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The road to success: how regional innovation ecosystems can improve participation in the European Framework programme for R&I

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The road to success: how regional innovation ecosystems can improve participation in The European Framework Programme for R&I

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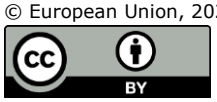

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EUROPEAN COMMISSION

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Working Paper

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ABSTRACT

This paper investigates the drivers of success at regional level in participating in EU-funded Research and Innovation (R&I) projects. We use multiple linear and fractional probit regressions to assess the importance of regional research capacities and assets, as well as intrinsic characteristics of the regions in defining success and participation in the European R&I Framework Programme. We find that a critical mass of factors such as size, economic development, R&D investments, human resources, and research quality is vital. Quality of research outputs matters more than quantity, particularly in projects targeting societal challenges, while quality of patenting activity matters more than quantity, particularly in projects targeting industrial objectives. Less-developed regions benefit from improved institutions, while advanced regions gain from increased R&D and human resources investments. These insights are then used to provide recommendations on how regions can improve their capacity to participate in and benefit from future government R&I funding programmes, distinguishing between more and less advanced regional innovation ecosystems.

1. Introduction

For the past decades, the European Union (EU) has taken steps to address societal challenges, foster sustainable development while ensuring that it increases its competitiveness on the international arena. European research and innovation (R&I) policies are important pieces of the policy mix to achieve these objectives, and a substantial amount of EU funds is dedicated to foster R&I in the EU.

Regional R&I ecosystems are critical players to stimulate the innovation capability and competitiveness of firms, regions and countries (Asheim, 2007; Asheim et al., 2019; Malmberg and Maskell, 2002), particularly since spatial proximity and concentration play a central role in the innovation process (Asheim and Gertler, 2006). Regional systems also constitute important platforms for the creation, absorption and diffusion of knowledge (Asheim, 2012) and innovation, thereby strengthening Europe's competitive position (Szopik-Depczyńska et al., 2020). Furthermore, collaboration between these regional R&I ecosystems has proven to be key to enable researchers to better meet the challenges posed by the increasing complexity of knowledge, integrate a diversity of technologies (Wuchty et al., 2007) and bring together different but complementary pieces of knowledge (Frenken et al., 2007; Boschma and Frenken, 2011), essential for tackling societal challenges.

Horizon 2020, the EU Framework Programme (FP) for R&I 2014-2020, with its budget of nearly 80 billion, included as key priorities strengthening and promoting collaborative R&I, tackling societal challenges and promoting environmental and social inclusiveness. Large part of its budget is dedicated to collaborative projects between organisations located in different regions and countries. Besides, it also aims at boosting linkages between science and

business, and promotes clusters and partnerships between public and private organisations. Compared to its predecessors, Horizon 2020, was characterized by a much larger and visible emphasis on tackling societal challenges, with seven key challenges to address, including climate action, sustainable agriculture, health, secure societies, smart transport, clean energy and inclusive societies. Overall, it had the ambition and the potential to support regional R&I ecosystems and to direct their activities towards radically new technological trajectories and addressing societal challenges.

Nevertheless, only a small number of organisations concentrated in Western Europe participate in the majority of EU-funded projects and take a lion's share of the EU funds for R&I activities (Balland et al., 2019; Protogerou et al., 2010; Enger, 2018). The European's scientific community remains dominated by a limited number of regions, whether one looks at resources, the number of researchers, or scientific "production" (European Commission, 2020; European Commission, 2022a). While some convergence process in terms of regional and innovation performance had occurred from 2005 to 2010 in the EU, over the 2015-2018 period, regional disparities have been on an increasing trend (European Commission, 2022a; European Commission, 2022b).

Numerous analyses have focused on the effects of competitive funding, including the EU FP for R&I, on regional performance in R&I. However, very few studies tackle how to boost a more equitable distribution of this funding, with a specific emphasis on the role of regional assets. In this context, this paper aims at providing insights on the factors of success in applying to public competitive R&I funding at the regional level. How can regions improve their performance in participating in an excellence-driven and competitive funding programme such as Horizon 2020 and reap the benefits of collaborative public-funded R&I?

Using econometric analysis on unique datasets on regional performance in participating in Horizon 2020, our study investigates the role played by the different characteristics of regional ecosystems in determining Horizon 2020's success rate and participation. In doing so, the paper suggests recommendations on how regions can improve their capacity to participate in and benefit from future government R&I funding programmes, distinguishing between advanced and moderate regional innovation ecosystems. Besides, it also proposes general advice to policy makers to avoid the concentration of competitive public funding in R&I.

Our analysis brings novelty to the related literature in three ways. Firstly, it finds novel evidence on the heterogeneous role of institutional quality, R&D and human capital in regional success with government R&I projects between more and less developed regions. Secondly, it presents new evidence on how drivers of regional success vary based on whether government R&I funding is targeted at societal challenges or not. Thirdly, it is a practical application to the largest EU R&I funding scheme.

The remaining of the paper is structured as follows. Section 2 introduces the theoretical framework underpinning our hypotheses about the regional drivers to success in the EU R&I FP. Section 3 presents the data and methodology

employed to carry out the empirical analysis, while section 4 presents the results and discussions. Finally, Section 5 concludes the paper by discussing the policy implications of our results.

