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Enhancing SME innovation across European regions: Success factors in EU-funded open innovation networks

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A R T I C L E I N F O

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A B S T R A C T

This study examines the funding allocations to Open Innovation (OI) networks involving small and mid-size enterprises (SMEs) and other organizational actors by the European Union's Horizon 2020 Fast Track to Innovation program (2018–2021). Using a unique dataset of program application information at the participant level, the technological, organizational and locational characteristics of SMEs' OI innovation networks are analyzed. Success in securing funding is found to be linked to host regional innovation performance and to technological distance among SMEs and their partners, while organizational distance has a curvilinear effect. Counter to program objectives, partner heterogeneity has some mixed effects. Insights are offered for SMEs on strategic positioning and to policymakers on the design of future innovation policy initiatives.

1. Introduction

European Union (EU) innovation policy has progressively embraced a multi-level set of initiatives aiming at easing the barriers to innovation and growth in small and medium-sized enterprises (SMEs) (OECD, 2019). This development has accelerated following the "Small Business Act" for European SMEs which established principles to stimulate entrepreneurship and the design of policy instruments to broaden the set of European SMEs engaged in innovative activities with an impact on growth and the consolidation of the EU industrial structure (European Commission, 2008).

Recent policy tools within the European Innovation Council have been built around the concept of open innovation (OI) (Bogers et al., 2018) emphasizing the formation of collaborative networks between SMEs and other organizations supporting access to external knowledge, skills, and complementary assets to effectively combine research and innovation with its implementation (European Committee of the Regions, 2019). With new technological trends fueling innovation at the intersection between disciplines and industries, the shift from a linear, closed model towards an open and interactive model of innovation represents a crucial element for the competitiveness of SMEs and European Regions (Bathelt et al., 2004; Rothwell and Dodgson, 1991; Rutten and Boekema, 2007).

The Horizon 2020 "SME Instrument" (SMEI) and "Fast Track to Innovation" (FTI) programs are prominent examples of such a change in the focus of innovation policies, emphasizing the involvement of a larger population of European SMEs and first-time applicants in developing close-to-market innovations through the design of collaborative innovation projects (European Commission, 2015, 2019). However, recent assessments of the SMEI program have revealed a lower engagement across the population of European SMEs than expected (Simonelli, 2016). Surprisingly, a large portion of the SMEI budget was awarded to mono-beneficiary applications rather than to collaborative innovation projects (De Marco et al., 2020) and most of the program beneficiaries were SMEs in the top quartile of employment growth performance, with patents and prior venture capital funding as strong predictors of success (Mina et al., 2021).

Our study complements the emerging discussion on public policies for OI (Bogers et al., 2018; Leckel et al., 2020; Santos et al., 2021) by focusing on the FTI program, the first policy initiative explicitly targeting the formation of collaborative innovation networks between European SMEs and other organizational actors across EU regions.

Building on an original participant-level dataset of 2720 European SMEs and 2837 partner organizations applying to the FTI scheme (2018–2020), the study examines a set of firm-level and network-level characteristics, and their relevance for success within the program.

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Four research hypotheses are elaborated which explore the technological and organizational characteristics of SMEs external networks, the attributes of their location and the probability of SME and their networks award funding through the program. Hence, the study addresses the call for more research regarding OI outside the firm environment, such as in networks, innovation systems, and public policies (Bogers et al., 2017; Leckel et al., 2020; Santos, 2015), and responds to the need for a stronger evidence base supporting the design of innovation policies (Dosso et al., 2018; Martin, 2016).

The article proceeds with a discussion of the conceptual setting through which the research hypotheses are derived. This is followed by consideration of empirical setting of the FTI program, along with the data and the methodological approach. Subsequent sections present the analytical results and discuss the main implications including management and policy insights.

