funding of the grants for these projects alternates a lot according to the complexity of the project itself. The average of the CP projects is 3.44€ millions. The CSA average is just 928,100€. However, there is a huge and significant difference from the CP, CSA projects to the CP-CSA and NOE projects. The average for the CP-CSA is 4.91 million and for NOE projects is around 5.58 million.

This means that, assuming the average of funding for a certain type of project correlates to its importance, either regarding research and complexity, either regarding the importance attributed by the EC, it means that the NOE and the CS-CSA projects are given much more importance than the others.

That´s why, although there is a positive correlation of 0.45 between the amount of signed grants to the amount of funding applied to each Specific Program, the average of funding per grant signals where does the European Commission lays greater importance. The answer to this is the fact that some of the grants regarding certain Specific Programs do not require a lot of funding and some others are not funded at 100%.

Appendix 4

An interesting fact to notice is that the People Specific Program has a clear higher number of signed grants while being merely the 3rd Specific program regarding funding and by far the one with the lowest average of funding per signed grant. This indicates that regarding the correlation analysis, the People Specific Program is the outlier. When removed from the correlation analysis, the correlation coefficient is an astounding 0.95 meaning an almost direct relation between signed grants and EU Contribution, which is to be expected.

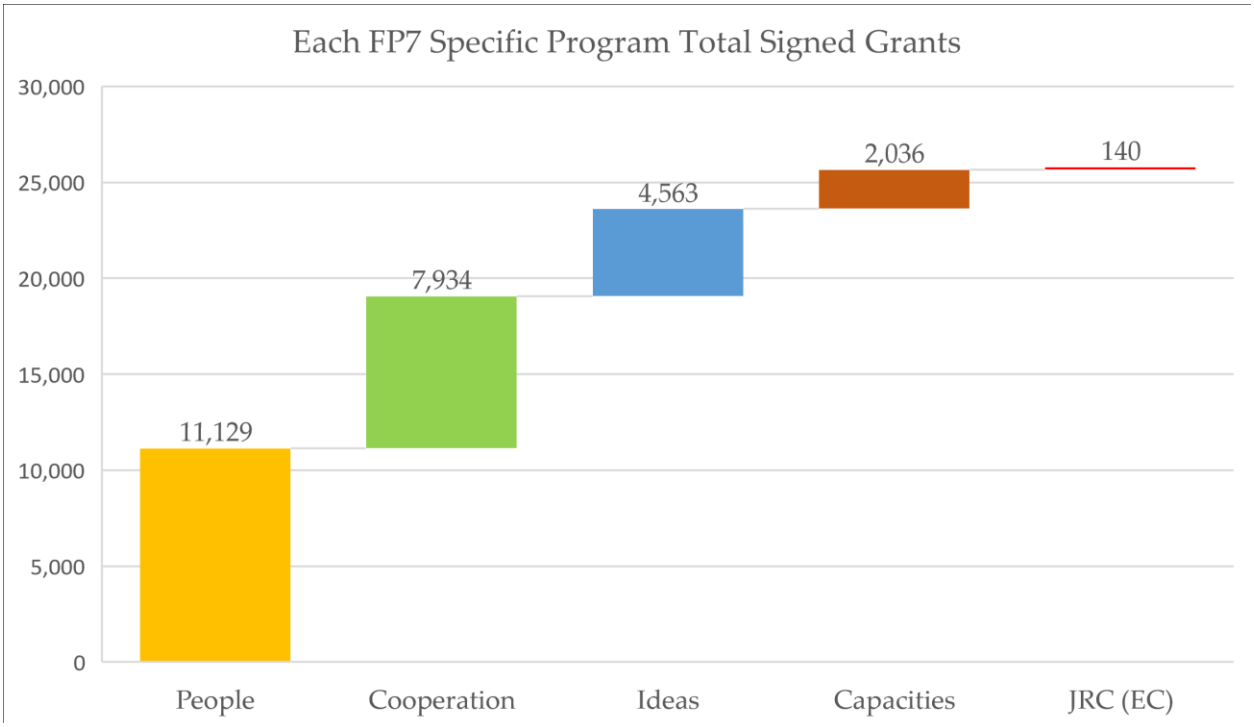

Figure 22 - Each FP7 Specific Program Total Signed Grants;

Source: https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1/sheet/076eedee-e14d-4554-a8a0-5545d89da416/state/0 – others calculation

Other interesting fact to notice is that the Cooperation Specific program, not only had much more fund available at the beginning, which makes it clear that it is a priority of the European Commission, but also has an average of funding per signed grant

significantly higher than the others. The fact that it didn´t hit the expected funding over the entirety of the FP7 program can lead to speculation regarding why that happened.

According to the 7th FP7 Monitoring Report, for the Cooperation Specific Program, until the end of June of 2014, there was a total of 40 158 submitted proposals. This means that the acceptance rate for this specific program was 19.42%[48].

Appendix 5

The remaining pillars, the Ideas, People and Capacity have smaller differences regarding predicted budget and effectively granted one, but those discrepancies allow us to reach the exact same conclusion. The Ideas Specific Program, with an over expansion of 225.869€ million (3% of the initial budget) is very well inside of what would be expected regarding deviations from predicted funding. The People Specific Program is over the expected budget 73.405€ million (1.55% of the initial budget) which is, again, inside the expected possible deviations. The Capacity Specific Program is under the expected budget by -318.947€ million (7.78% of the initial budget). This is a relatively bigger margin than the ones before. Another important fact regarding all this 3 Specific Programs is that, just as the others, they also had a much higher number of proposals than the ones that got approved. By June of 2014, each of these Specific Programs had a much bigger amount of presented proposals over the ones that had been accepted. The Ideas had 35 335 presented proposals and an acceptance rate of 12.66%, People had 49 639 and a 22.30% acceptance rate and Capacities had a total of 10 296 presented proposals with an acceptance rate of 19.62%. The similarities of all these situations lead to the same

[48] The difference in the numbers regarding the amount of proposals submitted on June 2014 and the end of the program in 2015 is, in total 281 proposals. according to the FP7 dashboard. This amount is not being considered for the calculation of any proposal acceptance rate has shown in table nº2

previous conclusions since the rules for all types of proposals under each Specific Program are the same.

Appendix 6

What follows is an analysis of each of this Specific Programs (except JRC) and their respective outcomes on several metrics. Each one, due to their specificity and unique objective, will have different approaches of analysis, although some indicators might exist for more than one of the Specific Programs being analysed. For the following analysis, the main tools will be all the dashboards available and provided by the European Commission in the dashboard hub[49] and some other sources that the European Commission might dispose on-line.

Capacities Specific Program

The Capacities Specific Program main objective was to equip researchers with the equipment and research capacity in order to improve performance. This Specific Program aimed at helping funding key research infrastructures, increase research potential, research for the benefit of SMEs, increase the amount of areas of knowledge being able to be researched and specific international cooperation. As it is possible to deduce, this Specific Program can be a good instrument to increase cohesion among EU Member States and help levelling the field among researchers of all the Member States.

According to the map below (Figure 5) describing the amount of funding regarding the Capacities Specific Program in each Member State, it is possible to visualize that the most capable of high-end research were the ones that received, in percentage, the biggest amount of funding for increasing research capacity. This can be a normal situation if the Capacitates Specific Program focus would be mainly upgrading the research and

[49] https://webgate.ec.europa.eu/dashboard/hub/stream/aaec8d41-5201-43ab-809f-3063750dfafd

innovation capacity of a Member State. However, the Capacities Specific Program intended to increase research capacity as well. The very low percentages in the peripheric countries demonstrated a lack of capacity by those Member States to capture funding to increase installed capacity. For the purpose of more cohesion in the EU it is a bad outcome.

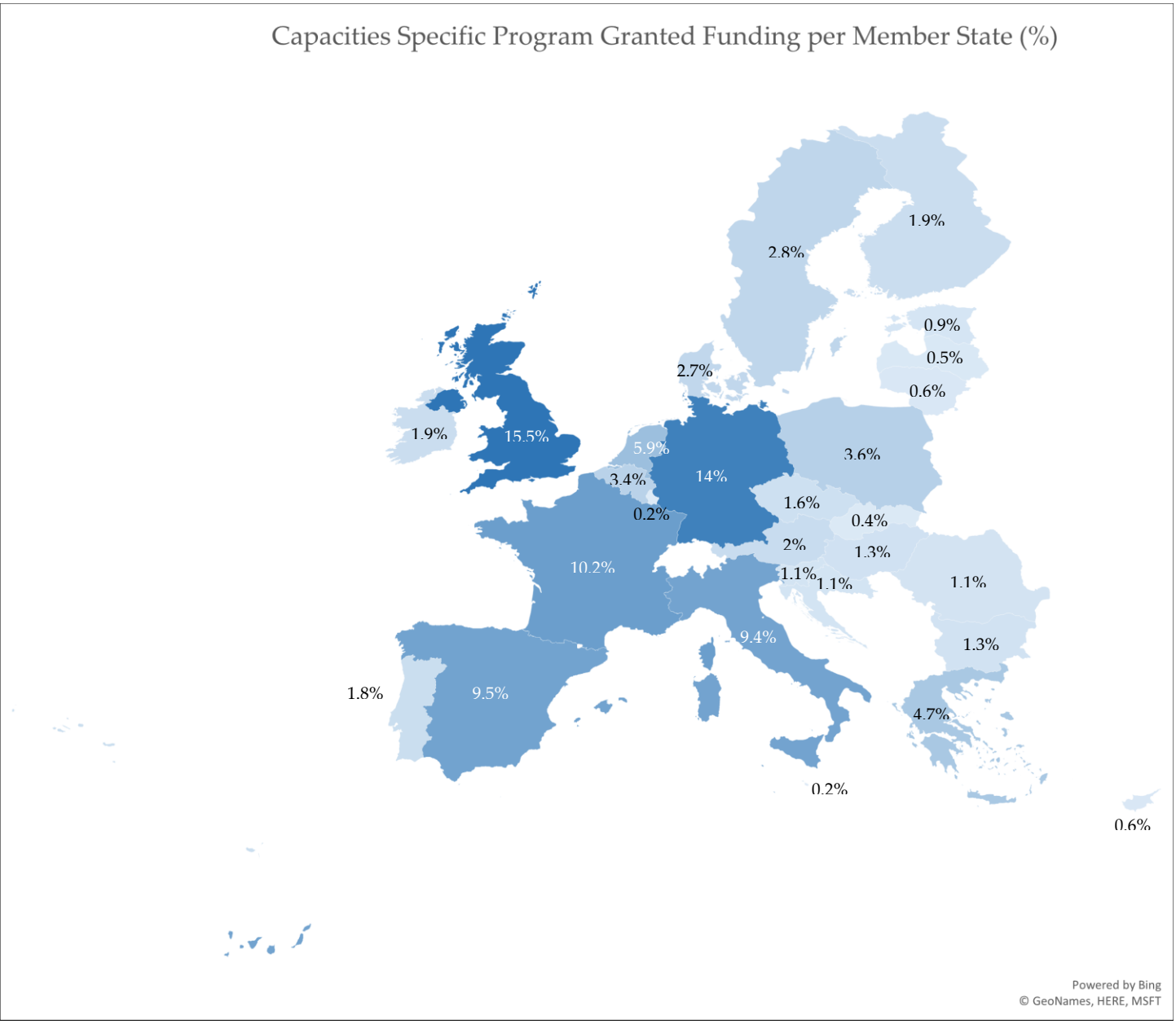

Figure 23 - Capacities Granted Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

It is possible to observe in Figure 23 that there are 2 big groups regarding Capacities funding. The 1st group was composed of the top 5 countries: United Kingdom, Germany, France, Italy and Spain. Every country in this group received 9.4% (Italy) or more of the total Capacities funding. The 2nd group is composed by the remaining member States. The highest value among these is the 5.9% of Capacities funding received by the Netherlands. It is important to notice that between the Netherlands (5.9%) and Italy (9.4%) there is a difference of 3.5 percentage points. This difference is quite big regarding the observed percentages. However, it is still important to compare this amount with other metrics. For example, the amount of Capacities funding in relation to what each country contributed to the EU budget is important, since that the FP7 was included in the efforts that the European Commission had promised in order to increase cohesion in the EU.

As it is possible to observe, the amount of direct participation in the EU budget follows closely the Capacities Specific Program with the top 5 receivers of such funds being the same has the ones that participate the most in the EU budget. The correlation between the Member States percentage of Capacities Specific Program funding received and the direct participation to the EU budget is 0.917. It is much bigger than what would be expected. During our analysis we could verify that Croatia had a particular situation since the country had been participating in the program but only joined the EU officially in 2014. This means Croatia only participated in the EU budget in 3 of the 8 analysed years. The same correlation is 0.916 if Croatia is removed demonstrating that Croatia, due to being a small peripheric country of the EU, doesn´t have capacity to make a significant change in the final result.

During our analysis, regarding this Specific Program, of the top 5 countries, the UK caught our attention. Being the 2nd largest economy in the EU, it was to be expected that it would be a net giver regarding EU programs. The UK is one of the top

leaders in research and innovation in Europe and yet, regarding the Capacities Specific Program they had the biggest net positive percentage of funding received minus their percentage of direct participation in the EU budget.

Table 38 - Net difference between Received Capacities Specific Program funding and Direct EU budget participation; Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Countries	Capacities Specific Program received funding	Member States direct participation in the EU budget	Result Received Funds - Budget participation (in percentual points)
BE	3.37%	3.15%	0.21
BG	1.25%	0.32%	0.93
CZ	1.57%	1.21%	0.36
DK	2.67%	2.05%	0.62
DE	13.96%	20.24%	-6.28
EE	0.86%	0.14%	0.72
IE	1.89%	1.27%	0.62
GR	4.70%	1.82%	2.88
ES	9.52%	8.86%	0.66
FR	10.16%	17.43%	-7.26
HR	1.07%	0.10%	0.96
IT	9.44%	13.23%	-3.79

CY	0.59%	0.15%	0.44
LV	0.53%	0.18%	0.35
LT	0.57%	0.26%	0.30
LU	0.16%	0.26%	-0.09
HU	1.34%	0.80%	0.54
MT	0.23%	0.06%	0.17
NL	5.86%	4.12%	1.75
AT	2.05%	2.30%	-0.26
PL	3.60%	3.07%	0.53
PT	1.83%	1.45%	0.38
RO	1.12%	1.11%	0.00
SI	1.06%	0.31%	0.75
SK	0.42%	0.55%	-0.12
FI	1.88%	1.61%	0.27
SE	2.80%	2.79%	0.01
UK	15.52%	11.16%	4.36

Of the top 5 receivers of the Capacities Program which coincide with the top 5 economies in the EU and also the top 5 direct givers to the EU budget, the UK was the only one with a significant net positive.

Table 39 - Top 5 Capacities Specific Program receivers;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Countries	Capacities Specific Program received funding	Member States direct participation in the EU budget	Result Received Funds - Budget participation (in percentual points)
DE	13.96%	20.24%	-6.28
ES	9.52%	8.86%	0.66
FR	10.16%	17.43%	-7.26
IT	9.44%	13.23%	-3.79
UK	15.52%	11.16%	4.36

Of the 5, the weakest economy, Spain, is the other one with a net positive: however, a 0.66 net positive is a very small number when taking into account the disproportionate capacity of research between Spain and the remaining top 5. The UK, in this particular case, is clearly the exception to the rule, being a centre for research and innovation, it received the most from the Capacities Program.