2. Theoretical Framework

To define our theoretical framework and specify the econometric models, we rely on three main strands in the literature. First, as we are interested in regional assets to access competitive funding for R&I, we use the literature on factors at regional level that influence R&I performance of a region that could also influence its ability to access competitive funding (Porter, 1998; Ottaviano and Puga, 1998; Fujita, Krugman and Venables, 2001; Glaeser, 2012; Rodríguez-Pose and Di Cataldo, 2015). Second, a stream of the literature adopted a social network perspective to investigate the regional factors influencing the position of a region in EU R&I funded-networks (e.g. Balland, 2012; Balland et al., 2013; Cassi and Plunket, 2015; Stuck et al., 2016; Balland et al., 2019). Third, most analysis aiming at identifying the factors determining participation and success in receiving public competitive funding for R&I study those at the level of the organisation (Barajas and Huergo, 2010; Wanzenböck et al., 2020, Lepori et al., 2015; Paier and Scherngell, 2011; Enger and Castellacci, 2016). While we are interested in regional assets, we use some conclusions of these studies to draw hypothesis for our models.

Using the extensive literature on agglomeration effects, we know that larger, denser and wealthier regions provide positive externalities that facilitate the interaction and networking behind the exchange of knowledge, strengthening regional innovation performance (Ottaviano and Puga, 1998; Fujita, Krugman and Venables, 2001; Glaeser, 2012). Furthermore, institutional quality is a key determinant in the innovation capacity of regions (Rodríguez-Pose and Di Cataldo, 2015). Therefore, our research hypothesis is that size, economic development and institutional quality of a region could be considered as predictors of regional success in accessing public competitive funds for R&I.

When looking at regional-specific indicators, the regional capabilities, such as R&D investments and employment in R&D, are important determinants of a region's innovation performance and its positioning in the EU-funded R&D network (Wanzenböck et al., 2015; Tavassoli and Carbonara, 2014; Boschma et al., 2014). We then hypothesize that research and innovation inputs at regional level could predict the success of a region in being involved in public competitive funding for R&I and include related indicators in our models.

Since institutions are prerequisites for countries to effectively harness the benefits of innovation and entrepreneurship (North. 1981, Robinson & Acemoglu. 2012), we hypothesize that institutions will play a more significant role in less developed countries, while R&D and human capital will carry greater relevance in more developed countries. Arguably, alterations in the levels of R&D or human capital will only yield minor effects in those less advanced regions that lack the appropriate institutions to leverage such intangibles.

We use some aspects of the literature investigating the determinants of succeeding in receiving EU funding at the level of the organisation to draw our hypotheses. Overall, research capabilities, resources and scientific excellence of organisations are elements affecting the probability to succeed in receiving funding from EU R&I FP (Enger, 2018; European Commission, 2017). Besides, the probability of succeeding in accessing EU grants for R&I is strengthened by the scientific reputation of the applicant organisation (Lepori, 2015; Enger and Castellacci, 2016; Wanzenböck et al., 2020). We then decide to include in our models R&I outputs, both in terms of quantity and quality.

These findings also result in defining two categories of R&I ecosystems, the most advanced ones and the moderate ones. This distinction allows to determine whether determinants of success in public competitive funding differ based on the level of performance and development of regional R&I ecosystems.

Similarly, performances in patenting activity in terms of thematic focus are found to increase the probability for organisations to collaborate in EU-funded R&I activities (Scherngell and Barber, 2009; Gilsing et al., 2008). That is why we decide to also study separately the participation and success in receiving funding in each of the different thematic Pillars of Horizon 2020. Furthermore, since research project targeting different objective are likely to require different endowments[1], we hypothesise that R&I projects focused on tackling societal challenges over industrial priorities will have different demands of quality over quantity in terms of research and innovation requirements.

To sum up, our theoretical framework can be summarized with three hypotheses to be tested empirically:

- Size, economic development, institutional quality, publications, patenting and citations of regions impact the success of local innovation ecosystem in government R&I programmes.

- In less advanced innovation ecosystem institutional quality plays a major role, while in advanced innovation ecosystem R&D intensity and human capital is more relevant.

- In projects aimed at tackling societal challenges regional quality of the publication output is more relevant, while for industrial challenges quality of the patenting activity is more important.

[1] As an example in its use of interdisciplinarity (OECD, 2020).

3. Methodology and data

3.1 Data collection

To carry out our analysis, we rely on a unique dataset built using information on the 242 EU regions (NUTS2) retrieved from different databases. The data on participation and success in Horizon 2020 is drawn from the Common Research Data Warehouse (CORDA)[2]. The data on research outputs, including patent applications and scientific publications has been collected by Science Metrix using the European Patent Office and Scopus data between 2000 and 2012. Data on regional R&I assets comes from Eurostat and data on institutional quality from the University of Gothenburg database (QoG data). As we study the determinants of receiving competitive funding under Horizon 2020 (2014-2020) at regional level, we consider the characteristics of the regions at pre-Horizon 2020 levels. Horizon 2020 calls opened in 2014. Following Wang and Hagedoorn (2014) and Belderbos et al. (2014), we introduce a one-year lag for regional R&I inputs and a two-years lag for patents and publications. For the controls, we use 2014 values. Table 1 presents the descriptive statistics of the explanatory variables included in the models.

Table 1. Description of the explanatory variables

Name of the variable	*Year*	*Unit*	*Min.*	*Median*	*Max.*	*Missing values*[3]	*Source*
RD intensity[4]	2013	Percentage of GDP dedicated to R&D investments	0.06	1.29	8.56	7	Eurostat
HRST	2013	Percentage of population working in Science and technology in the labour force	0.11	0.31	0.56	2	
EPO	2012	Number of EPO patent applications (fractional count)	1.00	805.30	40218.40	4	Science Metrix using European Patent Office data
Cited EPO	2012	Percentage of EPO patent applications cited at least one time	0.00	0.31	1.00	4	
Publications	2012	Number of publications (fractional count)	0.11	1135.18	29180.45	3	Science Metrix using Scopus data
Cited Publications	2012	Percentage of highly cited Publications (Top 10%)	0.00	0.10	0.22	4	
GDP per capita	2014	Hundreds of euros per inhabitants	38.00	256.00	928.00	0	Eurostat
Population	2014	Ten of thousands of inhabitants	2.87	146.18	1202.76	2	

[2] This database is maintained by the Common Support Centre of DG Research and Innovation (European Commission).