2. Theoretical background

SMEs differ significantly across European regions in terms of their capacity to persistently introduce innovations (Clausen et al., 2012) and in terms of resources and capability constraints regarding access to external knowledge networks (Audretsch et al., 2023; Hervás-Oliver et al., 2021a; van de Vrande et al., 2009). Such differences have been attributed to variations in such factors as spatial conditions for knowledge accumulation and diffusion, the nurturing of knowledge externalities and localized learning (Audretsch and Feldman, 1996; Camagni, 1991; Feldman, 1999; Malmberg and Maskell, 2002). Prior empirical evidence of the allocation of EU funds promoting R&D and innovation excellence confirms that both the probability of application and the allocation of awards are heterogeneous and positive for firms embedded in vibrant knowledge networks (Boschma and ter Wal, 2007; Fornahl et al., 2011), located in clusters (Broekel et al., 2015) and with prior experience in R&D cooperation (Barajas and Huergo, 2010; Cantner and Kösters, 2012).

However, when examining the relevance of SMEs' collaborative relationships for innovation, a framework including only spatial relationships would give a limited picture, as it inevitably discounts other factors (Fitjar et al., 2019). As knowledge recombination takes place in inter-firm relationships, it is not only the region but the structure and the characteristics of SMEs and their networks that should be considered as units of analysis. SMEs capacity to effectively introduce products, processes and services resulting from R&D investments is particularly affected by its long-run strategic choices (Clausen et al., 2012) where access to different information sources for innovation and the formation of inter-organizational ties play a central role (Gans and Stern, 2003; Laursen and Salter, 2006; Teece, 1986).

The relationships between SMEs and their external innovation partners are complex, yet also extending beyond geographical proximate linkages (Mohr and Spekman, 1994). In particular, non-spatial dimensions of proximity among SMEs and other actors in innovation networks as well as other non-proximate linkages between SMEs' and their innovation partners should be taken into consideration (Boschma, 2005).

Within the innovation and entrepreneurship literatures, there is much emphasis on the technological and cognitive dimensions of proximity as relational attributes taking a central role within innovation networks (Knoben and Oerlemans, 2006). The concept of technological proximity refers to shared technological knowledge and experience among actors (Zeller, 2009).

Based on the theory of absorptive capacity, technological proximity increases the extent to which firms are able to assimilate and exploit knowledge spillovers from other actors with a similar knowledge base (Cohen and Levinthal, 1989). On the other hand, the ability to access distant technological knowledge is considered as a source of opportunities to create new solutions from knowledge originating outside the industry, thus increasing the potential novelty of innovation outcomes (Colombelli et al., 2013; Dewar and Dutton, 1986).

For policy initiatives aiming to accelerate the market up-take of innovation projects with high technological novelty and significant expected impact (breakthrough, market-creating innovations), fostering a greater variety of technological knowledge, industry sectors and scientific disciplines among actors would likely represent a source of opportunities (Corsaro et al., 2012). Specifically, SMEs joining interdisciplinary OI networks should potentially be able to perform innovation tasks that are original and not proximate to local solutions (Katila and Ahuja, 2002). Thus, a greater technological variety among actors would enhance sharing opportunities and collaboration spaces, raising the capacity to deploy innovative concepts that have the potential to become breakthroughs into marketable products, services and processes, and translating in a higher probability of positive evaluation.

Nevertheless, the systematic effort to find partners that are distant in terms of technological knowledge should be balanced with the pitfall of losing the capacity to benefit from the acquired knowledge (Nooteboom, 1999). In this regard, the positive effect of technological distance among actors in an OI network could increase up to a point where a countervailing negative force (a diminished learning potential, due to underdeveloped absorptive capacity) challenges the ability of SMEs to understand partners' knowledge (Muscio, 2007; Makri et al., 2010) and to successfully exploit the results.

The combined effect of these two opposing latent forces (Haans et al., 2016) suggests:

H1. : At the network level, the degree of technological distance between an SME and its partners is curvilinearly related to the probability of being selected for funding (taking an inverted U shape).