A positive sign for the effects of the program is that almost every other country has a net positive when these 2 variables are compared. The exception to this case is Austria that has a net negative and the surprises are Slovakia, that also has a net negative and Romania that has no change whatsoever. Austria is just an exception and not a surprise because is one off the most powerful EU countries regarding Research and Innovation therefore being expected that would have a bigger direct contribution to the

EU budget than the percentage of the funding from the Capacities Specific Program. The biggest surprise is by far Slovakia. This small and peripheric country of the Union a former eastern bloc country should be expected to perform better regarding this metric. Its direct contribution to the EU budget accounts only for 0.55% of the total budget, and still had a net negative regarding the Capacities Specific Program by receiving only 0.42% of the funding distributed by the program.

The relevance of this metric lays in the fact that the Capacities Specific Program aimed at increasing research potential and it could have been a good tool for increasing the cohesion inside the EU. At the time of the FP7, the financial crisis of 2008 began, and these types of programs became vital tools for the possibility of the smaller and peripherical economies to turn around. The case of Slovakia is a unique case.

Another interesting case is Romania. The country accessed to 1.12% of this Specific Program funding while granting, during the same period, 1.11% of the EU direct budget demonstrating once again that this program could have helped more significantly.

The last note to take from this analysis is the fact that most of the countries that belong to the periphery of Europe, even the strong and wealthy Nordic countries, took small net positives from this Specific Program demonstrating that in the period 2007-2015 there was a research capacity gap that was deep between the big economies and the smaller and peripheric ones. During this period, it is safe to say that the UK was the biggest beneficiary of the Capacities Specific Program, while Slovakia, not having the losses of other countries, was the one that didn´t used the program to its fullest.

Another interesting number to analyse for this Specific Program is the average amount of funding per participant per country and the average amount of funding per participation per country. The results of such calculations gave us the table 6.

First point to notice is that, the top 5 economies in Europe keep taking their clear front runner spots in the global analysis. However, in these variables, the first spot regarding number of participants goes to Spain with 975 entities participating in the program although the biggest number of participations in it goes to the UK entities with a total of 2345 participations. The total of participants is the amount of singular entities that participated in the program while the total of participations is the total number of project participations by all the entities of a specific Member State.

Table 40 - Capacities Specific Program average funding per participant and per participation for each of the Member States;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	Total number of participants	Total Number of participations	Capacities Specific Program Total Funding (€)	Funding per participation (€)
AT	201	450	68,347,914.46	151,884.25
BE	314	594	112,386,490.57	189,202.85
BG	114	210	41,785,053.38	198,976.44
CY	57	147	19,669,049.84	133,803.06
CZ	124	250	52,332,167.17	209,328.67
DE	839	2015	466,037,620.34	231,284.18
DK	190	403	89,073,197.66	221,025.30
EE	80	197	28,815,975.87	146,273.99
ES	975	2086	317,885,269.86	152,389.87

FI	137	387	62,894,859.12	162,519.02
FR	589	1313	339,339,634.73	258,446.03
GR	236	724	157,114,898.52	217,009.53
HR	56	123	35,580,371.84	289,271.32
HU	169	380	44,758,393.59	117,785.25
IE	175	359	62,971,739.61	175,408.75
IT	768	1639	315,195,831.45	192,309.84
LT	52	122	18,982,809.70	155,596.80
LU	21	39	5,475,319.30	140,392.80
LV	41	66	17,752,637.19	268,979.35
MT	27	81	7,677,215.27	94,780.44
NL	380	896	195,848,129.94	218,580.50
PL	212	427	120,060,673.58	281,172.54
PT	216	429	61,161,749.98	142,568.18
RO	156	264	37,279,063.64	141,208.57
SE	244	543	93,468,460.45	172,133.44
SI	89	189	35,238,095.51	186,444.95
SK	70	106	14,078,661.22	132,817.56
UK	969	2345	518,321,718.93	221,032.72

By crossing the data in the table, it was possible to compare these different metrics to each other's. One of the metrics we decided to put side by side was the number of participants and the amount of participations in the Capacities Specific Program.

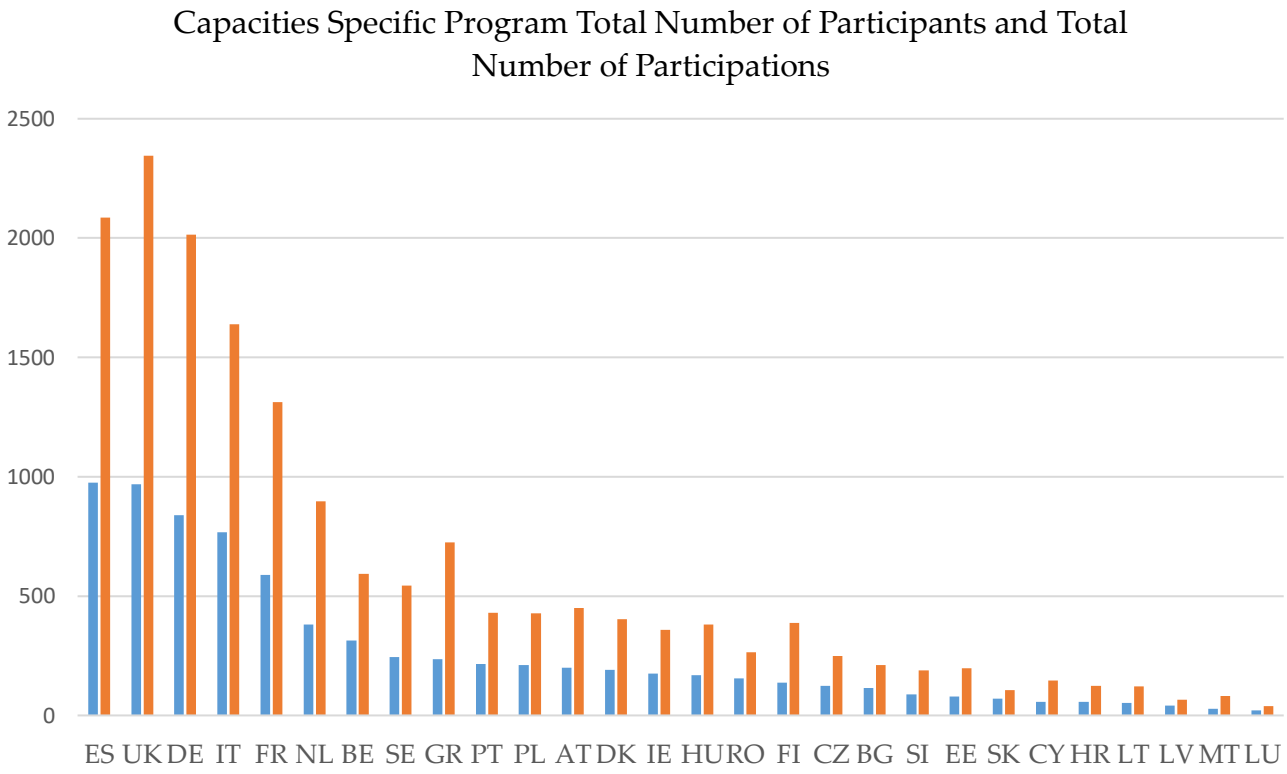

Figure 24 - Capacities Specific Program Total Number of Participants and Total Number of Participations;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

As it is possible to verify, by making such comparison we see that the centres of technology in Europe are the usual top 5 economies. These countries concentrate the major part of participations in the EU. This means that the same entity in one of these Member states is inside several diversified projects and they are the ones that are the most requested to be a part of projects. In total, the participations of the top 5 countries equals 56% of all participations. This means that every single project that was funded by the European Commission had, on average, at least one participant from one of these Member States.

The last point to retain from this Specific Program was the average funding per participation per Member State. Across the entire period, the average of funding per participation has shown a few surprises. Many peripheric countries have bigger funding averages per participation than the bigger economies except Spain.

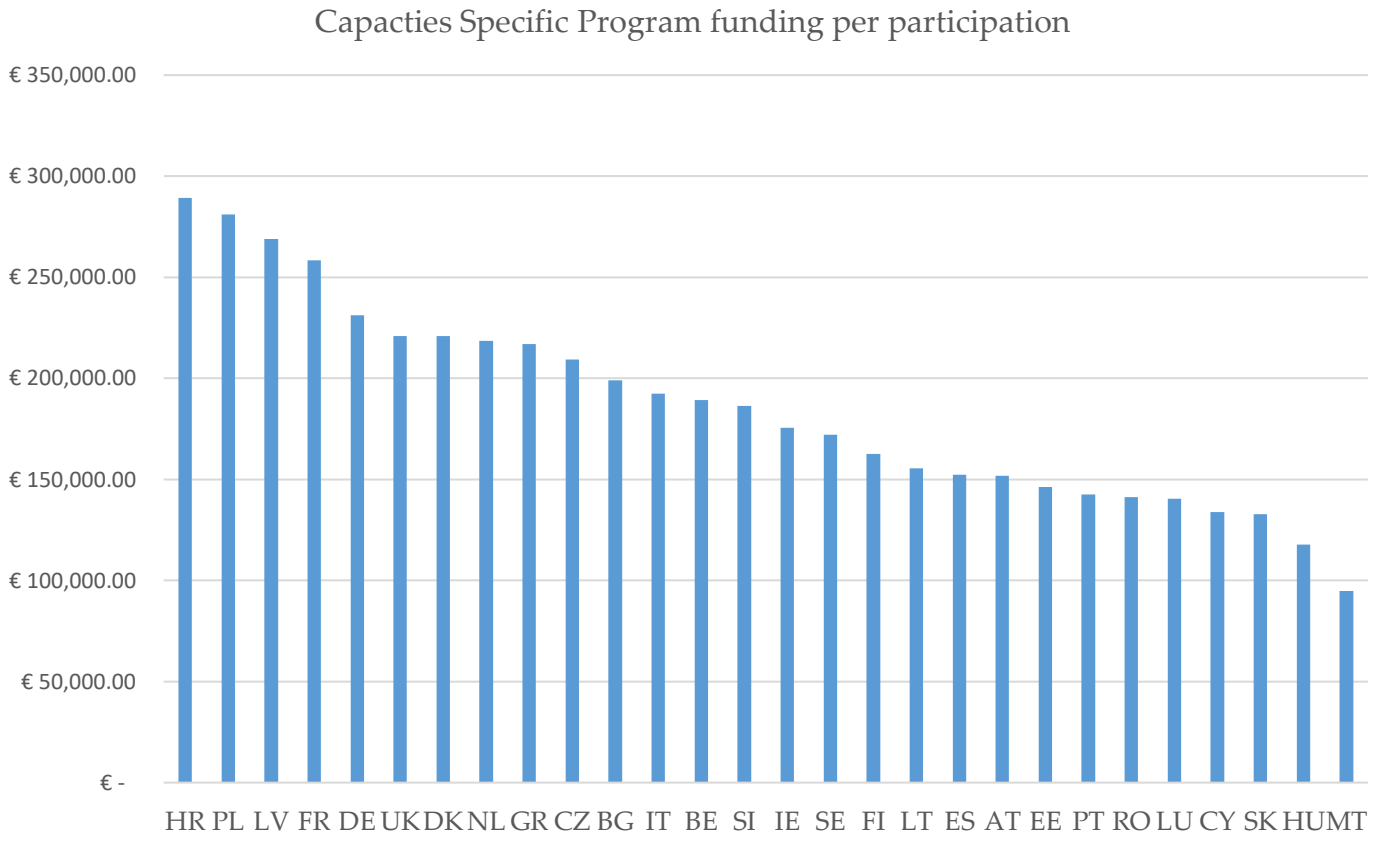

Figure 25 – Capacities Specific Program Average Funding per Participation per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

As it is possible to observe in Figure 8, countries such as Croatia, Poland and Latvia had bigger funding averages per participation than other major EU Member States, namely all the top 5 participating countries. Meanwhile, Spain, one of the top 5 biggest contributors to the EU direct budget, one of the top 5 receivers of funding from the Capacities Specific Program and the Member State with more participants was clearly the

Member State that under-performed regarding their ability to capture funding whenever participated in any Capacities Specific Program project.

However, there is another argument that should be made. According to Figure 8, the distribution of the Capacities Specific Program funding was much more equitable than expected. Although there are clearly Member States that over-performed and others that under-performed, the main purpose of this Specific Program is to increase research capacity as we have seen before, the top 5 economies concentrate more than half of the research capacity in the EU. Countries as the UK, France, Italy and Germany still have an average of funding per participation quite high when these countries have the economic capacity to actually have a bigger self-funding policy. In order to increase the cohesion of the Union, it should have existed a more equitable distribution of the Capacities Specific Program Funding in order to make sure that those countries that possess the economic capability to finance research capacitation could actually allow other countries from the periphery of Europe to receive funding per participation increasing the economic value of the research sector in those economies.

Cooperation Specific Program

The Cooperation Specific Program main objective is to allow a better diffusion of the already existing knowledge between Member States. That includes not only a higher and faster diffusion of empirical knowledge, but also a faster adaptation of the empirical knowledge into the practical area, mainly in the productive sector, either being for a product or a service. For such reason, it is not surprising that the average of funding granted by the Cooperation Program per proposal approved was the highest among all the FP7 Programs. Not only is the research and the innovation of putting empirical knowledge to practice quite expensive, these proposals required a bigger number of participants per proposal, especially among the top holders of knowledge which are the already mentioned top 5 economies in the EU.

Table 41 - Cooperation Specific Program Participations and EU Granted Funding per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	Participations	Participations (%)	Cooperation Specific Program granted Funding (€)	Cooperation Specific Program granted funding (%)
Germany	13,450	16.7%	4,901,809,712.94	18.8%
United Kingdom	10,275	12.8%	3,666,727,775.73	14.0%
France	8,806	10.9%	3,363,671,695.20	12.9%
Italy	8,747	10.9%	2,613,409,061.79	10.0%
Spain	7,510	9.3%	2,168,365,177.87	8.3%
Netherlands	5,885	7.3%	2,201,849,658.94	8.4%
Belgium	4,124	5.1%	1,265,241,714.21	4.8%
Sweden	3,187	4.0%	1,176,332,576.06	4.5%
Austria	2,597	3.2%	818,036,965.11	3.1%
Greece	2,555	3.2%	718,212,382.98	2.8%
Finland	2,140	2.7%	636,475,674.43	2.4%
Denmark	1,901	2.4%	687,820,910.84	2.6%
Portugal	1,562	1.9%	348,927,834.73	1.3%
Poland	1,376	1.7%	252,371,613.85	1.0%
Ireland	1,233	1.5%	394,169,214.04	1.5%
Czechia	907	1.1%	181,118,376.01	0.7%
Hungary	877	1.1%	151,169,370.41	0.6%
Romania	669	0.8%	104,344,780.11	0.4%
Slovenia	624	0.8%	117,273,901.27	0.4%
Bulgaria	377	0.5%	47,581,166.32	0.2%
Slovakia	295	0.4%	48,299,404.09	0.2%
Estonia	287	0.4%	51,757,157.64	0.2%
Croatia	239	0.3%	42,973,695.01	0.2%
Cyprus	233	0.3%	46,771,370.19	0.2%
Lithuania	218	0.3%	27,343,782.48	0.1%
Luxembourg	187	0.2%	42,807,234.12	0.2%
Latvia	178	0.2%	26,635,937.02	0.1%
Malta	91	0.1%	11,629,796.11	0.0%

The first expectations regarding this program is that the difference among central and peripheric Member States should be more visible. In the EU we find the top research centres and the top technologies in specific countries namely in the top 4 economies and the Nordic countries. The data we analysed confirms this suspicion. When analysed the total received funding per Member State, 56% of the granted funding was to the following countries: Germany, UK, France and Italy. Regarding this Specific Program, the Netherlands managed to be ahead of Spain in this metric demonstrating once again that the knowledge-based economy that the European Commission aims at being the main economic driver in the future is concentrated in a very narrow geographical area of the Union.