[3] In total, 11 NUTS2 regions could not be included in our analysis duet o missing values. Consequently, the total number of EU regions analysed is 231.

[4] For RD intensity, DE22, DE23 are 2015

EQI (institutional quality)[5]	2013	Index	-2.65	0.30	2.82	4	University of Gothenburg

Since there is a clear innovation divide across EU regions (European Commission, 2022), to be able to provide targeted policy recommendations for both advanced and less advanced regions, we build two subgroups of regions based on their R&D intensity:

- advanced R&I ecosystems, having R&D intensity above the EU median;
- moderate R&I ecosystems, with R&D intensity below the EU median.

Furthermore, since R&I objectives are likely to shape R&I processes, and drivers, we build three subgroups of projects based on their socio-political objective:

- R&I projects, having excellence as priority;
- R&I projects, having industrial potential as priority;
- R&I projects, having tackling societal challenge as priority.

3.2 Presentation of variables

3.1.2 Dependent variable

We investigate the factors driving the overall success rate of the EU regions participating in Horizon 2020, considering the entire period of the framework programme implementation, 2014-2021. The success rate (calculated for each NUTS2 EU regions) is defined as follows:

$$SR_i = \frac{Successful_i}{Submissions_i}$$

Where SR_i is the success rate of region *i*, $Successful_i$ is the number of successful proposals of region *i* over 2014-2021, and $Submissions_i$ is the number of submitted proposals of region *i* over 2014-2021. By construction, the dependent variable *SR* is bounded between zero and one.

Descriptive statistics of the dependent variable and related variables are presented in Table 2.

[5] EQI index is positively correlated with institutional quality.

Table 2. Participation and success of EU regions in Horizon 2020

Variable	*Unit*	*Min.*	*Median*	*Mean*	*Max.*	*Missing values*	*Source*
Number of participations	Total number	0.00	204.00	588.50	10432.00	0	Corda
Submitted proposals	Total number	1.00	1322.00	3259.00	44549.00	0	
Successful proposals	Total number	0.00	169.00	499.40	8246.00	0	
Success rate	Ratio	0.06	0.14	0.14	0.24	3	

Source: Authors' elaboration.

3.2.2 Explanatory variables

We build the econometric models using the hypotheses we draw in the theoretical framework section above. Predictors of regional success in Horizon 2020 include regional R&I outputs and inputs, as well as regional capabilities in R&I and specificities in terms of size, economic development and institutional quality.

Regional R&I inputs and outputs (quantity and quality indicators)

First, we consider regional R&I assets as potential predictors for success in Horizon 2020. We use R&D intensity[6] and percentage of population working in science and technology in the labour force[7]. To assess the quantity of research output produced in the regions, we use the stock[8] of both EPO patent applications filed by region between 2000 and 2012 and scientific publications by region between 2000 and 2012[9]. As statistics based on inventors are quite informative on the inventiveness activity associated, patent applications are linked to regions based on the investors' residence. Besides, the quality of research outputs produced in the regions is measured using regional percentages of both EPO patent applications cited at least one time and highly cited scientific publications (top 10%) in 2012. Patent citation impact indicators are used as proxy measurements of patent quality; highly innovative inventions will see their corresponding patent applications content useful for other inventions, whose own records will in turn cite the original patent. Whereas for patent, one citation is already a relevant indicator of quality, for publications, one citation is not enough to capture publication quality. In order not to set an arbitrary threshold, we rely on top cited publications (defined as the top 10% of cited publications) as a proxy for quality.

[6] Several NUTS2 regions are not covered, the 5 outermost regions of France (Martinique, Guadeloupe, Mayotte, French Guiana and Réunion), the two 2016 NUTS2 regions HR05 and HR06 of Croatia. Therefore, we could not include them in our analysis.

[7] We rely on Lasch et al. (2013) and Deichmann et al. (2003) to build the regression model with regional determinants (including ratios) to explain levels.

[8] Following Nerkar (2003), knowledge stock is valuable for measuring firm innovativeness.

[9] The German region of Saarbrucken (DEC0) and the autonomous Finnish region of Aland (FI20) are not covered, so we could not include them in our analysis.

Regional specificities and controls

The controls we include in the models are gross domestic product (GDP) per capita, population and the European index of institutional quality (developed by Charron et al., 2015)[10], all available at regional level and pre-Horizon 2020 levels.

3.3 Estimation method

We investigate the factors driving the overall success rate of the EU regions participating in Horizon 2020, considering the entire period of the framework programme, 2014-2021. As specified above, the variable success rate SR is bounded between zero and one.