The more general concepts of cognitive proximity and cognitive distance in inter-firm linkages (Nooteboom, 1999; Nooteboom et al., 2007) refer to the influence of similarities and diversities in organizational culture, norms, and routines (how actors perceive, interpret and evaluate knowledge) on effective communication and knowledge transfer within a network. As the cognitive base of different types of actors is expected to be substantially different, so will their role within inter-organizational partnerships.

The literature in innovation management has highlighted diversity as a factor enhancing collaborative R&D and innovation performance (Faems et al., 2010; Sarpong and Teirlinck, 2018; Van Beers and Zand, 2014). Yet, if collaborations reduce the fundamental risks inherent to innovation (Narula, 2004) not all external partners and related knowledge domains are of equal importance for SMEs (Brunswicker and van de Vrande, 2014), with the expectation of variations in the performance effect of R&D collaborations by different partner types (Du et al., 2014). While supply chain actors – especially larger firms – may enhance SMEs' knowledge of the market, universities and research centers, public sources, or private entities (such as, consultants) may help identifying new technological avenues for the firms to explore as well as giving support to commercialization strategies (Brunswicker and Vanhaverbeke, 2015). Accordingly, complementarities in innovation have been emphasized, at the overall level (Belderbos et al., 2006), and in terms of partner types (Sarpong and Teirlinck, 2018). Greater variety in the types of partners (i.e., market-based partners such as suppliers, customers, competitors, or science-based partners such as public or private research centers) with whom a firm simultaneously collaborates, is considered a factor enhancing innovation performance (Baum et al., 2000; Faems et al., 2005; Nieto and Santamaría, 2007).

Based on this literature, one would assume that a higher level of organizational distance among partners would lead to a higher likelihood of being selected for funding, given the higher capacity of the consortium. However, research exploring the mechanisms and conditions through which diversity operates in OI partnerships shows that high partner diversity can result in cost-increasing effects (Faems et al., 2010). Laursen and Salter (2006) show that the positive effect of search strategies involving deep links with an increasing number of partners might be counterbalanced by over-search and collaboration costs, hindering innovation performance as challenges to coordination and knowledge sharing emerge. Thus, although a positive impact of organizational distance among partners can be observed on innovation outcomes (Broekel and Boschma, 2016), a high degree of diversity might operate as a double-edged sword (Post et al., 2021). As creating and maintaining knowledge-related links with external partners requires increasing resources and attention, higher diversity could reduce the potential impact promise of collaborative innovation projects.

Conceptually, we deduce that the relationship between organizational distance among SMEs and other actors in the network and the probability of being selected for funding might be expected to take a curvilinear shape. While consortium capacity increases with organizational distance among partners, leading to a higher probability of perceived success, this effect will decrease when high heterogeneity will lead to coordination problems, resulting in a lower potential impact. This leads to the second research hypothesis:

H2. : At the network level, the degree of organizational distance between an SME and its partners within the network is curvilinearly related to the probability of being selected for funding (taking an inverted U shape).

In an extension of this line of inquiry, we also examine the attributes of SMEs location and the geographical composition of their OI networks as factors that are likely to shape the formation of effective inter-organizational linkages, influencing the assessment of their potential impact.

The availability of material and cognitive resources in a local environment is found to facilitate the formation of innovation networks between local SMEs and other actors (Capello and Faggian, 2005), as it raises the opportunities for SMEs to access new relevant knowledge and required resources (Colombelli, 2016), and to successfully exploit them in collaborative innovation projects (Leckel et al., 2022). Prior literature examining the links between collaborative R&D projects and innovation performance at the regional level has shown a positive impact for regions with higher innovation capacity (Broekel, 2015; Czarnitzki and Hottenrott, 2009). SMEs operating in such regional innovation systems have been associated with a higher number of innovative products (Lasagni, 2012; Parrilli and Radicic, 2021). As collaborative R&D and OI processes epitomize the formation of knowledge links between organizations, SMEs in regions with superior innovation performance will be more capable in building stronger and outward-looking innovation networks, and in maintaining their favorable positions (Bathelt et al., 2012; Bathelt et al., 2004; Broekel and Graf, 2012). These arguments suggest that the locational attributes of SMEs influence not only the formation of effective OI networks, but also their abilities to garner external resources.