As it is possible to verify the amount of participations by the top 4 countries in this Program were also equivalent to a little more than 50% meaning that these countries had entities participating in most or even all of the proposals approved under the Cooperation's pillar. This is positive since they are the major centres of knowledge and, for the purpose of spreading and sharing knowledge, it is important to have their participation. It also symbolises that the empirical knowledge needed for the creation of the knowledge base economy that the European Commission intends to create is concentrated. If this situation remains it is very possible that the creation of a knowledge-based economy might increase the disparities among the EU Member States and increase the flux of human capital and resources to the centre of the EU and also increase the dependence of the peripheric economies towards the central and bigger ones. According to the data regarding this Specific Program, even a country like Spain would suffer from the geographical and economic peripheric situation in which it is

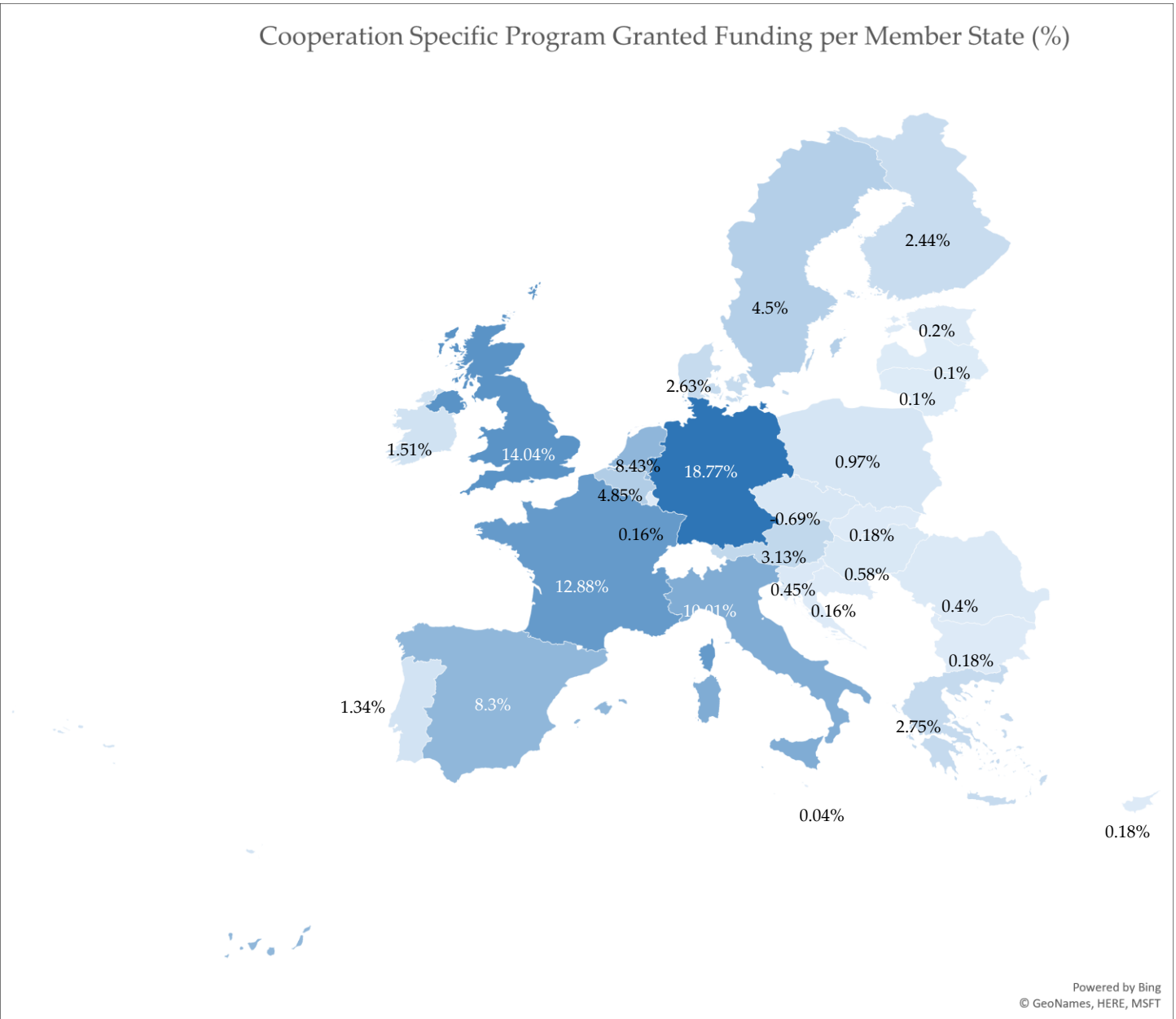

Figure 26 - Cooperation Specific Program granted funding for the period 2007-2015;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others

Regarding this program it is also important to verify the Cooperation Specific Program granted funding per Member State and compare it to the amount of direct participation in the EU budget for the period 2007 – 2015. According to Figure 9, the distribution of funding of this Specific Program was relatively different from the other

ones. The concentration of funding is clear, and it helps realize, together with the amount of participations that the main focus of this Specific Program does not have into account the problematic of the cohesion inside the Union. Although the main objective is the transmission of knowledge and helping in its implementation, the Specific Program rewards the knowledge centres. Because of this detail, it is possible that the incentives for other nations to participate in the Specific Program are weaker than the others. The fact that this Specific Program was, as it was seen previously, the most overrated by the European Commission being the one that got the furthest away from its target budget, it can be a sign that a more equative distribution of the funding can help incentivise the participation in these type of programs and might help spread the knowledge in order to create the economy in the EU that the European Commission pursues.

Table 42 - Net difference between Received Cooperation Specific Program funding and Direct EU budget participation;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Countries	Cooperation Specific Program granted funding (%)	Member States direct participation in the EU budget	Result Received Funds - Budget participation (in percentual points)
BE	4.85%	3.15%	1.69
BG	0.18%	0.32%	-0.14
CZ	0.69%	1.21%	-0.52
DK	2.63%	2.05%	0.59
DE	18.77%	20.24%	-1.47
EE	0.20%	0.14%	0.06
IE	1.51%	1.27%	0.24
GR	2.75%	1.82%	0.93
ES	8.30%	8.86%	-0.55
FR	12.88%	17.43%	-4.54
HR	0.16%	0.10%	0.06
IT	10.01%	13.23%	-3.22

CY	0.18%	0.15%	0.03
LV	0.10%	0.18%	-0.08
LT	0.10%	0.26%	-0.16
LU	0.16%	0.26%	-0.09
HU	0.58%	0.80%	-0.22
MT	0.04%	0.06%	-0.01
NL	8.43%	4.12%	4.32
AT	3.13%	2.30%	0.83
PL	0.97%	3.07%	-2.10
PT	1.34%	1.45%	-0.12
RO	0.40%	1.11%	-0.71
SI	0.45%	0.31%	0.14
SK	0.18%	0.55%	-0.36
FI	2.44%	1.61%	0.82
SE	4.50%	2.79%	1.71
UK	14.04%	11.16%	2.88

The most surprising fact regarding this Specific Program, is the difference of percentages between each of the member States Cooperation Specific Program granted funding and their direct participation in the EU budget.

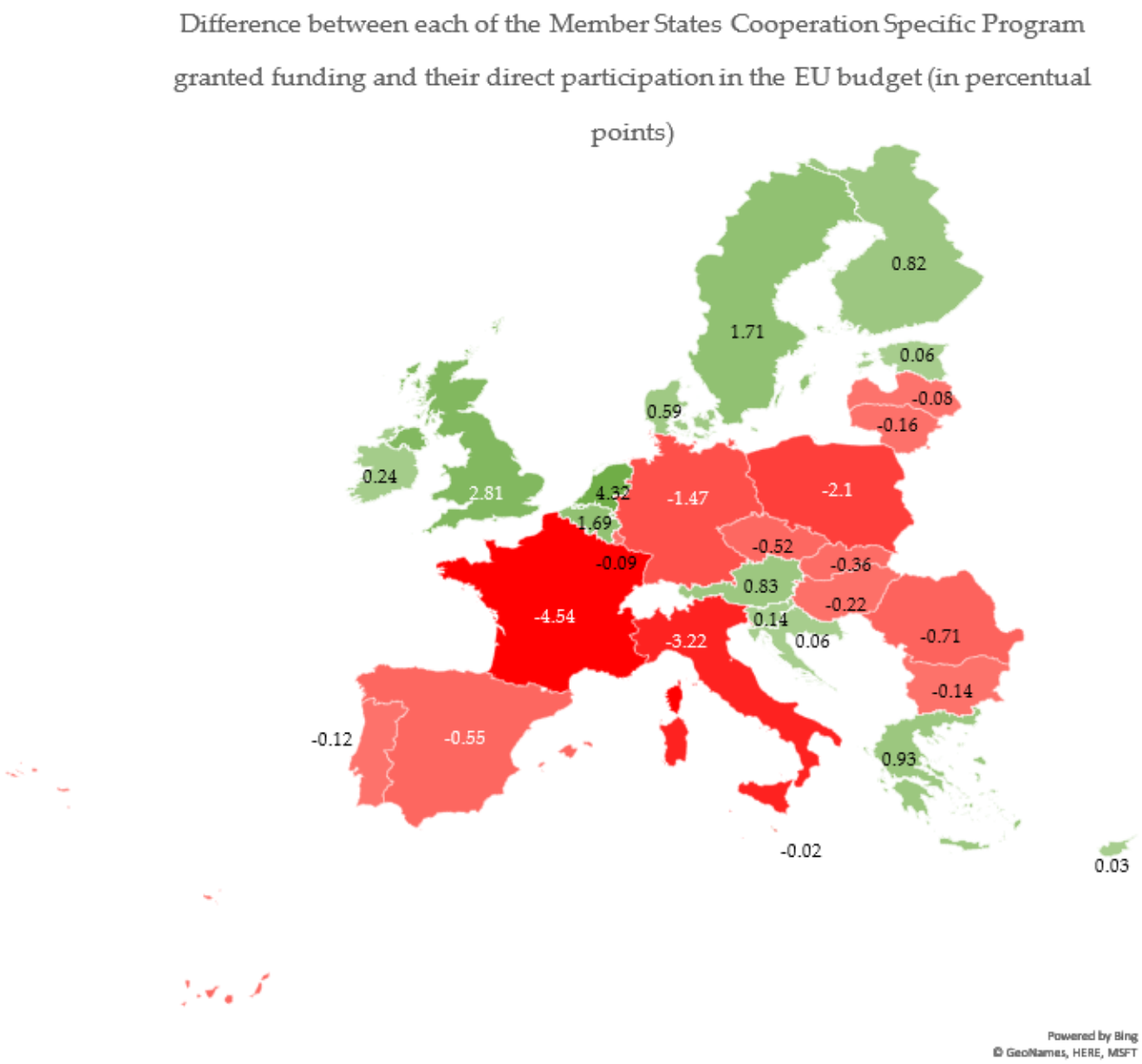

Figure 27 - Difference of percentages between each of the Member States Cooperation Specific Program granted funding and their direct participation in the EU budget;

Source *https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others*

Has it is possible to observe, in the main Specific Program of the FP7, we can verify a paradox between the objective of the Specific Program and the distribution of the

funding. We should remember that this Specific Program contained the biggest funding average per proposal of any of the Specific Programs, it was the one that included the bigger amount of entities per proposal and yet it clearly shows a big inequality regarding its funding distribution. Although very big economies such as Germany, France, Italy and even Spain were net negative, the most surprising aspect was the existence of negative transaction between the weakest economies and some of the strongest ones. The only exceptions were Greece, Cyprus, Croatia, Slovenia and Estonia. These 5 Member States managed to receive a bigger percentage of the Cooperation Specific Program than the percentage of the direct EU budget they financed. The Eastern economies seem particularly affected by this negative transaction together with the Iberian Peninsula. Other surprising aspect is the fact that even France and Italy had a bigger percentual difference between these 2 variables than Germany. The UK once again managed to be a net beneficiary despite being the 2nd largest economy in the EU. Most of the wealthier Nordic Member States managed to be net beneficiaries as well. Although the biggest beneficiary was the Netherlands. The country, although not contributing to the EU budget as much as Spain or Italy, it is by far one of the most developed economies in the EU. This country participated directly to 4.13% of the EU budget within the FP7 period. The Netherlands received 8.43% of the entire Cooperation granted funding. Such disproportionate distribution goes against the main purpose of the program which is to help spread and apply the existing knowledge in all the EU. That same knowledge is located in the most developed countries that also happen to be net positive countries. The redistribution system of these type of funding regarding this Specific Program should be re-thought.

To demonstrate this inequality regarding the distribution of funding, we analysed the amount of participations and the funding per participation. The system that the FP7 and the present H2020 Programs use to assess how to distribute the funding. is the Person-month[50] system. However, the wealthier economies have higher standard of livings than the peripheric ones. Therefore, with fewer participations they can obtained has much funding as those with weaker economies.

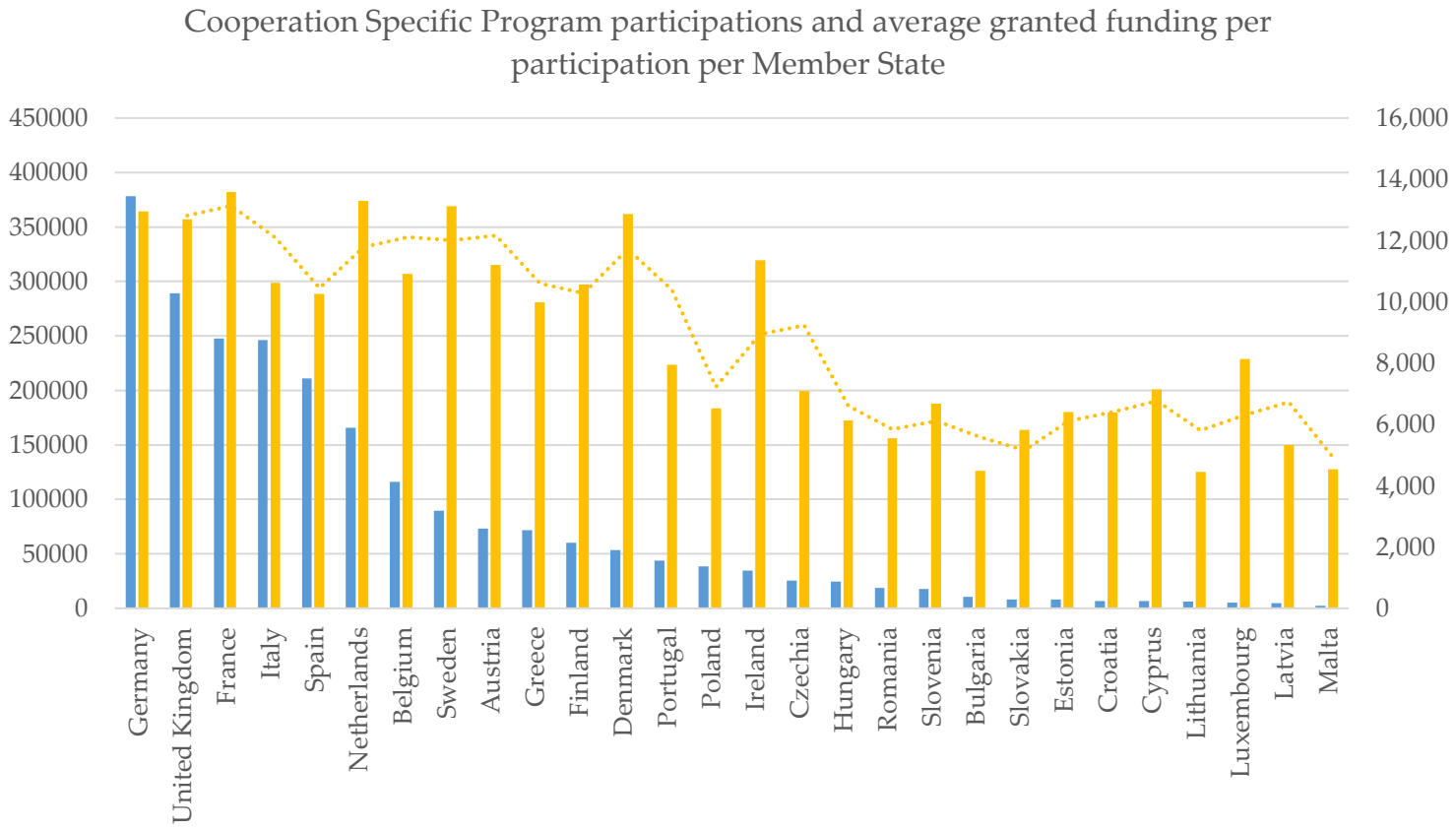

Figure 28 - Cooperation Specific Program participations and average granted funding per participation per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

[50] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

In figure 11 is possible to see the staggering difference between the major countries and the Nordic countries in comparison to the southern and eastern countries. A different system of assessing the amount of funding is recommended since the ability of creating incentives for research and innovation is to have researchers and entities motivated. Most of the research infrastructures in the peripheric EU Member States greatly depend on the EU funding and programs such as the FP7 to operate. Increase funding per participation in these countries might be fundamental for a cohesion policy that can foment the knowledge-based economy that the European Commission seeks.