As demonstrated by Papke and Wooldridge (2008), in these cases, standard models do not provide an accurate picture of the impact of covariates. Linear models may indeed generate predictions outside the admissible interval [0, 1], while models estimated on the log-odds transformation of variables are not defined for the boundary values 0 and 1, unless ad hoc adjustments are made (Gallani et al., 2016). The fractional regression model becomes then most advantageous, as it accounts for the boundedness of the dependent variable, predicts response values within the interval limits of the dependent variable and captures the nonlinearity of the data. Following Papke and Wooldridge (1996), to estimate the parameters, we then use a quasi-maximum likelihood method. The model described in equation (1) is first run for all EU regions, and then distinguishes between advanced R&I ecosystems and moderate R&I ecosystems:

$$(1)\mathrm{E}(SR_i|X_i) = \Phi(\beta_0 + R\&IAssets_i\beta_1 + R\&IQuantity_i\beta_2 + R\&IQuality_i\beta_3 + X_i\beta_4 + \varepsilon_i)$$

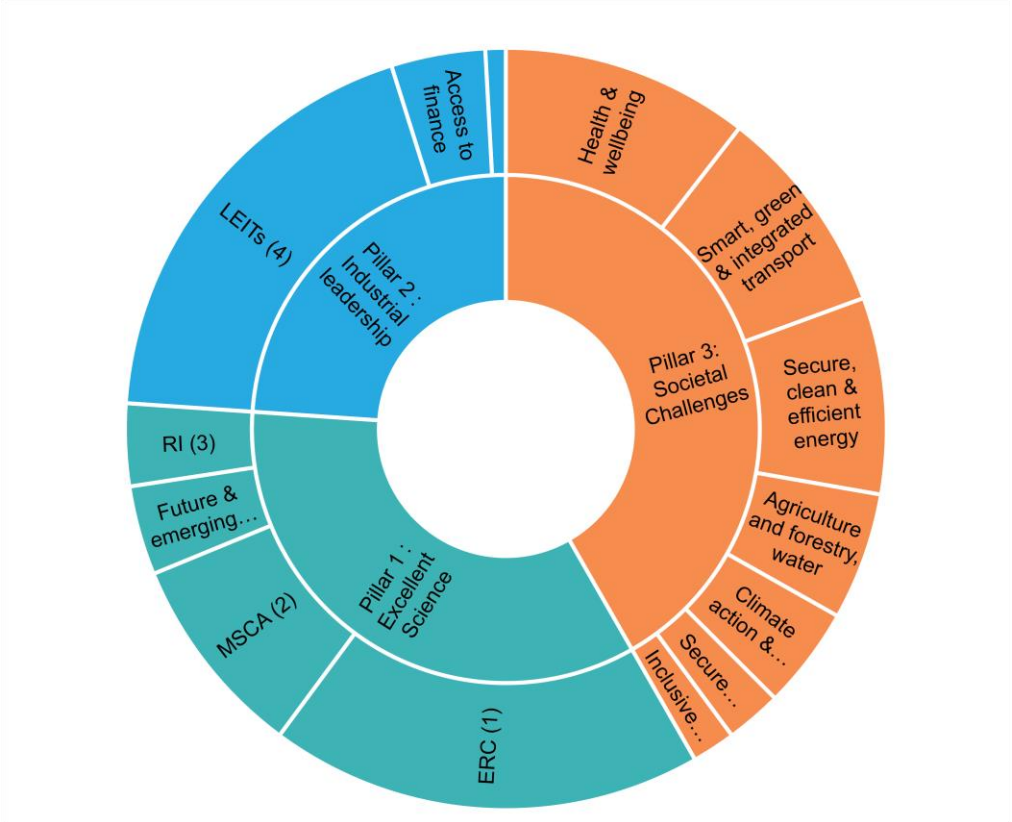
Where the dependent variable SR_i is the success rate of region *i*; $R\&IAssets_i$ is a vector that includes regional R&D investments and human capital resources in science and technology; $R\&IQuantity_i$ denotes patent and publication volumes produced in the region; $R\&IQuality_i$ is a vector that includes patent and publication citations; and *Z* indicates a set of covariates that are relevant to explain success at the regional level: size of the region (based on population size), regional economic development (based on GDP per capita of the region) and quality of institutions.

Heterogeneity analysis

Finally, we investigate the heterogeneity of the drivers of success across the advanced and moderate R&I ecosystems and the different parts of the Framework Programme. We choose to focus on the three main pillars of Horizon 2020, i.e. 'Excellent Science', 'Industrial Leadership' and 'Societal challenges' (Figure 1).

[10] The two autonomous Spanish NUTS2 regions and cities of Ceuta and Melila are not covered, therefore we could not include them in our analysis.

Figure 1. Distribution of the budget of Horizon 2020 across its three pillars



Notes : (1) European Research Council; (2) Marie Skłodowska-Curie actions; (3) research Infrastructures; (4) Leadership in enabling & industrial technologies.
Source : European Commission.

3.4 Robustness checks

We proceed to check the robustness of our results by using OLS and Fractional Probit for each model specified. To test how certain the effects of the explanatory variables are, we change specifications by removing and adding explanatory variables at regional level, notably the flow of patents (number of patent applications filed in 2012), the number of universities, employment density, employment in knowledge intensive industries, unemployment. We specifically study separately the effects of R&I inputs, such as R&D investments and employment, and R&I outputs, such as patents and publications stocks. All the effects of our "core" explanatory variables hold with different specifications and control variables. However, because the stock of patents is too correlated with R&D investments and human resources in science and technology, we decided to remove this explanatory variable from our models. Besides, the variance inflation factors (displayed in Table 4) identify no critical issues of multicollinearity.

We also used the categories of the Regional Innovation Scoreboard in 2013 to study separately advanced and moderate ecosystems, as well as the categories used by the EU Cohesion Policy, such as less developed, more developed and transition regions. The effects of core explanatory variables are robust with these categories as well.