Specifically, SMEs operating in regions with higher innovation performance will be likely to deploy the capacity to extend their relationships to a wider range of external knowledge sources, such as universities, research organizations, government labs, and industry associations, and to mesh their priorities with those set by ecosystem leaders (Nambisan and Baron, 2013; Radziwon and Bogers, 2019). Thus, the location of SMEs in more innovative European regions is expected to enhance opportunities to be part of successful partnerships and hence to be positively associated with funding selection.

H3. : At the firm level, the stronger the innovation performance of the region where an SME is located, the greater the probability of being selected for funding.

Based on these arguments, we anticipate that there might be interactions between the relational characteristics of SMEs collaborative networks and their geographical composition.

Beyond technological gaps, different regional settings play a greater role than other internal factors (such as R&D investments) in influencing how local firms innovate (Hervás-Oliver et al., 2021b). In discussing the heterogeneity of innovation performance across SMEs in different European regions, Fitjar and Rodríguez-Pose (2013) and Parrilli and Radicic (2021) emphasize that different innovation modes are likely to influence SMEs engagement with different types of external actors, and to have an impact on the formation of effective partnerships.

Specifically, innovation modes based on science and technology drivers (STI), which are typical of more advanced regions, will foster R&D collaborations with universities and research institutions based on the development of scientific knowledge. However, innovation modes based on learning by doing-using-interacting (DUI) in less developed or peripheral regions will be more likely to generate non-R&D technological innovations, based on collaborations with suppliers and other actors in the value chain (Hervás-Oliver et al., 2015).

As the formation of effective knowledge links between SMEs and other organizational actors is influenced by the industrial settings and knowledge bases of European regions (De Noni and Belussi, 2021), and is triggered by different innovation strategies (Hervás-Oliver et al., 2021a; Parrilli and Radicic, 2021) networks of actors from different innovation performance regions will be likely to face higher search and coordination costs and increased uncertainty about the outcomes, *coeteris paribus*:

H4a. : At the network level, geographical heterogeneity in the composition of the network is negatively related to the probability of being selected for funding.

Based on the above arguments, we also hypothesize that, for geographically heterogeneous OI networks, the mix of a higher negative latent effect (higher search and coordination costs) and an unaffected positive effect (increasing benefits from partners' diversity) at the same degree of organizational distance among actors would lead to the following:

H4b. : A flattening in the curvature of the inverted U-shaped relationship between organizational distance among partners and the probability of being selected for funding will occur when partners from above-average and below-average innovation performance regions are involved in the network.

The next section discusses the materials and methods, including the case study program, used to explore the study's research hypotheses.

3. Materials and methods

3.1. Case study program: Fast Track to Innovation (FTI)

The FTI program was announced in 2017 under the EU Horizon 2020 Work-Programme 2018–2020 and opened for funding applications in the period 2018 to 2020 (European Commission, 2017). FTI was implemented by the then Executive Agency for Small and Medium-sized Enterprises (EASME) as a pilot for the agency's successor in 2021: the European Innovation Council and Small and Medium-sized Enterprises Executive Agency (European Commission, 2020: 64–71).

This reinforces the value of FTI as a case. Since its inception as part of the European Innovation Council's (EIC) flagship innovation program, FTI sought to deliver on EU innovation policy objectives to enhance collaborative SME engagement in breakthrough, market-creating innovations, namely “radically new, breakthrough products, services, processes or business models that open up new markets with the potential for rapid growth at the European and global level” (European Commission, 2020:7). The FTI scheme aimed to increase the participation in Horizon 2020 of SMEs in OI projects with other companies and organizations, targeting the deployment of scientific and technological advances into marketable products, services and processes with a high expected market impact (European Commission, 2015).