Ideas Specific Program

Both the Capacities and Cooperation Specific programs had objectives that allowed them to be less narrow regarding the entities that could fit the aims of such programs and, by consequence, be more open regarding the projects that were approved. For such reason it would be expected that those Specific Programs would have a much bigger range regarding funded entities and Member States. However, it is still of great contrast the brutal difference between a more criterions funding program such as the Ideas Specific Program and those two.

While in both of the previously analysed specific Programs, the top 5 economies amounted for around 50% of the participations leaving space for entities of other Member States to use and access to the funding, in the Ideas Specific Program that number grows to a staggering 81.17%.

In this Specific Program, projects can change drastically among themselves.

Table 43 - Ideas Specific Program Correlations table;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Correlation between Granted Funding and …	Correlation value
Number of participants	0.853
Number of participations	0.998
Number of participations per participant ratio	0.694

We also analysed some correlations and the result was somewhat expected. The amount of participations was the key factor for obtaining more funding. The interesting thing was the ratio between number of participations per participant giving the smallest correlation of them all. This indicates that even the countries that make a lot of participations do not have that many entities participating in each project.

Table 44 - Ideas Specific Program Average Funding per participant;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	Number of participants	Average of funding per participant (€)
AT	26	7,196,772.593
BE	16	15,593,814.32
BG	3	1,053,465.56
CY	4	3,414,997.228
CZ	10	1,632,509.044
DE	129	8,910,636.102
DK	13	1,1388,486.74
EE	3	1,716,790.713
ES	79	5,148,807.933
FI	10	1,1278,979.11
FR	84	1,1660,507.53
GR	15	3,708,646.251
HR	3	1,259,952.333
HU	18	3,254,150.342
IE	10	5,585,545.017
IT	82	4,950,702.253
LU	1	1,009,910
LV	1	1,360,980
MT	3	157,978

NL	29	23,939,820.33
PL	12	1,732,337.678
PT	21	2,663,404.658
RO	1	366,960
SE	16	17,505,176.05
SI	3	714,360.6667
SK	1	1,155,970
UK	91	18,829,569.91

Most interesting is that their type of participants are not key for obtaining that huge amount of funding. The fact is that the top researchers in the EU are the 5 biggest economies plus the Netherlands. Their entities participate in all the projects regarding the Ideas Specific Program and that guarantees to them a huge part of the funds since they have a lot of entities. However, since the correlation between the ratio and granted funding isn´t has high has the others it indicates that Member States with fewer entities per participation have the ability to guarantees more funding per participant in each of their participation indicating that there is a research and innovation sector in the European periphery that should be secured and can be a very important tool for the success of those countries' economies and the creation of an knowledge based economy across the Union because it all indicates specialization.

Table 45 - Net difference between Received Ideas Specific Program funding and Direct EU budget participation;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Countries	Column1	Member States direct participation in the EU budget	Result Received Funds - Budget participation
BE	3.77%	3.15%	0.61
BG	0.05%	0.32%	-0.28
CZ	0.25%	1.21%	-0.96

DK	2.24%	2.05%	0.19
DE	17.36%	20.24%	-2.88
EE	0.08%	0.14%	-0.06
IE	0.84%	1.27%	-0.43
GR	0.84%	1.82%	-0.98
ES	6.14%	8.86%	-2.71
FR	14.79%	17.43%	-2.63
HR	0.06%	0.10%	-0.04
IT	6.13%	13.23%	-7.10
CY	0.21%	0.15%	0.06
LV	0.02%	0.18%	-0.16
LT	0.00%	0.26%	-0.26
LU	0.02%	0.26%	-0.24
HU	0.88%	0.80%	0.08
MT	0.01%	0.06%	-0.050
NL	10.48%	4.12%	6.37
AT	2.83%	2.30%	0.52
PL	0.31%	3.07%	-2.76
PT	0.84%	1.45%	-0.61
RO	0.01%	1.11%	-1.11
SI	0.03%	0.31%	-0.28
SK	0.02%	0.55%	-0.53
FI	1.70%	1.61%	0.09
SE	4.23%	2.79%	1.44
UK	25.87%	11.16%	14.72

As it is possible to verify, only 9 of 28 nations see a positive effect in their balance between what is received by the Ideas Specific program and their share in the direct EU budget. Once again, the UK is the biggest beneficiary. With 14.72 percentage points of positive difference, it hits a record regarding this discrepancy. In terms of the research and innovation the UK has clearly demonstrated that it is the one off the biggest receivers

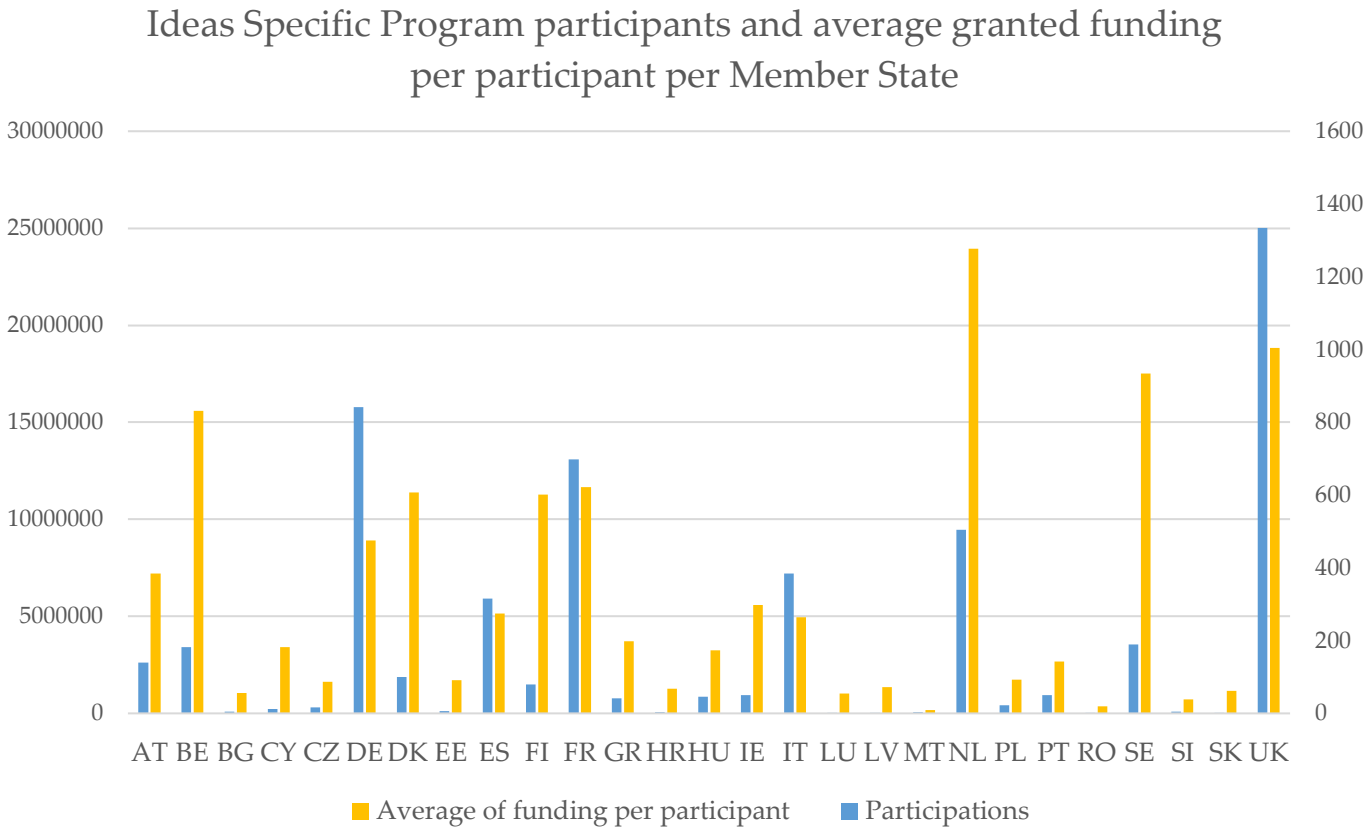

Figure 29 - Ideas Specific Program participants and average granted funding per participant per Member State; Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

of EU funds. The cause of this might be that the UK has a much more established research and innovation culture and economy than other Member States (PĂUNICĂ, 2017, page 166). Nothing makes that argument more clearly than the numbers presented by the Ideas Specific Program.

The disparities between the funding average per participation between the wealthiest countries in the Union and the poorest ones couldn´t be more notable than in Figure 13. Such disparities in the distribution of the funds are a visualization of the disparities between economies and how far they are regarding valorisation of research and innovation. The Ideas Specific Program aimed at funding front edge research and technology. It is now possible to verify which are the Member States that benefit the most from the scientific funding plans although it might be questionable if such distribution is fair.

People Specific Program

This Specific Program aims at securing projects that guarantee mobility and training to researchers. One of side effect of this is the creation of a contact network among researchers across the Union that will benefit the research field in general. This is probably one of the greatest effects of this Specific Program and should be better studied and researched. The People Specific Program only has one type of actions called Marie Curie Actions. Because the objective of each proposal is simpler than the others, this Specific Program has the lowest average funding per proposal. That indicates that it is the pillar with far more approved proposals, on absolute terms. However, because it is about moving and empowering people, in this Specific Program, the averages of granted funding varied more between Member States than in previous Specific Programs.

The differences of funding between Member States per participation in the People Specific Program reinforces the argument that the mechanism of distribution of European funds might be helping to fund crucial research but is not helping increasing the capacity for the peripheric countries to contain and take advantage of the human capital they themselves create.

Table 46 - Difference between participations (%) and Received Funding from the People Specific Program;

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Country	People Specific Program participations (%)	People Specific Program received funding (%)	Difference Between Participations and Received Funding (in percentual points)
United Kingdom	23.21%	25.64%	2.43
Germany	12.28%	13.27%	0.99
France	11.17%	10.73%	-0.44
Spain	9.59%	9.23%	-0.36
Italy	7.86%	6.74%	-1.12
Netherlands	6.55%	7.34%	0.79
Belgium	3.54%	4.36%	0.82
Sweden	3.43%	4.27%	0.84
Greece	2.58%	2.08%	-0.50
Austria	2.55%	2.78%	0.23
Denmark	2.52%	3.61%	1.09
Portugal	2.20%	1.42%	-0.79
Ireland	2.10%	2.67%	0.57
Poland	2.05%	1.05%	-1.00
Hungary	1.63%	0.75%	-0.87
Finland	1.40%	1.20%	-0.21
Czechia	1.10%	0.69%	-0.41
Bulgaria	0.57%	0.13%	-0.44
Romania	0.53%	0.22%	-0.31
Slovenia	0.51%	0.34%	-0.17
Latvia	0.49%	0.07%	-0.43
Cyprus	0.43%	0.30%	-0.13
Slovakia	0.39%	0.26%	-0.13
Estonia	0.37%	0.24%	-0.13
Lithuania	0.37%	0.11%	-0.27
Croatia	0.27%	0.22%	-0.05
Luxembourg	0.15%	0.26%	0.12
Malta	0.15%	0.03%	-0.12

Interestingly, this Specific Program does not present a big disparity between the percentage of participations and the percentage of the funding received. Although there are a few countries, all of them peripheric and one exception, Italy, that do present reductions close to one percentual point of difference. However, the positives are bigger with the UK having more than 2 percentual points of the received budget above the percentage of participations.

We start from the most equitable point of view which is, for example, 1% of participation would equal 1% of the budget. Having this in mind, the differences aren´t very much significant. Of course, if we include in this analysis, the knowledge that 1% of the funding equals a nominal amount of euros and that amount has different weights depending on the countries cost of living. That's why, although the differences are quite small, that most countries with less percentage of the received funding in comparison to the percentage of participations made still are the peripheric countries. Regarding this Specific Program, if the European Commission intends to value the human capital in the Union, then it would be better if this difference would start to come closer to 0 percentual points.

. The same argument can be made when analysing the difference between received funding from the People Specific Program and the direct contribution to the EU budget.

Table 47 - Difference between People Specific Program granted funding (%) and Member States direct EU budget participation (%);

Source https://webgate.ec.europa.eu/dashboard/sense/app/eaf1621c-67ce-4972-a07b-dddba31815c1– others calculation

Countries	People Specific Program granted funding (%)	Member States direct participation in the EU budget	Result Received Funds - Budget participation (in percentual points)

BE	4.36%	3.15%	1.20
BG	0.13%	0.32%	-0.19
CZ	0.69%	1.21%	-0.52
DK	3.61%	2.05%	1.56
DE	13.27%	20.24%	-6.97
EE	0.24%	0.14%	0.10
IE	2.67%	1.27%	1.40
GR	2.08%	1.82%	0.26
ES	9.23%	8.86%	0.37
FR	10.73%	17.43%	-6.70
HR	0.22%	0.10%	0.12
IT	6.74%	13.23%	-6.48
CY	0.30%	0.15%	0.15
LV	0.07%	0.18%	-0.12
LT	0.11%	0.26%	-0.16
LU	0.26%	0.26%	0.00
HU	0.75%	0.80%	-0.05
MT	0.03%	0.06%	-0.03
NL	7.34%	4.12%	3.22
AT	2.78%	2.30%	0.48
PL	1.05%	3.07%	-2.02
PT	1.42%	1.45%	-0.04
RO	0.22%	1.11%	-0.89
SI	0.34%	0.31%	0.03
SK	0.26%	0.55%	-0.28
FI	1.20%	1.61%	-0.42
SE	4.27%	2.79%	1.48
UK	25.64%	11.16%	14.48

Our analysis showed that the big economies, except the UK and Spain, and the peripheric and weakest economies had negative differences regarding these metrics. However, it is not enough to state that the difference in this Specific Program between the percentage of funding taken from the Specific Program by the UK and the percentage of its direct contribution to the EU budget is staggering and the highest of all the pillars. For every 5€ that the EU gave in funding under this program, 1€ went to the UK. This

gave the country a net positive of 14.48 percentage points. The remaining net positive countries are quite spread across the EU not existing a singular geographic bloc that can be identified. This indicates that the redistribution of the funding regarding the People Specific Program was quite dispersed and diverse. For example, of the Nordics, both Denmark and Sweden had net positives regarding this metric and Finland got a net negative. In the south something similar happened as well. Spain, Greece and Cyprus had net positives, although not that big, and Portugal and Italy had net negatives although the Portuguese difference is almost 0 and the Italian one is the 3rd largest net negative difference. It is possible to say that regarding this Specific Program the major differences were among the 4 biggest economies in the EU while all the other Member States registered very mild percentual differences contributing for cementing the leadership role the UK has been demonstrating in the research and innovation area.