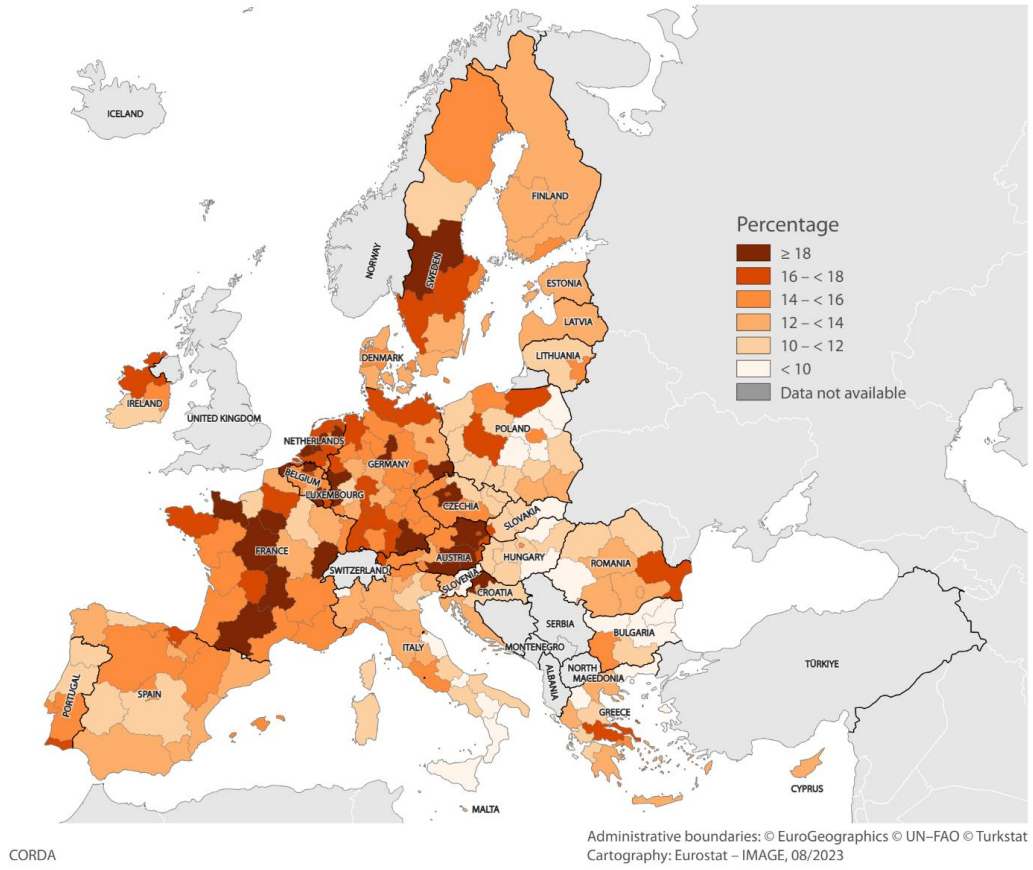
4. Results and discussion

4.1 Descriptive Analysis

Overall, the attractiveness of the Horizon 2020 programme, together with its limited available resources, led to very low success rates, leaving some parts, such as the Future and Emerging Technologies (FET) schemes, the Marie Skłodowska-Curie Actions (MSCA), the societal challenge on Europe in a changing world - inclusive, innovative and reflective societies, strongly underfunded. An additional EUR 62.4 billion would have been needed to fund all the high-quality proposals evaluated during the first three years of the FP. Horizon 2020's focus on excellence leads to a high concentration of funding (both in terms of participants and geographical representation) (European Commission, 2017).

The highest success rates (above 18% of submitted proposals are successful) can be found in Western and Northern regions, such as in France, the Netherlands, Austria, Sweden. Interestingly, German regions, which are often characterized by the highest tracks in terms of R&D investments and R&I capabilities are characterized by high success to moderate success rates. Lowest success rates (below 10% of submitted proposals are successful) can be found in Southern and Eastern regions, such as Italian, Polish, Hungarian, Slovakian and Bulgarian ones. However, overall, we observe a distribution of high success rates quite scattered across the EU regions (Figure 2).

Figure 2. Success rate in H2020 by EU region (NUTS2 level)



Source: Authors' elaboration using Corda database.

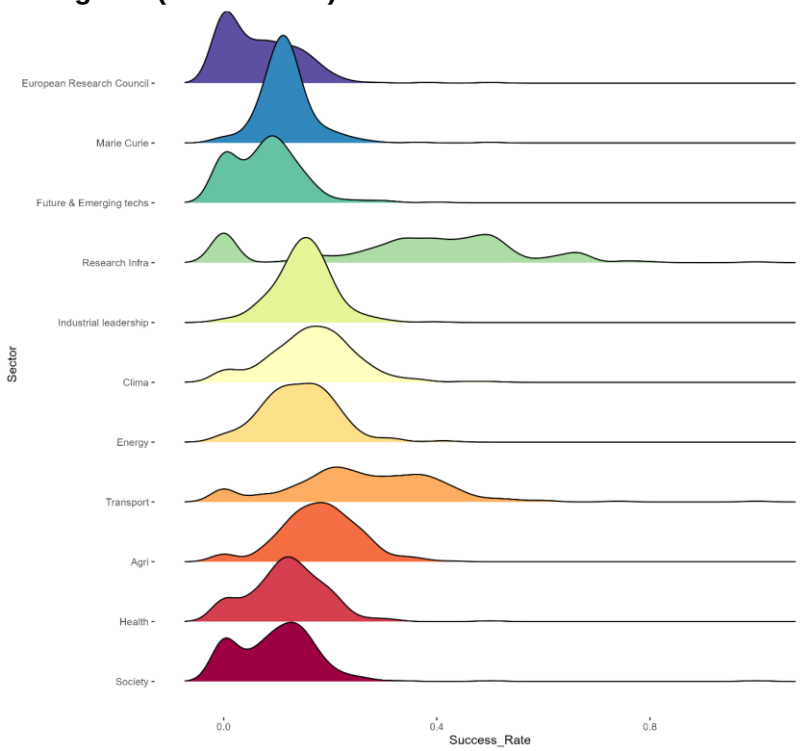
The distribution of success rates across the sample of EU regions also varies considerably for the different parts of the Framework Programme (Figure 3). For pillar 1 ('Excellent Science'), as expected, success rates in research infrastructures are more heterogenous across regions in the sample, which is linked to the objective of this action, aiming at better coordination of development and use of research infrastructures across the whole EU. This is also the case though less pronounced for support through the European Research Council, part of pillar 1. On the contrary, the Marie Skłodowska-Curie Actions under this pillar, targeting individual academics, is highly attractive and only the very top proposals get funded, which could explain why success rates are so homogenously low.