Differently from prior programs allowing individual firms to apply for funding, SMEs applying to the FTI scheme could only be part of larger networks with a minimum size of three and a maximum size of five partners (including a minimum of two and three private business participants respectively). Partnerships could be set between SMEs and other private and public organizations, including large companies, Universities, public entities, research centers, and other institutions (e.g., industry associations and similar), and had to include (at least) participants from three different countries. Innovation project activities in demonstration stage to market uptake continuum were eligible, including pilots, test-beds, systems or business model validation, pre-normative research, and standards. The programmed budget for FTI was €300 million allocated over three years, with EU contributions of up to €3 million to awarded projects (European Commission, 2020). Applicants could propose OI projects of up to three years duration within which market uptake was expected.

In contrast to previous measures, no pre-defined topics were included in the call (Bogers et al., 2018), and proposals were classified according to the keywords introduced by applicants. The ex post classification of proposals comprised 15 categories, corresponding to a matching number of evaluation panels: agriculture/rural development/fisheries; biotechnology; construction and transport networks; consumer products and services; cultural and creative economy; earth and related environmental sciences; energy; engineering and technology; finance; food and beverages; health; information and communication technologies (ICT); public sector innovation; security; space.

After eligibility checks, external independent experts in these categories evaluated and scored proposals. Evaluators were appointed based on the EU criteria promulgated for participation in Horizon 2020 (European Parliament, 2013). For the FTI there was a pool of approximately 700 evaluators to choose from, subject to a rotation of 20 % each year. About three-quarters of evaluators were from business with the balance from academia and research (European Commission, 2019). The evaluators were assigned to category panels and received proposals in their domain of expertise based on applicant's keywords.

Every eligible proposal was reviewed by four different experts, individually and then in group discussion moderated by EU staff. In the final review, experts were organized by category panels containing complementary expertise (technical, commercial, financial, business/industrial) to assess both technical and commercial potential.

Proposal evaluation was based on three groups of criteria: (1) Technological excellence (50 % weight), assessing if the innovation project had potential in terms of novelty beyond the state of the art in its field; (2) Impact (25 % weight), assessing the business model and the commercialization strategy, as well as the financial planning and projections for market take-up; and (3) Implementation (25 % weight) assessing consortium capacity.

3.2. Data sources and sample characteristics

From the Horizon 2020 FTI (CORDA) database (European Innovation Council and SMEs Executive Agency, EU Commission), we retrieved participant-level data on proposals submitted for evaluation to the FTI program (2018, 2019, 2020). The original dataset comprised 2108 proposals. This was cleaned by deleting duplicate submissions (i.e., the same project presented by the same consortium in different cut-offs), resulting in 1320 unique proposals. The information on the number of duplicate submissions for each consortium was retained and used as a control variable.

These proposals were submitted by consortia involving 2720 European SMEs and 2837 partner organizations (large private companies, universities, public entities, research centers, and other institutions). Bureau van Dijk's ORBIS Global database was linked to the FTI participant-level data to collect information on industry characteristics (NACE rev.2 industries) and location (NUTS2 regions) for each participant. The dataset was complemented with the EU Regional Innovation Scoreboard (EU-RIS) database covering 240 EU Regions (NUTS2). The EU-RIS allowed associating each participant with the innovation performance indicator of the EU region of origin.

Within the reference population of 2720 applicant SMEs, data on 119 firms were not matched in the ORBIS database. Additionally, 237 SMEs were based in non-EU associated countries or in countries where EU-RIS data was not available at the regional level. This resulted in 2364 SMEs from 226 regions in 27 European Countries that were considered valid for analysis (Table 1). From the matching with ORBIS Global and the EU-RIS database, we obtained a satisfactory coverage percentage (87 % of the population of applicant SMEs).

3.3. Variables definition and measurement

This section details the variables used in the analysis and describes the sources and the measurement method.

The dependent variable (EVAL) represents the outcome measure of the FTI evaluation process, and is measured on a categorical scale. It indicates whether an SME was not selected for funding (coded as "0"), received the Seal of Excellence certificate ("1"), or was awarded funding ("2") by the program. Recipients of the Seal of Excellence certificate are proposals scoring above the threshold for funding under the FTI scheme but not funded because of the program budget limits.