Appendix 7

Source: (European Commission, 2010)

Such targets had to be "representative of the theme of smart, sustainable and inclusive growth" (European Commission, 2010). Obviously, these targets had to be measurable, capable of reflecting the diversity of Member States economic and financial situation at the time and being capable of comparison by being based on reliable data. Of all the targets set by the European Commission, some are the reason for the existence and the creation of programs such as the H2020. The following targets are those that we believe to be more important and directly or indirectly correlated to the actions of H2020:

- The EU currently has a target of investing 3% of GDP in R&D. The target has succeeded in focusing attention on the need for both the public and private sectors to invest in R&D but it focuses on input rather than impact.

There is a clear need to improve the conditions for private R&D in the EU and many of the measures proposed in this strategy will do this. It is also clear that by looking at R&D and innovation together we would get a broader range of expenditure which would be more relevant for business operations and for productivity drivers.

  - It´s fair to assume that since the main target of H2020 is funding research in all areas of study and promote development and innovation on all fronts, that this target is directly correlated to the existence of H2020.

- Reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30%, if the conditions are right; increase the share of renewable energy sources in our final energy consumption to 20%; and a 20% increase in energy efficiency.
  - The fight against climate change requires investment in new technologies and new and innovative products and services as well as a deep transformation of the economic tissue that constitutes the EU economic market. For such reasons, H2020 is indirectly related to this target since that it has a small component regarding climate fight but the projects that aim to fund will always have to have the climate fight into account.

However, it is also fair to assume that all targets set by the European Commission regarding the Europe 2020 strategy are interrelated. The economic reality of modern-day Europe is by far a much more complex than the previous generations had. It cannot be defined by any national or even continental borders since the EU market has close relationships with most of its neighbours. That's why, for instance, that better educational

levels (another Europe 2020 strategy target) inevitably help employability and progress that, on their hands will lead to a reduction in the unemployment rate and poverty (also another Europe 2020 strategy target). It is also true that greater capacity for investment in research and development leads to greater innovation across the board. This innovation is crucial to increase productivity and resource efficiency. Such achievements can guarantee improved competitiveness (super important if Europe wishes to compete in an XXI century globalized economy), job creation (reduction of poverty) and greener outcomes and key reductions on emissions.

Meeting these targets should be a collective European task and have the European countries united in their achievement. Not only because it would structurally improve Europeans standard of living, but also because they affect every single EU nation. A cleaner economy and greener energy can help to reduce all EU nations on their reliance of fossil fuel providers, especially from its eastern and southern neighbours. A better standard of living is also helpful to most EU nations in order to ensure a stable society. And most of all, the increase in the innovation and technological level is of utmost importance in order to guarantee a future to the European economy as an all and a stronger chance against foreign technological threats.

Appendix 8

Table 48 - Percentual Difference between SMEs Total H2020 Contribution and the SMEs Total FP7 Contribution;

Sourcehttps://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/62509062-153c-48c2-9716-afdc498336c8/state/0 – others calculation

Country	SMEs Total H2020 Contribution (€ in millions)	SMEs Total FP7 Contribution (€ in millions)	Net Difference (€ in millions)	Percentual Difference (%)
AT	281.889	206.008	75.881	36.83%

BE	391.150	350.370	40.779	11.64%
BG	26.703	27.363	-0.659	-2.41%
CY	72.332	30.583	41.750	136.51%
CZ	60.045	57.011	3.034	5.32%
DE	1,008.036	944.691	63.345	6.71%
DK	266	169.041	96.963	57.36%
EE	47.439	33.358	14.082	42.21%
EL	233.114	161.366	71.748	44.46%
ES	996.997	595.708	401.289	67.36%
FI	227.168	95.894	131.274	136.90%
FR	799.5456	615.953	183.593	29.81%
HR	15.700	17.135	-1.434	-8.37%
HU	83.733	81.251	2.482	3.05%
IE	215.760	132.954	82.807	62.28%
IT	756.890	569.293	187.597	32.95%
LT	21.964	17.084	4.880	28.56%
LU	25.465	11.075	14.390	129.94%
LV	10.948	5.977	4.970	83.15%
MT	5.966	8.056	-2.090	-25.94%
NL	741.810	415.485	326.325	78.54%
PL	157.213	63.434	93.779	147.84%
PT	171.558	135.455	36.103	26.65%
RO	24.244	33.256	-9.012	-27.10%
SE	262.849	218.934	43.915	20.06%
SI	73.156	42.160	30.996	73.52%
SK	21.011	20.207	0.804	3.98%
UK	842.661	899.579	-56.919	-6.33%
EU	7,841.350	5,958.679	1,882.671	31.60%

Bulgaria, Croatia, Malta and Romania are some of the countries that have the lowest direct contributions to the EU budget which indicates that they are some of the weakest economies in the Union. These countries need the European funds to help them develop and improve their industrial and economic welfare. Having a reduction in the EU funding regarding SMEs is a worrying sign. Malta is a very small country and it doesn´t have economic dimension to support big entities and enterprises. The reduction

of 25.94% of received funding for SMEs is a sign that the country isn´t able to attract diverse set of entities to participate in this type of programs. It also indicates that the country is not focused in the research and innovation sector which is understandable due to its size. However, the European Commission should attempt to improve the conditions of the sector on the country. The reduction in the UK is expected. Regarding the research and innovation sector, the fears regarding the Brexit event has come to have effects regarding this country participation in the EU programs. The reduction of 6.33% goes along the observed trend and the reduction of participation of British SMEs is expected.

Although most countries have increased its SMEs participation compared to FP7 there are a few cases that present non expected results. Three Member States presented an improvement above 100% which indicates that they more than doubled the granted funding received. However, two of these countries was Finland and Luxembourg. Finland, despite being the Nordic country that least receives in EU funding it has a research and innovation sector capable of attract a bigger percentage of the funding available than its direct EU budget participation. This data indicates that they have a research and innovation sector that is well established and with potential. The increased of the received funding comes as a sign that the Finnish research and innovation sector is becoming more competitive and revitalized. However, it is necessary to state that the country has a cost of living higher than the EU average. This most probably helped to the achievement of this result since the Person-month[51] system is basically indexed to the cost of living. This is the same case in Luxembourg. The country has also achieved a better participation regarding SMEs entities which indicates an increase in the capacity for the research and innovation sector of the country to attract the participation of such entities.

[51] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

However, such as Finland, the country has a cost of living higher than the European average and therefore this fact must be taken into account.

The third country to obtain such a big result was Poland. Poland is a peripheric country from the eastern bloc of the EU and it has invested a lot in its economy over the last years. The increase of received funding by SMEs entities from a research and innovation program indicates that the country is becoming more attractive and giving more incentives for this entity's participations. It also indicates that the country has reacted positive to the investment made in the research and innovation sector of the country and that the sector is growing and increasing its potential. However, Poland has still to increase the ability to do research and innovation of high-end in order to be a participant in the knowledge-based economy aimed by the European Commission.

Appendix 9

Table 49 - Net Difference between Average H2020 and FP7 EU contribution per SME participation;

Source[*https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/62509062-153c-48c2-9716-afdc498336c8/state/0*](https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/62509062-153c-48c2-9716-afdc498336c8/state/0) *– others calculation*

Country	Average H2020 EU contribution per SME (€)	Average FP7 EU contribution per SME (€)	Difference (€)
AT	314,959.28	265,132.33	49,826.95
BE	298,815.56	278,957.14	19,858.42
BG	173,398.80	180,018.03	-6,619.23
CY	292,843.60	208,045.03	84,798.57
CZ	212,925.59	178,159.68	34,765.90
DE	338,949.43	279,577.10	59,372.33
DK	412,407.88	340,807.63	71,600.25
EE	252,336.58	209,797.00	42,539.58
EL	271,378.62	209,023.17	62,355.45
ES	286,823.18	222,694.58	64,128.60
FI	457,078.07	239,734.01	217,344.06

FR	349,299.10	273,756.87	75,542.23
HR	198,735.09	203,982.32	-5,247.22
HU	248,465.86	194,847.15	53,618.72
IE	381,876.49	270,231.05	111,645.43
IT	256,051.93	235,147.75	20,904.18
LT	215,335.97	189,827.08	25,508.89
LU	257,223.09	194,296.13	62,926.96
LV	192,065.25	127,178.54	64,886.71
MT	180,794.17	161,119.80	19,674.37
NL	403,815.95	279,036.37	124,779.59
PL	400,034.13	182,281.95	217,752.19
PT	257,208.09	233,140.94	24,067.15
RO	142,611.21	144,589.18	-1,977.97
SE	373,896.35	328,237.04	45,659.31
SI	272,970.11	197,007.31	75,962.81
SK	165,442.78	214,971.88	-49,529.11
UK	330,584.90	295,816.96	34,767.94
EU	316,732.65	257,895.66	58,837.00

Since Malta is a smaller country and has a very small amount of participations, the loss of one participation has a bigger impact compared to a loss of one participation in bigger Member States. Another interesting fact is that the bigger increases in the averages received per SME participation happen in Finland and Poland. This indicates that their big increase in funding received is due more to the type of participation rather than to the increase of the number of participations. This is a very positive sign for both countries since it indicates a higher added-value participation in the research and innovation sector of the country and the generation of more value in each participation.

Meanwhile, Slovakia and Hungary have opposite situations. Hungary had a reduction of participations but had an increase in received funding. Its average per participation increase substantially indicating that the country is following the same path as Poland since they belong to the same peripherical bloc and have similar economic

backgrounds. Slovakia on the other hand lost value in its average funding received per SME participation but increased substantially its participation numbers which enabled better results compared to the FP7 period.

Appendix 10

This is because close-to-market projects indicates that those SMEs are being able to adapt new methods and technologies and increase its competitiveness and ability to compete in a knowledge-based economy where cooperation between the research and innovation sector and the economic sector is fundamental. Another point that our analysis as shown is the fact that some countries have, percentually, received more funding than they have participated, and others have more participations than received funding. Interestingly is that these differences follow no pattern.

Appendix 11

The Innovation in SMEs had been a success and has gone overbudget quite a bit compared to the budget of the program. Our analysis also demonstrated that regarding the SME instrument the inability to grant funding for the demand is difficult. The amount of requested budget by proposals that received good evaluation but had to be declined by shortness of funding was €19.97 billion. This is a significant amount of money that wasn´t invested in SMEs and, since they were good proposals and received the seal of excellence, it means this amount, if awarded, could have had a very positive impact in the economy at large of the EU and especially the research and innovation sector.

Appendix 12

The first case to notice in our analysis is the difference between the requested EU contribution for proposals with the seal data between Table 31 and Table 32 is the nearly €3.3 billion difference between the amount requested globally and the amount requested by the EU Member States. This indicates that these programs are also quite interesting to foreign entities and that the collaboration between the EU entities and research and innovation sector with SMEs from other parts of the world is possible and its encouraged. The main advantage is the possibility of the EU research and innovation sector to have good partnerships with SMEs than can also bring other know-how from abroad and that can also help the EU economy and create competitiveness.

Table 50 - Percentage of Seal of Excellence Applicants per Member State per application stage;

Source https://webgate.ec.europa.eu/dashboard/sense/app/4b6dfaa1-a4e6-46c4-8937-90f0f38f002b – others calculation

Country	Applicants per Member State (%)	Percentage of Applicants in Proposals with Seal	Retained Applicants (%)
AT	1.73%	30.42%	11.04%
BE	1.72%	22.98%	7.09%
BG	1.73%	7.67%	1.24%
CY	0.37%	13.72%	4.33%
CZ	1.11%	12.06%	3.50%
DE	7.02%	24.90%	7.77%
DK	3.00%	31.28%	10.77%
EE	1.36%	19.51%	7.00%
EL	1.63%	10.25%	3.11%
ES	17.18%	24.38%	8.20%
FI	3.40%	27.22%	6.94%
FR	6.34%	25.07%	7.75%
HR	0.62%	7.79%	1.73%
HU	3.27%	16.85%	4.02%
IE	2.11%	24.36%	9.54%
IT	18.63%	17.18%	5.42%
LT	0.68%	14.76%	6.50%

LU	0.22%	15.43%	6.79%
LV	0.88%	14.02%	2.59%
MT	0.16%	15.70%	4.96%
NL	4.43%	24.89%	7.83%
PL	3.15%	11.68%	4.54%
PT	2.21%	20.82%	8.11%
RO	0.98%	6.04%	1.65%
SE	4.18%	30.00%	8.76%
SI	2.14%	13.38%	4.50%
SK	1.02%	12.06%	3.28%
UK	8.74%	22.84%	7.51%

Despite these countries being the ones with more SME applicants, they are not the countries with the highest rate of proposals awarded with the seal or even with granted funding. Austria, Denmark and Sweden are able to have at least 30% of their applicants in a proposal that is awarded with the seal which demonstrate higher standards and quality. Austria and Denmark are also those countries that managed to have more than 10% of their applicants in proposals that receive funding. This indicates that their SMEs are capable of convincing European Commissions evaluators of having better proposals. It also indicates that there is an interest on the research and development sector to work with these countries SMEs and that they are dynamic and more competitive.

Most significantly, the countries that are able to have bigger applicants has part of funded proposals are those that already have the most advanced research and innovation sectors. All those countries have more than 7% of their applicants making part of funded projects. The top 5 economies plus Netherlands, Belgium, Austria and the Nordic Member States being Finland the one with the lowest percentage, it being 6.94%. There are only two exceptions, Portugal with 8.11% and Estonia with 7%. This goes along with the previous positive results and it is a positive sign for these two countries. As we have seen, the H2020 as showed better results for these two countries compared to the

FP7. Once again, these Member States demonstrate to be evolving positively and their ability to have SMEs participating in funded projects in the same degree as those with higher research and innovation sectors is a very positive sign.

Appendix 13

Table 51 - Excellent science Priority Projects General Metrics;

Source https://webgate.ec.europa.eu/dashboard/sense/app/93297a69-09fd-4ef5-889f-b83c4e21d33e – others calculation

Theme	Number of Projects	Number of participations	EU Contribution (€)	Participations per projects	EU contribution per project (€)	EU contribution per participation (€)
ERC	5473	6732	8,953,554,446.22	1.23	1,635,950.02	1,329,999.18
MSCA	8450	21789	4,763,689,743.94	2.58	563,750.27	218,628.20
Research Infrastructure	290	5589	1,831,616,565.09	19.27	6,315,919.19	327,718.12
FET	404	3475	1,593,467,374.79	8.60	3,944,226.18	458,551.76
Totals	14617	37585	17,142,328,130.04	2.57	1,172,766.51	456,094.93

The analysis we performed to the main three priorities of the H2020 program indicated that the projects with higher funding per participation belonged to the ERC variant of the Excellent science priority. This goes along to the conclusions that the ERC variant could be equivalent to the Ideas Specific Program of the FP7 and that the projects related to this variant are focused in the development of technological developments that demand big amounts of capital in order to finance such research. These are characteristics of high-end research and it goes along our previous analysis that the major part of this research and innovation projects are happening in the most developed Member States such has the Nordics, the top 5 economies and some smaller but central countries such as the Netherlands, Austria and Belgium. However, it also indicates that, being the projects

that have the highest amount of funding per participation, those countries end up receiving higher percentages of H2020 funding since one participation in an ERC project makes an entity of the participating country receive much more funding individually than entities participating in projects of other variants and other priorities. Being the ERC variant the one with the highest attributed funding in the H2020 program and its projects being mostly in more developed countries, it demonstrates that this variant is contributing for the better results presented by the previously mentioned countries.