For pillar 2 ('Industrial Leadership'), success rates are globally higher than for pillar 1. Pillar 2 is indeed business-driven, with part of this pillar targeting primarily SMEs. Private companies, in particular SMEs, are less likely to go through the submission of proposals than academics may be. Competition is then less pronounced and with fewer applicants, fewer failures in succeeding, leading to higher success rates. While attractiveness of pillar 1 may vary according to the availability of regional and national funds for research, attractiveness of pillar 2

depends more on market funding opportunities. If companies may secure private funding for their innovative products and processes, they are less likely to resort to public funding, particularly when applying implies a relatively high administrative burden.

For Pillar 3 dedicated to societal challenges, success rates are quite heterogenous across the sample. It could be explained by specialisation in different fields of science that may vary from a regional ecosystem to another, or by the availability of funding and maturity of the different markets for each sector.

Figure 3. Distribution of Success rates in H2020 by programme part across EU regions (NUTS2 level)

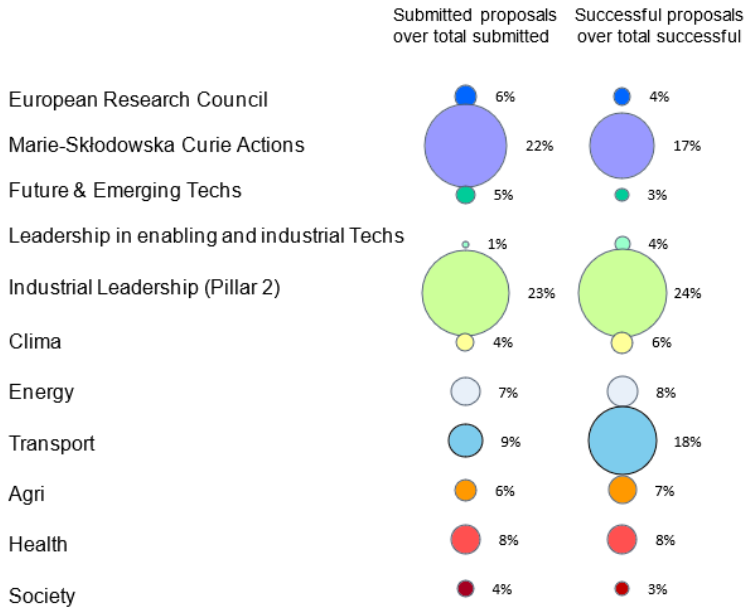


Source: Authors' elaboration based on Corda database.
Note: The titles of the six societal challenges are shortened in the graph. The names are Climate action, environment, resource efficiency & raw materials (Clima), Secure, clean & efficient energy (Energy), Smart, green & integrated transport (Transport), Food security, sustainable agriculture and forestry, marine/maritime/inland water research and the bioeconomy (Agri), Health (Health, demographic change & wellbeing), Inclusive, innovative & reflective societies and Secrure societies (Society).

While the European Research Council represents the most in terms of funding (Figure 1), Marie-Sklodowska Curie Actions represent the majority in terms of number of proposals under the 'Excellent Science' pillar. They offer international doctoral programmes, collaborative research and accompanying fellowship schemes (Figure 4). Proposals for Leaderships in enabling and industrial technologies, represent only 1% of the total proposals under Horizon 2020. Regarding societal challenges, the largest of three pillars in terms of budget, secure societies and climate action attracts less applicants than other fields, such as health and well-being or secure and efficient energy. Proposals in the field of

smart, green and integrated transport[11] have a higher chance of success than in any of the five other fields, even if there is proportionally not as many submitted proposals in that field compared to others.

Figure 4. Representativeness of the different sectors in H2020



Source: Authors' elaboration based on Corda database.

4.2 Econometric analysis

The regressions on the success rates of a region in participating in the FP allow to draw some conclusions on the factors that impact them at regional level. Population size shows a positive corelation with overall success rates, while economic development does not (see Table 4, Part 1).[12] This result is fully in line with the literature on agglomeration economies. Regional amenities, accessibility of the global market through location and availability of transport infrastructure in highly populated (often urban) areas attract workers and researchers, which results in higher chances to take part in large and top-quality research projects.