Two diversity metrics were computed at the network level, to assess technological distance (TEC_D) and organizational distance (ORG_D) among partners. As in similar works, (Powell et al., 1996; Sarpong and Teirlinck, 2018) the two measures of diversification in the collaboration network were based on the concept of diversity as functional variety, and operationalized through the Blau (1977) index of heterogeneity.

For J categories, the index is computed as follows:

Table 1
Sample characteristics (n = 2364).

Variable		Frequency	Percentage
Final evaluation	Awarded with funding	180	7.61
	Seal of excellence	188	7.95
	Not selected for funding	1996	84.43
Year of participation	2018	727	30.75
	2019	736	31.13
	2020	901	38.11
Industry	Agriculture, mining and quarrying	27	1.14
	Manufacturing	560	23.69
	Utilities	11	0.47
	Waste management & treatment	9	0.38
	Construction	33	1.40
	Wholesale and retail trade	114	4.82
	Transport, travel, accommodation	16	0.68
	Information and communication	471	19.92
	Financial and insurance activities	20	0.85
	Real estate activities	8	0.34
	Business Services	571	24.15
	Biotechnology and life sciences	407	17.22
	Other industries	117	4.95
Evaluation panels	Agriculture/Rural Dev./Fisheries	130	5.50
	Biotechnology	99	4.19
	Construction and transport networks	118	4.99
	Consumer products and services	67	2.83
	Cultural and creative economy	30	1.27
	Earth and environmental sciences	75	3.17
	Energy	243	10.28
	Engineering and technology	571	24.15
	Finance	28	1.18
	Food and beverages	85	3.60
	Health	496	20.98
	ICT	306	12.94
	Public sector innovation	32	1.35
	Security	49	2.07
	Space	35	1.48

$$D = 1 - \sum_{j=1}^{J} p_{ij}^2$$

where for firm *i*, *p* is the share of ties of type *j* out of its total number of ties *J* (*j* = *1* …*J*). The diversity index consists of a continuous variable bounded in the interval *[0, (J-1)/J]*.

The measure of technological distance among partners in the network (TEC_D) was computed based on 31 categories in the NACE Rev.2 industry classification. The measure of organizational distance (ORG_D) was computed on six categories of institutions: SMEs, large private companies, universities, public entities, research centers, other private institutions (e.g., industry associations and similar). To remove the influence of measurement units, RII, TEC_D and ORG_D were rescaled in the interval from 0 to 1.

The 2018 Regional Innovation Performance Index (RIPI), a measure of the innovation performance score of the region where each SME is located was further included as explanatory variable. The regional innovation index is a regional extension of the European Innovation Scoreboard (EIS), assessing the innovation performance of European regions on a more limited number of indicators. The RIPI is an average composite measure of regional innovation performance, calculated as the unweighted average of the normalized scores of 21 sub-indicators in the following categories: human resources, attractive research systems, digitalization, finance and support, firm investments, use of information technologies, number of innovating SMEs, SMEs linkages in innovation, intellectual assets, employment, sales, environmental sustainability. Relative performance scores are calculated by dividing the RIPI of each region by that of the EU and multiplying it by 100 (European Commission, 2021).

A categorical variable assessing the regional composition of each network of partners (REG_C) was computed based on the performance groups assigned by the EU-RIS to regions, based on the RIPI distribution in the year (2018) of launch of the FTI program. REG_C was coded as "1" if the network was composed exclusively of partners from below-average performance regions (moderate and emerging innovators), "2" if the network partners were located in regions belonging to different (below-average and above-average) performance regions; "3" if the network was composed exclusively of partners from above-average performance regions (innovation leaders and strong innovators).