Meanwhile, the Research and Infrastructure variant has the biggest amount of participations per project. The average is of 19.27 participations per project. This is a very big amount of entities participating in a single project. These projects with such a big amount of entities require a lot of roles of coordination and it also indicates that these projects most probably have entities from several Member States. Not only the roles of coordination have more funding attributed due to the H2020 rules, but also the bigger amount of entities from across the Union helps that the distribution of funding might be more friendly towards the peripheric and the weaker economies. The Research and Infrastructure projects also have the biggest funding pep participation. This value was expected since with an average of 19.27 entities per participation, each project would require a huge amount of funding. This indicates that this variant of the Excellent science priority is a good program for the wide distribution of funding and for the construction of cohesion in the research and innovation sector. The fact that it has the biggest average of funding per project is a positive sign however its average per participant is not as high as other projects. It is understandable that this average isn´t as big as the average presented by the ERC since both variants have quite distinctive objectives. With €347718.12 of average per participation, the Research and Infrastructure variant still distributes a significant amount of funding to each entity participating in any project. The detail that we must have into account is that the coordinator entity receives more funding

than the rest of the entities and that each entity received funding has to be measured through the Person-Month[52] system and this brings also into account the cost of living in each Member State. Therefore, the average of funding per participation, for most of the entities involved in the project, would be significantly less. In such a program so important for the construction of research and innovation capacity and for the creation of cohesion across the Union in the research and innovation sector it would be recommendable that the European Commission would change the attribution system of funding of variants or programs that could be identified as vital for the spread of cohesion in the research and innovation sector.

Other fact we noticed was the reduction of average funding per participation in the MSCA variant which is compared to the People Specific Program of the FP7. The reduction of average funding per participation might be the reason why this variant presented a big difference between the received funding and the predicted budget. During the FP7 the People Specific Program had an average of €240,320 per participation and that was a good way of improving cohesion among the Union since this Specific Program was aimed at enhancing the human capital of the research and innovation sector. This Program normally does not have a lot of participations per project indicating that this average value goes almost all to each participating entity. In the MSCA of the H2020 Excellent science has very similar Metrics except for the average funding per participation. The MSCA is an important program in the EU efforts for the Knowledge-based economy since such an economy will require skilled human capital. Therefore, we recommend that this program should have a better average funding per participation and that the European Commission should evaluate the best possibility for this to be made in the most equitable way.

[52] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

Appendix 14

Table 52 - Industrial Leadership Priority Projects General Metrics;

Source https://webgate.ec.europa.eu/dashboard/sense/app/93297a69-09fd-4ef5-889f-b83c4e21d33e – others calculation

Theme	Number of Projects	Number of participations	EU Contribution (€)	Participations per projects	EU contribution per project (€)	EU contribution per participation (€)
Information and Communication Technologies	1626	13610	5,260,732,061.42	8.37	3,235,382.57	386,534.32
Advanced manufacturing and processing	246	3295	1,288,223,165.14	13.39	5,236,679.53	390,963.02
Innovation in SMEs	2372	4518	1,011,603,842.71	1.90	426,477.17	223,905.23
Advanced materials	147	2139	853,801,686.09	14.55	5,808,174.74	399,159.27
Space	388	2398	702,004,242.41	6.18	1,809,289.28	292,745.72
Nanotechnologies, Advanced Materials and Production	346	1293	499,022,752.28	3.74	1,442,262.29	385,941.80
Biotechnology	116	749	350,082,053.94	6.46	3,017,948.74	467,399.27
Access to risk finance	12	48	9,370,733.25	4.00	780,894.44	195,223.61
Industrial Leadership - Cross Theme	2	30	3,975,474.56	15.00	1,987,737.28	132,515.82
Totals	5255	28080	9,978,816,011.80	5.34	1,898,918.37	355,370.94

In the Industrial and Leadership priority, the Information and Communication Technologies variant is the type of project that more funding distributed in total. However, it doesn´t show wither an average number of participations per project quite good (8.37). This number is quite acceptable since it is not a high number as seen in the Research and Infrastructure or the Advanced Materials variant and it is not a low number such as the ERC variant. The average contribution per participation is also quite similar to most of the variants in all the priorities and it isn´t either close to the higher or the lower of the averages analysed. With a little more than €3 million per project, and such an average contribution per participation, it still is the second variant with more participations inside the Industrial Leadership priority. This indicates that this program is highly competitive, and it has a lot of demand. Due to its nature regarding the research and innovation in such a key economic sector and one that has been registering a very good growth in the last 2 decades, the ICT, we reach the conclusion that this sector requires more research regarding what the EU can promote and create in terms of funding programs for the research and innovation sector connected to this activities. For the creation of the knowledge-based economy in the Union as it is pretended by the European Commission this economic sector and its technological development will be a fundamental part in the success of the Commissions strategy.

One variant in the Industrial Leadership priority, the Innovation in SMEs, shows good metrics but we believe the European Commission should attempt to create conditions to reinforce its appeal and improve its performance. The SMEs sector is a fundamental economic sector since most of the economic tissue of the Union is composed by SMEs, especially in the weaker and peripherical economies such as the southern and the eastern ones. Therefore, this variant is a very good tool to achieve a lot of objectives and results across the Union. This type of programs can allow and facilitate the creation of more competitiveness and more growth across every economic area and sector. It also

allows to increase the research and innovation capacity to adopt and learn from the practical implementation of certain technology or improvements. Other effect of this is the modernization of the economies and the sector that can mostly benefit from it. This variant shows the highest amount of projects in the Industrial Leadership priority nearly the twice of participations. However, the average per participation is €223905.23 and this average can vary due to the conditions previously mentioned. With such a good program and its capacity to have effects across several sectors, we believe the increase of the average per participation, especially for the projects affecting weaker and peripheric economies.

This priority has two variant programs with a lot of participations per project average. The Advanced Materials and the Advance Manufacturing and Processing variants have attributed a good amount of funding and they also have a good average per participation metric being both nearly €400000. This are also variants that for including a lot of participations per project they have participation from entities from a lot of the Member States make them capable of contributing to the cohesion of the EU, both economically and in the research and innovation sector. Because their focus is on Industrial sector research makes both this variants very important for emerging economies since those are the economies that need to increase, accelerate or improve their industrialization process, their industrial competitiveness and their industrial capacity in order to come closer economically to the biggest economies of the Union.

Appendix15

Table 53 - Societal Challenges Projects General Metrics;

Source https://webgate.ec.europa.eu/dashboard/sense/app/93297a69-09fd-4ef5-889f-b83c4e21d33e – others calculation

Theme	Number of Projects	Number of participations	EU Contribution (€ in millions)	Participations per projects	EU contribution per project (€ in millions)	EU contribution per participation (€)
Smart, green and integrated transport	1467	11128	4,538.304	7.59	3.093	407,827.52
Health, demographic change and wellbeing	999	9176	4,347.349	9.19	4.352	473,773.86
Secure, clean and efficient energy	1171	9628	3,491.486	8.22	2.982	362,638.71
Food security, sustainable agriculture and forestry, marine and maritime and inland water research	713	7702	2,239.809	10.80	3.141	290,808.74
Climate action, environment, resource efficiency and raw materials	578	5610	1,747.490	9.71	3.023	311,495.52
Secure societies - Protecting freedom and security of Europe and its citizens	319	3186	960.529	9.99	3.011	301,484.42

Europe in a changing world - inclusive, innovative and reflective Societies	389	2880	737,806,255.58	7.40	1,897	256,182.73
Societal Challenges - Cross-theme	2	4	280,000.00	2.00	0.140	70,000.00
Totals	5638	49314	18,063,053,545.29	8.75	3.204	366,286.52

The Societal Challenges priority is the most measured priority of all the three. The metrics represented by all the variants in this priority show very close results. The average of participations per project vary between 7.4 and 10.8 except for the cross-theme that has 2 projects and 4 participations making it an outlier. Most of the variants also have around €3 million in funding per project and values between €290000 and €408000 in average funding per participant. This indicates that all the majority of the Societal Challenges priority variants have projects that are very similar regarding dimension and complexity making this priority the most versatile regarding the type or organization that can participate in them. As we seen before, it is also in this priority that the most peripheric and weaker economies have higher percentages of funding received regarding the totality of funding that was distributed. The conclusion we can reach is that this priority has been able to be the most effective in dispersing funds across the EU in the most equal way which makes the entire priority a good mechanism for the creation and increase of cohesion across the research and innovation sector.

Besides the outlier of the Societal Challenges – cross theme variant, the Health, Demographic Change and Wellbeing variant obtained out of the ordinary metrics. Its funding per project was the biggest of all the variants in the priority as well as the average

per participation. The average participation per project was the second one. This indicates that the health-related projects had a bigger focus when compared to the rest of the variants. Although we are unable to take a strong conclusion regarding why that happened, we assume that research and innovation regarding the health sector tends to be quite expensive and entities in this sector tend to have human resources costs higher than the average and most of the research entities that due high-end research on this area also tend to be in the Member States that have bigger cost of living with a few exceptions. Therefore, the Person-month[53] system might have helped for the presented metrics to be higher than their variants in the Societal Challenges priority.

Appendix 16

This success is due especially to the SME Instrument topic of the Pilot indicating that the SME sector is fundamental in the EU economy to generate not only value, but also competitiveness and high-end research and innovation that can help the EU competing with its biggest rivals in this field such as the United States of America and Japan. This is expressed in the fact that of the three topics, the SME Instrument is the one with the lower participation per project average. It means that the biggest majority of entities participating in the topic are willing to risk, grow and innovate on their own initiative.

Based on the keywords regarding every project, the H2020 dashboard divides the projects into Research Subject Groups. This allow us to identify trends regarding what focus in research and innovation are most of the companies interested in. This is important because it allows us to see what the market seeks and what most probably in the future, we will see most of the entities pursuing funding for.

[53] https://ec.europa.eu/newsroom/just/item-detail.cfm?item_id=643967

Table 54 - EIC Research Subject Groups Keywords;

Source https://webgate.ec.europa.eu/dashboard/sense/app/5046bacd-e195-4efe-9161-942854c7393c – others calculation

Keyword Level 3	1st Main Keyword	2nd Main Keyword	1st+2nd Key Word	In Percentage of all the Keywords
Computer and information sciences	322	361	683	13.91%
Electrical engineering, Electronic engineering, Information engineering	173	206	379	7.72%
Clinical medicine	161	156	317	6.46%
Environmental engineering	143	130	273	5.56%
Space	135	102	237	4.83%
Earth and related environmental sciences	125	97	222	4.52%
Civil engineering	123	94	217	4.42%
Biological sciences	100	90	190	3.87%
Medical engineering	107	81	188	3.83%
Energy	82	101	183	3.73%

The top ten regarding Research and Subject Groups only based in the amount of the 1st and 2nd Keyword obtained 58.85% of all the keywords stated in regarding all the projects. The Computer and Information Sciences is by far the leader regarding projects focus in research and innovation and entities attempting to scale up. The other nine areas have small differences between their percentage indicating that the fields where the European entities are investing belong to different areas. This is positive because it indicates that there are a lot of entities from a lot of field attempting to invest and innovate. This is good news regarding the creation of new value and diversified high-end research and innovation. For the EU to succeed in competitiveness and research and innovation capacity and ability it is important that the EU be able to have research and

innovation in a lot of fields and diversified that same investment. It is also positive that in the top ten fields there are projects regarding fields such as the environment, medical engineering and clinical medicine. This fields are important in allowing the EU to compete with the United States and Japan. The Space related projects are in accordance to a trend already seen in the Industrial Leadership priority where the Space variant had shown good performance. The space field regarding research and innovation is positive since it can lead to a better performance of related industries in which the EU have a strong presence, mainly Aeronautics and related industries.

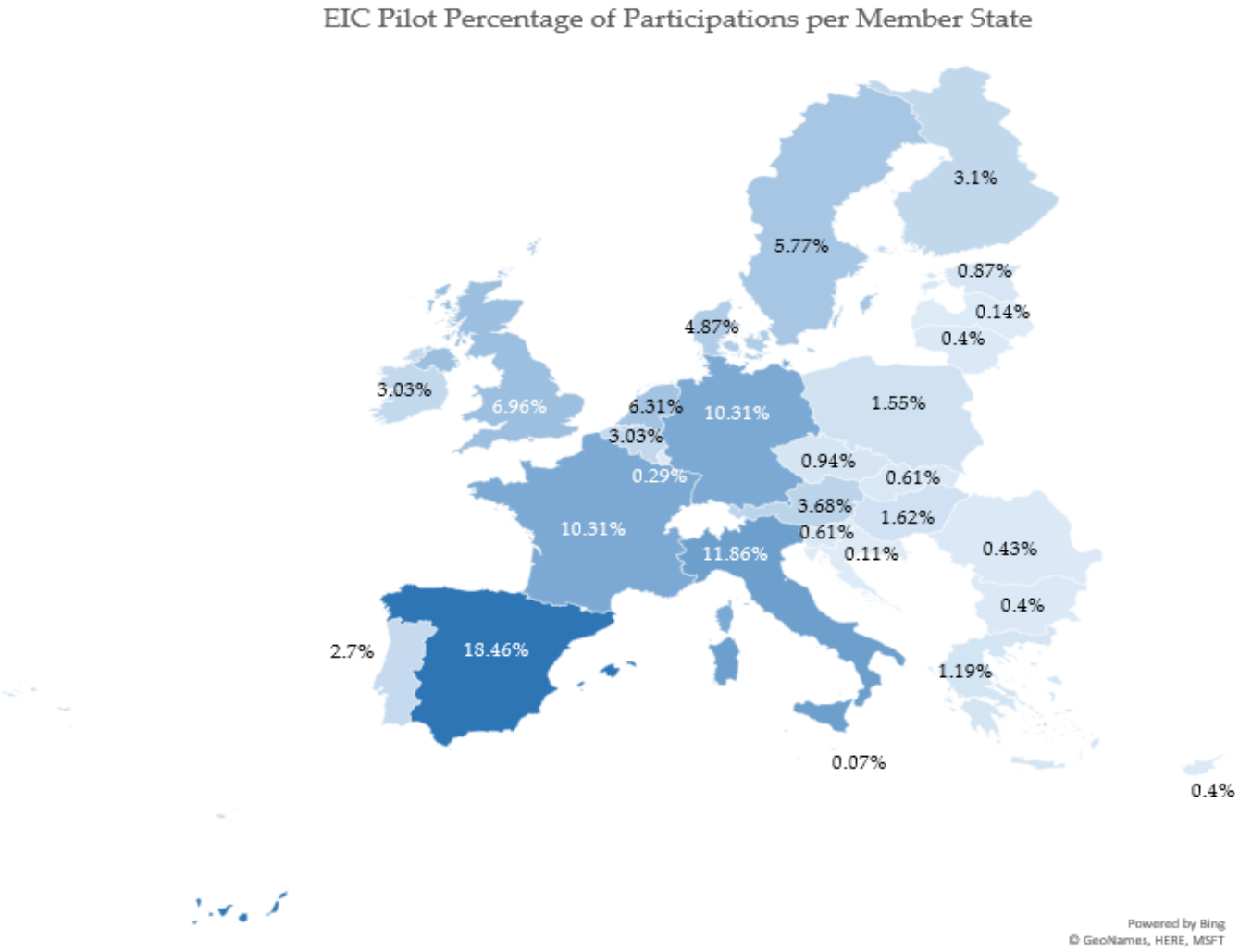

Figure 30 - EIC Pilot Percentage of Participations per Member State;

Source https://webgate.ec.europa.eu/dashboard/sense/app/5046bacd-e195-4efe-9161-942854c7393c – others calculation

Appendix 17

The FP7 program started in 2007 until 2013. However, 80.7% of all the publications regarding the FP7 have been presented or reported after the program ended reaching its highest mark in 2017, four years after the FP7 ended. This is a very big time difference. The FP7 still has publications being presented in 2020 counting, as of April, already 4126, meaning it will most likely increase this number considerably. With 14830 projects that have already contributed and 281390 publications already presented, the FP7 has an incredible publication average per project of 18.97. With such a high average, the European Commission can strongly argue that the FP7 program has contributed for the enhancement of the research and innovation sector since the amount of publications per project that has contributed with publications is very high.