Institutional quality[13] demonstrates a positive correlation with overall success rates, particularly within moderate R&D ecosystems. R&D intensity shows a positive correlation with overall success rate, particularly within advanced R&D

[11] See note of figure 3.
[12] These results are robust for 2012 and 2014 values of population and GDP per capita.
[13] Institutional quality as defined by Charron et al. (2015;2019;2022) refers to corruption, quality, and impartiality in such services as education, healthcare services, and law enforcement, among other public-sector functions at regional level.

ecosystems. Additionally, the presence of human capital in science and technology exhibits a key correlation with success, particularly within advanced R&D ecosystems.

These findings provide empirical support for the second main hypothesis and align well with the perspectives of innovation theory from a political economy standpoint. This alignment arises from the recognition that institutions, encompassing factors like property rights, the distribution of political power, market organization, and government integrity, play a pivotal role in shaping the incentives and constraints that economic actors encounter. Consequently, these institutional factors influence individual behaviours and economic outcomes (Besley & Persson, 2011).

These results underscore that in the absence of the requisite institutional framework needed to fully leverage the economic benefits arising from research and innovation efforts, heightened R&I endeavours may yield limited results, ultimately lacking significant correlation with the success of R&I projects. (See Table 4, Part 1)

The quantity of publications is negatively related to overall success rate. The quality of scientific publications positively relates to overall success rate, particularly within advanced R&I ecosystems, while the quality of patents is positively related to overall success rate, particularly within moderate R&I ecosystems. These results provide empirical support to the first main hypothesis. They emphasize the paramount significance of prioritizing quality over quantity[14], as well as the potential for greater returns in advanced R&I ecosystems through knowledge creation, and in moderate R&I ecosystems through the application of existing knowledge (see Table 4, Part 1).

Table 4. Part 1 - Success Rate in H2020 – Multiple Linear and Fractional Probit Regressions

	OLS	Frac. Probit - Total	Frac. Probit – Adv. R&I ecosystems	Frac. Probit –Mod. R&I ecosystems
RD intensity	**0.00502****	**0.0204****	**0.0165***	0.02072
	(0.0287)	(0.00922)	(0.0093)	(0.0594)
HRST	**0.0968*****	**0.424****	**0.574****	0.1639
	(0.0392)	(0.178)	(0.024)	(0.2784)
Publications (ln)	**-0.0064****	**-0.0275****	**-0.060157*****	-0.0165
	(0.0025)	(0.0114)	(0.0168)	(0.018)
Perc Cited EPO	**0.0315****	**0.156*****	0.12	**0.1636****
	(0.0127)	(0.0594)	(0.112)	(0.077)
Perc Cited Publications	0.0806	0.326	**0.994****	-0.1614
	(0.0714)	(0.323)	(0.4024)	(0.5485)

[14] Point discussed by different studies such as Rawat & Meena (2014) and Sandström & van den Besselaar (2016)

GDP per capita (ln)	0.0086	0.0433	0.0461	0.0391
	(0.0064)	(0.0294)	(0.0424)	(0.0453)
Population (ln)	**0.0094****	**0.0415****	**0.0598*****	0.0276
	(0.0038)	(0.0176)	(0.0225)	(0.0277)
EQI (institutional quality)	**0.0064****	**0.0307****	-0.0267	**0.0581*****
	(0.003)	(0.0137)	(0.0204)	(0.0207)
Constant	0.0392	-1.565***	-1.4823***	-1.4526***
	(0.0287)	(0.132)	(0.2061)	(0.206)
Observations	231	231	116	113
R-squared	0.378			

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

If we differentiate the results by R&I projects political priority[15], the population size is positively related to success rate within the Industrial leadership and Societal challenges pillars, while economic development becomes significant for the Societal challenges pillar. This result likely highlights how concerns and resources devoted to tackling societal challenges increase with the increase of economic prosperity (see Table 5, Part 2).

Institutional quality is positively related to success rate within the Industrial Leadership pillar, targeting firms. R&D intensity is positively related to success rate within the Societal challenges pillar, targeting research projects aimed at tackling societal challenges. Human capital in science and technology explains success rate within both the Excellent science pillar, with researchers as beneficiaries, and the Societal Challenges pillar, targeting research projects tackling societal challenges (see Table 5, Part 2). Such result confirms the primary role of institutions (such as the rule of law and property rights) in facilitating market-oriented innovation. Notably, secure property rights contribute to economic gains by reducing transaction costs related to trade, as well as the expenses associated with monitoring and enforcing contracts. When firms are uncertain about the potential economic returns, they are unlikely to take the gamble of investing their capital and resources, falling short in creating and industrial innovative ecosystem. On the other hand, the positive relationship between R&D intensity and human capital in research projects addressing societal challenges may be attributed to the fact that these factors, through critical mass, facilitate the transfer of for-profit innovation into diverse areas of application (ex: societal challenges).

As observed on the overall sample, the quantity of publications has no or a negative relationship with success rate. Quality of publications is positively related to the success rate within the Societal challenges pillar, while quality of patenting activity is positively related within the Industrial Leadership pillar, the more market-

[15] H2020 pillars: Excellent Science, Industrial Leadership, Societal challenges

oriented pillar of Horizon 2020 (see Table 5, Part 2). This evidence goes in line with the idea that patenting activity is usually performed by the industry with a focus on performance and competitiveness, while scientific publications can be of greater intellectual breath, more indicative of the knowledge reflection required to systematically address societal issues.