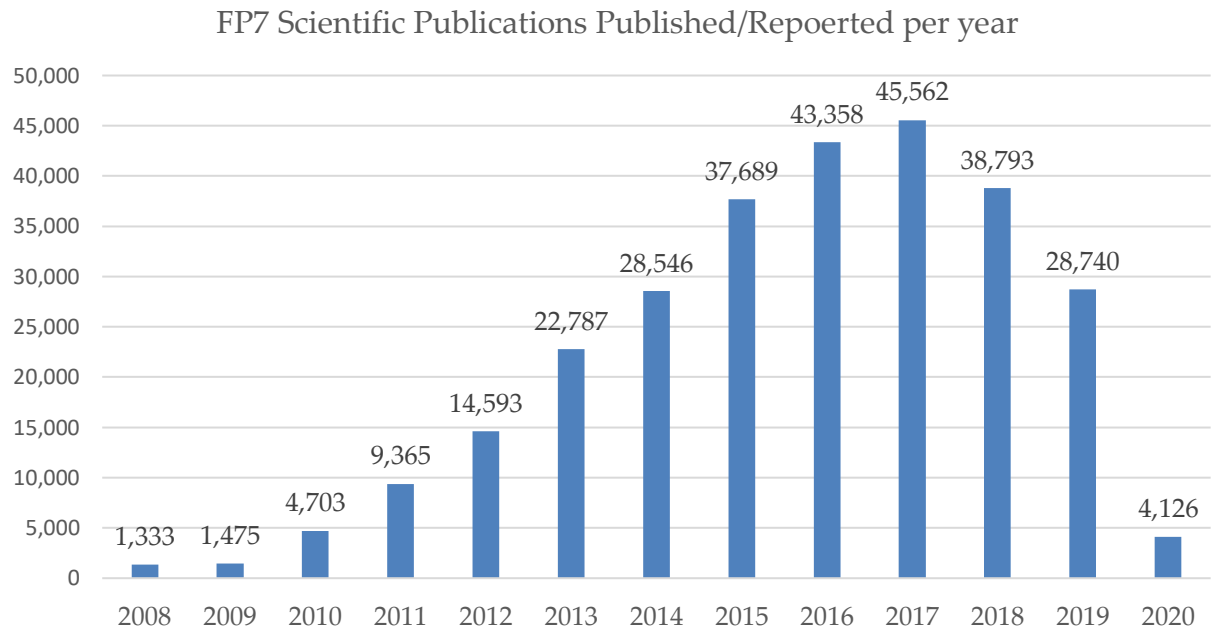

Figure 31 - FP7 Scientific Publications Published/Reported per year;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Of all the types of publications that FP7 projects have released of reported, 80.34% was in the form of a peer reviewed article totalling 226079 peer reviewed article publications. Such a high number of publications of this type indicate that the SPs constituting the outcome of the FP7 projects have been already validated indicating that the research and innovation conducted by such projects resulted in positive developments regarding the field of knowledge they tackled. Such a high degree of validation is positive for the image of the European research and innovation sector.

Table 55 - FP7 Funding per Scientific Publication per Specific Program;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

FP7 Specific Programs	Publications	EU Contribution (€)	Funding per SP (€)
Ideas	142104	7,606,080,042.59	53,524.74
People	31746	1,013,169,873.51	31,914.88
Capacities	19316	2,396,423,393.93	124,064.16

Cooperation	87063	17,338,574,468.16	199,149.75
JRC	1161	242,482,086.81	208,856.23

The analysed dashboard allows us to acquire an average per publication that can be used to symbolise the Program efficiency. It is also important to notice that not all of the EU contribution given to the program was made for projects that had the purpose of creating SPs. Therefore, this metric, we consider, it is a very important one to measure the capacity of the EU projects to create research and innovation of quality and the associated cost of each publication. We must remember that in the FP7 program, the Cooperation Specific Program was the one that had received most funds since it was also the main focus of the FP7 program since the European Commission had given to it nearly two thirds of the available budget. However, the Cooperation Specific Program was the second most expensive regarding publications granted. That indicates that this program was the least efficient of the main four Specific Programs. The JRC had the highest average per publication however, since the JRC funds projects regarding nuclear research and fusion/fission, it means that their research and innovation projects are quite specific, quite detailed, and so complex that there is a very limited amount of entities that participate in the projects since very few Member States have Nuclear facilities operating. It is also quite a technological challenge and its average per publication is quite good having into account the dangers and the technological capacity needed to deal with nuclear projects.

The People Specific Program average funding per publication is a very good sign for the research and innovation sector in general. Since the sector relies heavily on its human capital and its enhancement is one of the best drivers for achieving more cohesion across the Union, having a low funding average per publication related to the Peoples

Specific Program is very promising. It shows a bigger deal of efficiency regarding the European funding application.

The Capacities Specific Program had €124064.16 as an average funding per publication. Since the Capacities aim is to improve the ability and the infrastructure of the research and innovation sector it would be expected that its research and production of SPs to have a bigger expression. Although, as we´ve previously seen, it appears that the funding regarding this Specific Program was mainly focused in the Member States that had shown to have an already strong research and innovation sector, we assume that the efficiency demonstrated is a sign that those countries have a bigger capacity of producing more publications with the respective EU funding.

The Ideas Specific Program is a real positive surprise. The Ideas Specific Program had the biggest funding per signed grant, besides the JRC, and had a big average per participation as well. However, it is the second Specific Program of the FP7 with the lowest average funding per publication. This indicates that the high-end research and innovation sector of the EU is capable of producing great research and results efficiently. It also indicates that, since most of the Ideas Specific Program funding was concentrated in the top 5 economies as well as Nordic and central countries such as Belgium, Netherlands and Austria, that our statement that these Member States possess the most advanced research and innovation sectors of the union was correct. This is a positive sign since the results of this Specific Program are very positive for the economic capacity of creating a knowledge-based economy. However, it also demonstrates that the least efficient research and innovation sectors in the peripheric economies are quite behind. The Cooperation Specific Program was the Specific Program that had the biggest dispersion of funding across the weaker and peripheric economies. Its average funding per publication being the highest shows that there is a big gap in the research and innovation capacity between the already established sectors and those who are

developing and maturing. This is an indication that if the European Commission intends to create a knowledge-based economy, it is in its own interest to diminish this gap as much as possible in order to increase the efficiency of the sector across the EU.

When analysing the ratio of publications per project of each individual Specific Program it is possible to verify that there is no correlation between the average of SPs per project and the average funding per publication since the correlation, we obtained was of -0.013. This means that there is no correlation between the amount of funding each project receives per publication and the amount of publications it produces. Therefore, we can safely conclude that the efficiency lies in the research and innovation sector maturity since it is the only remaining variable that we were capable of observing across our analysis.

Table 56 - Comparison per FP7 Specific Program between Scientific Publications per projects and Funding per Scientific Publication;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

FP7 Specific Programs	SPs per project	Funding per SPs (€)
Ideas	33.10	53,524.74
People	5.88	31,914.88
Capacities	22.00	124,064.16
Cooperation	20.84	199,149.75
JRC	14.33	208,856.23

Appendix 18

The FP7 program presented the registering of 6082 IPR applications based on the work of 2409 projects as of April of 2020. Just as it happened with the SPs, most of the registered IPR applications happened after the FP7 program ended. Since 2014, it was registered 63.81% of all the IPR applications associated with the FP7.

Of all the IPR reported, 81.7% were registered as patents. This is important since the patent suggests something that has been invented and, most probably can be used for commercial purposes. This are very good news for the research and innovation sector of the EU because indicates that the EU is capable of creating innovative services and products that can make it more competitive. This is also important because proves that the EU funding is fundamental to keep the EU a dynamic and competitive zone and that the public investment is vital for the research and innovation sector to be able to adapt and evolve.

Regarding the registration office of the EU funded IPRs, 46.45% of them were registered either in the European Patent Office (EPO) or the World Intellectual Property Organization (WIPO). This is a positive sign that the European research and innovation sector is not putting its IPR applications solely in each national responsible public entity. The recurring to the EPO and to the (WIPO) indicates a willingness to use these IPRs beyond the European borders. That is very positive since it can create value chains that bring wealth to the EU and an increase of the European relations with the rest of the world. The most curious is that in third, with 13.5% of registered IPRs is the United States. We believe that happens because some economic sectors require the existence of IPRs in the US own regulatory entity for them to be able to operate in that market. Other possibility is that the IPR located in the US might become easier to be transactional of used in the largest consumer market in the world making it a strategic move. We recommend the European Commission to do more research regarding this matter since

it can mean the loss of some economic value to one of our main competitors in the research and innovation field

The IPR applications regarding the FP7 program also reached its highest after the end of the program with 63.81% As of April 2020 there are no registration of IPR applications regarding the FP7 program after 2019 giving us the indication that, unlike the SPs, there might not be more IPR applications registered under any FP7 project. When comparing with the SPs behaviour it is possible to verify that the registering of IPR applications happens faster than the publishing or reporting of SPs. This happens because the IPRs are a more common outcome from more practical projects than those with more academical characteristics. It is positive that the EU research and innovation sector is capable of creating IPR applications and put them fast in the market. This demonstrates a good dynamism in the research and innovation market across the EU.

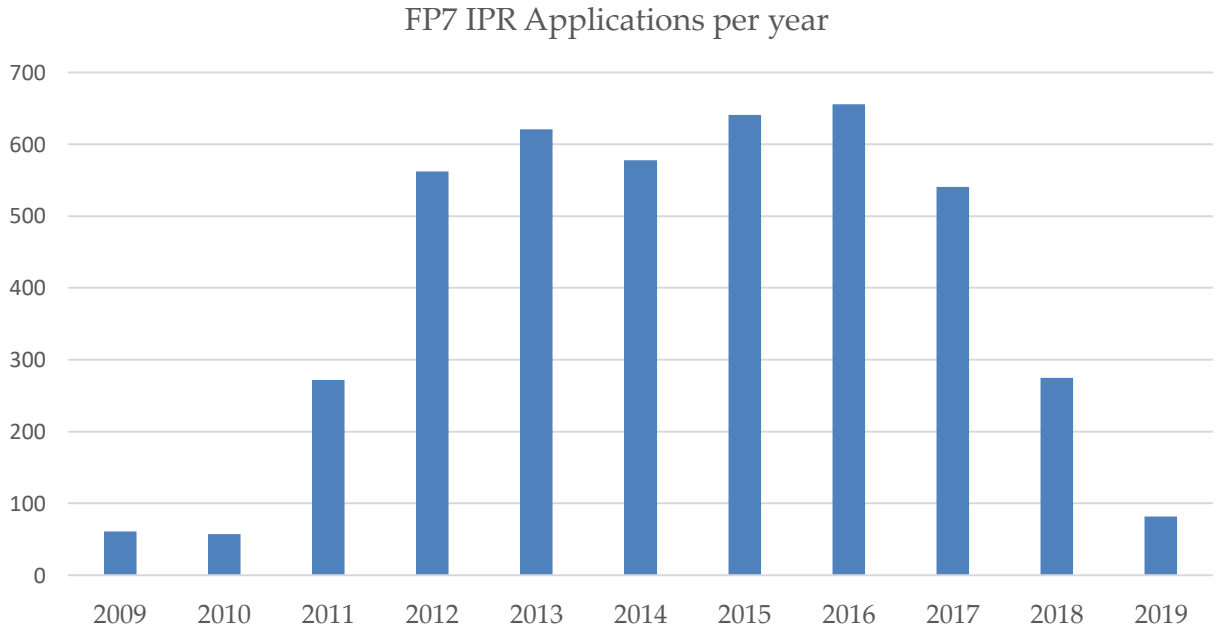

Figure 32 - FP7 Intellectual Property Rights (IPR) Registered/Reported per year;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

Regarding the average amount of funding granted per each IPR application our analysis showed a significant increase across all Specific Programs. The JRC remain the

one with the biggest average funding per IPR application. Due to its complicity and the fact that this Specific Program does research and innovation regarding the nuclear sector, it is to be expected that breakthroughs in this field are to be more expensive than in the other Specific Programs.

Table 57 – Average Funding per IPR application per FP7 Specific Program;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

FP7 Specific Program	IPR Applications	EU Contribution with IPR (€)	Average funding per IPR Application (€)
Ideas	1736	1,200,000,000.00	691,244.24
People	855	467,000,000.00	546,198.83
Capacities	612	807,770,693.87	1,319,886.75
Cooperation	2860	5,580,170,000.00	1,951,108.39
JRC	19	51,300,000.00	2,700,000.00

The Specific Program with the second lowest average funding per IPR application was the Ideas Specific Program. Just as with the SPs, this FP7 program was responsible for the funding of the high-end projects. It would be expected that it would be the Specific Program with the higher average of funding per IPR application but as we´ve seen before, most of its funding went to the Member States that presented to have the most matured research and innovation sectors. Besides, the average funding per project of the Ideas Specific Program was lower than the rest except the People Specific Program. Therefore, we can conclude that the typology of the projects it funded, and their high-end nature make this Specific Program ideal for the creation of IPR applications allowing for a lower average funding per IPR.

One interesting result is the average funding per IPR publication regarding the Capacities Specific Program. In the FP7, the average of funding per SPs regarding the same Specific Program was relatively higher than the Peoples Specific Program and

slightly lower than the Cooperation Specific program. However, regarding the IPR registrations, the Capacities Specific Program increased its distance from the Peoples Specific Program average funding per IPR application coming closer to the Cooperation average funding per IPR. This indicates that regarding the production and development of IPR applications, comparatively, the Capacities Specific Program is less efficient than the others with the exception of the Cooperation Specific Program between the creation of SPs and IPRs. One of our conclusions is that there was FP7 Specific Programs that were designed to be better and more efficient at the creation of different types of outcomes. The Ideas Specific Program was by far the Specific Program that demonstrated more ability to be able to be efficient when producing either SPs or IPR applications while the Capacities Program demonstrated to be less efficient regarding the production of IPR applications than the creation of SPs.

The Cooperation Specific Program was the program that demonstrated the least efficiency regarding average funding per IPR application if we exclude the JRC due to its very narrow and specific field. The Cooperation had an average funding per IPR application that almost triples the People Specific Program. The ability for the Cooperation Program to produce an IPR application was, according to our analysis, worse than the rest of the Specific Programs. As previously mention, the Cooperation Specific Program had the higher average funding per project as well as the biggest average of participants per project. This is significative because the Specific Program that had the projects with more entities and more funding appears to be the least efficient. The fact that this Specific Program had more entities participating in its projects from the peripheric and weaker economies also leads to an increase in the average funding per IPR application since those Member States have research and innovation sectors that are less matured and, therefore make the analysed metric go up.

Table 58 - Comparison per FP7 Specific Program between Average IPR Applications per project and Average Funding per IPR Application;

Source https://webgate.ec.europa.eu/dashboard/sense/app/f586ea07-ebee-4054-9e0b-328be7de8e7f – others calculation

FP7 Specific Program	Average IPR Applications per Project	Average funding per IPR Application (€)
Ideas	2.77	691,244.24
People	1.95	546,198.83
Capacities	2.67	1,319,886.75
Cooperation	2.59	1,951,108.39
JRC	1.90	2,700,000.00

In the inverse direction of the average funding per IPR application that raised significantly compared to the same metric but regarding SPs, the average of IPR applications per project decrease to extremely closed numbers between Specific Programs. The highest average of IPR applications was achieved by the Ideas Specific program with 2.77 IPR per project while the lowest was the JRC with 1.9. This is very small difference and much lower values when compared to the FP7 Specific Programs results regarding the SPs. This comes to the conclusion that achieving IPR applications is much more expensive and complicated that achieving the SPs. It is significant since the complexity of the projects leads to a higher funding being attributed and, since the IPR per project will be lower than the creation of SPs per project, will make the average funding per IPR application higher. However, it is possible to verify that the average funding per IPR application regarding the Cooperation Specific Program is the highest due to the bigger amount of funding per project than the lower amount of IPR applications reported per project. This is a sign that the projects that performed under this Specific Program were less efficient and its entities lack certain research and innovation capacities or skills. This is indicative, as analysed previously, that the

Cooperation Specific Program has a bigger participation of entities from peripheric and weaker economies leading to a bigger inefficiency regarding the outcome of the projects.

Appendix 19

The HE has a proposed budget of €100 billion and is planned to run through 2021 – 2027 and, to happen, will represent the "largest multinational collaborative research and innovation investment in Europe" (European Commission, 2019b) and, such has the H2020, it will be open to participants worldwide. The focus still remains the investment in research and innovation sector since it will be fundamental to "create new opportunities, tackle climate change, support sustainable economic growth and the competitiveness of our businesses and industries, and to enable better welfare and public services for all Europeans" (European Commission, 2019b).

According to the European Commission there are major "social, economic, political, environmental and technological" drivers that develop in a stable and more predictable manner allowing "some degree of certainty" about the challenges these drivers will create.

The European Commission states demographic change, climate change, increased mobility and scientific and technological developments as main driver for the period of action of the HE. The demographic change will be driven by global population growth. The European Commission believes that the growth of populations to our east in Asia and to our south in Africa will shift the world economy gravity centre in the same direction (European Commission, 2019b). The European Commission defends that the growing Asian middle class will represent "new market opportunities for European businesses" but it will have a major impact in the global resources putting them in an even bigger pressure. Meanwhile, Africa "is a continent of opportunities where decentralised, digitally enabled solutions are flourishing" and will, most likely, be the

continent with the biggest population growth until 2050 (European Commission, 2019b). As these new centres of power take their place in the global stage the established international status-quo will change and the "multilateral and rules-based world order can no longer be taken for granted" and this situation can create an increasingly complex environment for Europe by challenging businesses and industries operating internationally.

The immense pressure on the world resources and production and consumer patterns is putting the world under serious environmental pressure. The European Commission defends that the climate change is an existential threat and that the consumption of energy is a particular concern. While the renewable energy systems are struggling to keep up with the global demand, the effects of climate change are already evident and causing an impact in certain areas of the globe. The United Nations Intergovernmental Panel on Climate Change (UNIPCC) has stated that "while the limitation of global warming is possible, doing so will require unprecedented changes in our ways of life, moving towards sustainable societies and economies" (European Commission, 2019b). The needed transition towards sustainable development and sustainable economy will change our societal and economic structures to their cores and this change and adaptation cannot be made without a strong R&D presence and development in the EU.

The scientific and technological developments, especially digitalisation. The European Commission defends that the "process of innovation has been shortened "significantly while the amount of disruptive and market-creating innovation has increased, also due to new innovative companies and methods of innovation" (European Commission, 2019b) and all of those factors will be important for the EU to be able to surpass its difficulties.

The increased mobility driver will develop due to the increase in urbanization that, if uncontrolled, can create challenges such as "poor infrastructure, abandoned rural areas and territories, biodiversity loss, inequalities and lower quality of life". Since cities are the biggest economic centres, they also represent centres of innovation and centres of progress where standards of living tend to be better with better access to education and better employment opportunities and therefore should be seen where the solutions can be found.

Appendix 20

Investments in research and innovation concerning health will contribute to the zero-pollution ambition, especially through a cross-cutting strategy in order to provide protection of citizens' health and well-being from environmental degradation and pollution, including by addressing air and water quality, hazardous chemicals, industrial emissions, pesticides and endocrine disruptors.

Concerning digital, industry and space the EU will contribute to transforming itself to a climate-neutral and circular economy through climate-neutral, circular and clean EU industries, for instance by creating plants in several regions with zero emissions and zero waste, to make decisive contributions to the fight against climate change and the protection of the environment, increased autonomy in critical raw materials, through substitution, resource efficiency and recycling and primary production, greening ICT, for instance by developing low energy consumption components and combination of approaches, to enhance the efficiency of computing by several orders of magnitude, technological and digital solutions contributing to the decarbonisation of key economic sectors, space services that contribute to climate mitigation and environmental protection, mobility and security.

Concerning climate, energy and mobility the EU will transform to a climate-neutral and resilient society by novel competitive cross-sectoral solutions for decarbonisation such as batteries, hydrogen, and other types of storage (chemical, mechanical, electrical and thermal), as well as sustainable buildings and infrastructure enabling low carbon solutions and other break-through technologies, a cost-efficient, net zero-greenhouse gas energy system centred on renewables, demand side solutions to decarbonise the energy systems, mainly as regards buildings and industrial facilities, low-carbon and competitive transport solutions across all modes (road, rail, aviation, and waterborne).

Concerning food, bio-economy, natural resources, agriculture and environment will advance knowledge, build capacities as well as develop and demonstrate innovative solutions to accelerate the transition to a sustainable management and use of natural resources from land and sea, ensuring ecosystem integrity as well as sustainable development and human well-being, including water, food and nutrition security, in the EU and globally. The European Commission intends to target improved knowledge and innovations build the foundations for climate neutrality by reducing GHG emission and enhancing the sink and storage functions in production systems and ecosystems, and foster adaptation of ecosystems, water management and production systems as well as of rural, coastal and urban areas to climate change, halt of biodiversity decline and restoration of ecosystems enabled through improved knowledge and innovative solutions towards reaching the global vision for biodiversity 2050, better understanding of planetary boundaries facilitates innovative solutions for sustainable and circular management and use of natural resources as well as prevention and removal of pollution, guaranteeing healthy soils and clean water and air for all as well as boosting competitiveness, value creation and attractive jobs, improved knowledge

and innovations enhance sustainable primary production, food and bio-based systems, which are inclusive, safe and healthy and ensure food and nutrition security for all within planetary boundaries, better understanding of the behavioural, socio-economic and demographic changes leads to innovative approaches that drive sustainability and a balanced development of vibrant rural, coastal, peri-urban and urban areas, environmental observations, strengthened evidence base and tools are delivered and used for the establishment and monitoring of governance models enabling sustainability.

Appendix 21

Investments in research and innovation, in particular concerning health will target improved health promotion and disease prevention supported by healthier behaviours and lifestyles, effective health services to tackle diseases, as well as to reduce the burden of diseases on families and communities, provide timely access to affordable health care services of high-quality to everybody while being environmentally and fiscally sustainable.

Concerning culture, creativity and inclusive society the HE will look for reversing socio-economic, gender and cultural capital inequalities via strategies of inclusion, non-discrimination, solidarity, social protection and social investment, a comprehensive European strategy for inclusive growth and upward convergence, the value of European cultural heritage is safeguarded by promoting the value, protection, access to and sustainable use of European cultural heritage and its contribution to the cultural and creative sectors.

regarding digital, industry and space the HE will seek iincreased inclusiveness, by helping industry provide attractive and creative jobs in Europe; making a two-way engagement in the development of technologies a reality, developing human-

centred approaches, promoting social innovation; and helping foster skills and empower the young in, for instance, the digital and advanced manufacturing areas.

Appendix 22

Investment in research and innovation regarding health will be unlocking the full potential of new tools, technologies and digital solutions for a healthy society by providing significant gains in health outcomes, address unmet medical needs and inform regulatory standards and requirements and seeking a sustainable and globally competitive health-related industry in the EU by making health industries, including SMEs, increase their productivity and sustainability in developing relevant health innovation due to the potential of data-enabled research and development, the related convergence of pharmaceutical, digital and medical technologies, and the prospect of the digital transformation of health and care supported by data-driven manufacturing of tailor-made products and the delivery of personalised services.

Concerning culture, creativity and inclusive society will contribute to improved approaches in addressing the societal – including political, ethical and economic – effects of technological advancements and the impact of drivers of change on jobs, skills, productivity, income, education, welfare and inequalities.

Regarding digital, industry and space the objectives are digitising and transforming industry, increased sovereignty in key enabling technologies and digital technologies, in strategic value chains, and a secure, sustainable and responsibly-sourced supply of raw materials, a European approach, involving a human-centred and ethical development and use of new technologies as well as industrial leadership in key enabling and digital technologies, uptake of new

technologies, and space services and data, through technology infrastructures and autonomy in strategic value chains.

Regarding climate, energy and mobility the HE will attempt seamless, smart, safe, accessible and inclusive mobility systems to reap the benefits of digitalisation, increase efficiency and European competitiveness, enable better and sustainable door-to-door mobility for all and increase safety, smart and cyber-secure energy grids to enable more interaction and utilisation between producers, consumers, networks, infrastructure and vectors.

Appendix 23

Investments in research and innovation, concerning culture, creativity and inclusive society must look for an increased use of evidence-based strategies in the management of mobility and migration and the integration of migrants in European society, including a better understanding how migration interacts with other relevant policy fields (e.g. welfare, education, skills provision, housing).

Within civil security for society the EU aims at Improving disaster risk management and societal resilience through better understanding of natural and man-made disasters and by the development of novel concepts and technologies to counter these risks, improving management of EU external borders (air, land and sea) by the development of tools and concepts towards an Integrated Border Management, including better knowledge of societal factors with regards to border security, better protection of public spaces through enhanced detection, a more secure design assisted by comprehensive vulnerability assessments and with quicker response to threats without compromising the open character of such spaces, improving security and resilience of infrastructure and vital societal

functions enabled by improved risk assessments and more efficient response to disruptions with a view of quickly restoring performance levels, improving maritime security based on the EU Maritime Security Research Agenda to counter threats such as trafficking, piracy as well as cyber and hybrid threats, more effective fight against crime and terrorism by better understanding of societal factors leading to radicalisation and crime, and by developing state of the art capabilities for Law Enforcement Agencies in the EU, notably against cybercrime, increasing cybersecurity based on more effective use of digital technologies, strong orientation on privacy and fundamental rights and a robust digital infrastructure to counter cyber-attacks.

Appendix 24

Investment in international actions in research and innovation, cutting across all clusters, will contribute to achieving targeted impacts. The HE strategy will aim at a strengthened scientific and technological links with key partners through policy dialogues and strategic partnerships in research and innovation in areas of mutual benefit and common interest, multilateral alliances to address key objectives such as more effectively tackling environmental pollution, antimicrobial resistance, (re)emerging infectious diseases, epidemic outbreaks and other risk factors and threats to global health, gaining access to and share environmental observation data, or contributing to international climate and environmental assessments, an international level playing field and reciprocity through industrial and policy dialogues in areas such as safety standards and the life-cycle assessment of materials, and the regulatory context of manufacturing, digital technologies, and consumer products and services, commonly accepted ethics approaches for scientific knowledge and the development of technologies such as Artificial Intelligence through science governance dialogues including for example the

promotion of guidelines for research ethics and integrity, and the promotion of ethics by design principles.

Appendix 25

Investments in research and innovation, in particular concerning culture, creativity and inclusive society must enhance democracy and governance through bolstering the accountability, legitimacy, transparency and effectiveness of democratic systems and the protection of fundamental rights and the rule of law and create better approaches to tackling political extremism and polarisation by strengthening democratic participation and active citizenship, fostering awareness and exercise of democratic rights, and understanding the role of media in fostering or inhibiting political dialogue.

Appendix 26

Cluster 1, Health, aims to promote and protect human health and well-being, prevent diseases and decrease the burden of diseases and disabilities on people and communities, support the transformation of health care systems in their efforts towards fair access to innovative, sustainable and high quality health care for everyone, and foster an innovative, sustainable and globally competitive European health industry. The research and innovation under this cluster is to address the health research and innovation capabilities delivering new know-ledge and technological solutions (European Commission, 2019b)..

Cluster 2, Culture, Creativity and Inclusive Society aims to meet EU goals and priorities on enhancing democratic governance and citizens participation, and on the

safeguarding and promotion of cultural heritage, and to respond to multifaceted social, economic, technological and cultural transformations. Research and innovation will support sustainable growth and job creation through contributing to a European industrial policy for the cultural and creative industries (European Commission, 2019b).

Cluster 3, Civil security for Society, aims to contribute to protecting the EU and its citizens from the threats posed by crime and terrorism (including in the cyber environment) and from the impacts of natural and man-made disasters. Modern security threats are evolving rapidly, and technological and societal changes are creating unprecedented complexity, but so also are opportunities for addressing them more efficiently (European Commission, 2019b).

Cluster 4, Digital, Industry and Space will advance key enabling, digital and space technologies, underpinning the transformation of our economy and society, support the digitisation and transformation of European industry and contribute to securing global industrial leadership and autonomy / sovereignty in terms of technologies and resources. t will contribute to addressing the challenges European industry is facing, such as its reliance on imported key technologies and raw materials, the scarcity of resources including energy, as well as skills mismatches and ethical considerations relating to technological progress (European Commission, 2019b).

Cluster 5, Climate, Energy and Mobility, aims to fight climate change while improving the competitiveness of the energy and transport industries as well as the quality of the services that these sectors bring to society. This entails establishing a better understanding of the causes, evolution, risks, impacts and opportunities of climate change, as well as making energy and mobility systems climate- and environment-friendly, smarter, safer, and more resilient, inclusive, competitive and efficient (European Commission, 2019b).

Cluster 6, 'Food, Bioeconomy, Natural Resources, Agriculture and Environment' will advance knowledge, expand capacities and deliver innovative solutions to accelerate the transition towards the sustainable management of natural resources (such as biodiversity, water and soils). Climate adaptation and climate neutrality of sustainable primary production (agriculture, forestry, fisheries and aquaculture), value chains, food systems and bio-based industries; optimising ecosystem services including for climate mitigation; reversing biodiversity decline; and reducing environmental degradation and pollution are the biggest measures promoted by the cluster (European Commission, 2019b).

Appendix 27

Opening the European Research Area to future challenges requires developing synergies with the European Higher Education Area in a complex landscape of universities and research organisations with a view to underpinning open science, innovative entrepreneurial practices, life-long-learning and upskilling talent and breaking down disciplinary and inter-sectoral barriers to match emerging business and societal needs. Impacts will include better alignment of national reforms and increased programme level collaboration across Member States and Associated Countries and will help increase the impact of both national and European investments in research and innovation. The evidence base for policymaking across all these domains will be further developed, including through economic analysis of research and innovation policies and performance, design of research and innovation strategies, work to refine indicators and to develop new ones, when needed in cooperation with international organisations and foresight (European Commission, 2019b)