Table 5. Part 2 - Success in H2020 and its three Pillars – Fractional Probit Regressions

	VIF	Total H2020	Excellent Science	Industrial Leadership	Societal challenges
RD intensity	2.3	**0.0204****	0.0147	0.0204	**0.026****
		(0.00922)	(0.0107)	(0.0153)	(0.0126)
HRST	3.4	**0.424****	**0.491****	0.4194	**0.4245***
		(0.178)	(0.331)	(0.0153)	(0.2491)
Publications (ln)	4.5	**-0.0275****	-0.0213	**-0.0333***	-0.0248
		(0.0114)	(0.0199)	(0.0181)	(0.0152)
Perc Cited EPO	1.1	**0.156*****	-0.0387	**0.2989*****	0.0898
		(0.0594)	(0.1081)	(0.0986)	(0.0843)
Perc Cited Publications	2.8	0.326	0.3527	0.1806	**0.8144***
		(0.323)	(0.5765)	(0.5226)	(0.4362)
GDP per capita (ln)	5.3	0.0433	-0.0045	-0.0091	**0.0963****
		(0.0294)	(0.0530)	(0.0481)	(0.0404)
Population (ln)	3.1	**0.0415****	-0.0075	**0.0497***	**0.0647*****
		(0.0176)	(0.0313)	(0.0285)	(0.0236)
EQI (institutional quality)	2.9	**0.0307****	-0.0153	**0.0776*****	0.0217
		(0.0137)	(0.0244)	(0.0227)	(0.0187)
Constant		-1.565***	-1.1533***	-1.2684***	-1.9054***
		(0.132)	(0.239)	(0.2183)	(0.1821)
Observations		231	231	231	231

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

The European Framework Programme for Research and Innovation, with its budget on an increasing trend since its first edition in 1983, aims at delivering tangible research and innovative solutions to ensure prosperity and sustainability. For regional R&I ecosystems, participating in transnational research and innovation projects can not only improve the quality of research, but also facilitate its diffusion and uptake by the market and society as whole.

Similarly to several other R&I government funding programmes, the EU FP is embedded in an excellence principle, with excellence of research proposals

remaining the main criterion for selection. In the EU, only a small fraction of regions takes a large share of funds under this programme. Against this backdrop, this paper provides some policy recommendations for regions to increase their success in participating in this programme, and for policymakers to avoid a "closed-club effect" (Enger, 2018) in competitive R&I funding programmes.

Our main conclusion is that critical mass is needed for a regional ecosystem to take part in the European R&I Framework Programme, in terms of population size, economic development, R&D investments, human resources, and quality research, and institutions. As we demonstrate that determinants of success in receiving public funding vary with the level of development of regional R&I ecosystems, and the political priority of the projects, we recommend to national or supranational policymakers to consider those when developing competitive public funding.

Our results emphasize the paramount significance of prioritizing quality over quantity in research. We then suggest to all R&I ecosystems' stakeholders to focus on quality of research outputs, such as scientific publications and patents, rather than quantity, to be recognised as relevant partners in international projects and increase their chances to succeed in participating in competitive public funding programmes for R&I.

For more advanced R&I ecosystems, investing in R&D and human resources dedicated to science and technology should be a priority to increase their chances of success. On the other hand, our results suggest that moderate R&I ecosystems could strongly benefit from improvements in institutional quality to increase their access to transnational competitive funding. As a result, in order to boost the potential of moderate R&I ecosystems to participate in competitive funding programmes for R&I, we propose that regional policymakers take concrete steps to enhance institutional quality while increasing the R&I capacities. This could involve measures and initiatives aiming at promoting transparency and accountability in regional institutions, developing capacity-building programmes for regional officials, and updating the legal and regulatory frameworks governing regional organisations.

In the case of EU policy, this highlights the importance of synergies between R&I policy and policies aiming at improving institutional framework of the regions, general R&I assets and research capacities that are fundamental for success in participating in the Framework Programme, such as the EU Cohesion Policy. The European Structural and Investment Funds (ESIF), which include the European Regional Development Fund (ERDF) and the European Social Fund (ESF), can for example be used to finance projects that enhance institutional capacity, improve public administration, and support good governance at the regional and local levels. We recommend to prioritize fostering synergies between these programmes to facilitate the participation of moderate R&I ecosystems in the European Framework Programme for R&I.

More generally, R&I public funding attributed based on competition can accentuate regional disparities in R&I capabilities. The regions which are already advanced are more likely to reap the benefits of such public funding, which will strengthen

even more their competitive advantage, resulting in a virtuous circle leading in concentration of public funding. In this context, as this study clearly demonstrates that the factors influencing success in participating in public funding for R&I vary according to the level of development of regional R&I ecosystems, our results suggest that national or supranational policy makers could consider economic development, human capabilities and institutional quality of the targeted beneficiary regions when formulating competitive public funding programmes for R&I. This consideration is particularly important to mitigate the risk of fostering a 'closed-club effect'. It also stresses the importance of programmes that channel R&I funding not only to increase R&I capacities, but also to support the implementation of structural reforms that strengthen institutional capacity and promote the focus on excellence of the R&I system.

Finally, our findings concerning the Societal Challenges Pillar of Horizon 2020 indicate that the quality of scientific publications and basic research, in contrast to applied research leading to patenting activities, plays a pivotal role in achieving success within this part of the program. Consequently, this suggests that budget for fundamental research should not be neglected within large R&I funding programmes as it also contributes to address societal challenges effectively.

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This paper uses multiple linear and fractional probit regressions to assess the importance of regional research capacities and assets, as well as intrinsic characteristics of the regions in defining success in the European R&I Framework Programme. We find that quality of research outputs matters more than quantity, particularly in projects targeting societal challenges, while quality of patenting activity matters more than quantity, particularly in projects targeting industrial objectives. Less-developed regions benefit from improved institutions, while advanced regions gain from increased R&D and human resources investments. We provide recommendations on how regions can improve their capacity to participate in the EU FP for R&I.

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