We included as controls 13 industry dummies, three dummies for year of participation and 15 dummies referring to the evaluation panel to which each proposal was assigned. Prior participation (the number of times the same proposal was submitted for evaluation by the same consortium) and the share of private businesses over the total number of partners were also included as control variables, as factors that could have an influence on the evaluation outcomes. Finally, a dummy variable indicating the role of SMEs in the network was included. The variable was codified as "1" if an SME was the formal coordinator of the proposal, "0" otherwise. Table 2 describes the measurement method for each variable, while the descriptive statistics and the pairwise correlations for the continuous variables can be found in Table 3.

Table 2
Variable names, acronyms, measures and sources.

Name	Acronym	Measurement	Source
Evaluation outcome	EVAL	Categorical variable: "2" if the SME was awarded funding; "1" if the SME received the Seal of Excellence; "0" if the SME was not selected for funding	EU Commission, CORDA
Technological distance	TEC_D	Blau index (31 industry categories)	ORBIS Global
Organizational distance	ORG_D	Blau index (six categories of institutions)	EU Commission, CORDA
Regional Innovation Index	RIPI	Innovation performance index of the region where the SME is located	EU Commission, RIS
Regional composition of the partnership	REG_C	Categorical variable: "1" if the network is composed of partners from below-average performance regions; "2" if composed of partners from below-and-above average performance regions; "3" if composed of partners from above-average performance regions	EU Commission, RIS
Share of private businesses	Sh_Prb	Share of private businesses over the total number of partners	EU Commission, CORDA
Prior participation	P_Part	N. of times the same proposal was submitted for evaluation by the same consortium	EU Commission, CORDA
Industry	Ind	SME industry (NACE Rev.2, 4 digits)	ORBIS Global
Evaluation panel	Panel	Evaluation panel	EU Commission, CORDA
Year	Year	Year of participation	EU Commission, CORDA
Role	Coord	Dummy variable indicating the role of the SME in the partnership: "1" if coordinator; "0" otherwise	EU Commission, CORDA

3.4. Empirical strategy

Ordered logistic regression modeling was used to model the likelihood to be selected for funding, based on the three categories: "0" Not selected for funding; "1" Seal of Excellence; "2" Awarded funding".

We hierarchically approached the estimation by running a baseline model including the control variables (Model 1) and then including the independent variables TEC_D and ORG_D (Model 2), and their squared terms (Model 3–4), to test for curvilinear effects. Model 5–6 include the RIPI associated to each SME and REG_C. Then, the linear and non-linear moderating effects of REG_C on the relationships between TEC_D, ORG_D and EVAL were tested (Models 6–9).

As n = 30 observations in Panel 5, "Cultural and creative economy" and n = 28 observations in Panel 9, "Finance" had the same covariate patterns (100 % of applications were not selected for funding), such observations were completely determined (i.e. the probability of EVAL = 0 was predicted perfectly). As including such observations in the empirical analysis would have led to biased standard error estimates, we decided to exclude them from the model (n = 2306) and to run robust standard errors estimates. We performed *t*-tests and chi-squared tests on the two groups on all the variables to be included in the model. As no statistical difference between the groups was found at the $p = 0.05$ level, we concluded that no significant selection bias hindered our analysis.

Table 4 reports the coefficients of the regression models estimated in terms of ordered log-odds.

The interpretation of the ordered logit coefficient is that for a one-unit increase in the predictor, the outcome variable is expected to change by its regression coefficient in the ordered log-odds scale (i.e. the log-odds of moving in a higher EVAL category – from "Not selected for funding" to "Seal of Excellence" and from "Seal of Excellence" to "Awarded funding"- are expected to change by the regression coefficient), given the other variables are held constant in the model.

4. Results

The results of this study support the contention that technological distance among actors at the network level has a positive effect on the

Table 3
Descriptive statistics and pairwise correlations.

	Variable	N	Mean	SD.	Min	Max	(1)	(2)	(3)	(4)	(5)
(1)	RIPI	2364	0.60	0.16	0	1	1				
(2)	TEC_D	2364	0.76	0.16	0	1	0.053	1			
(3)	ORG_D	2364	0.70	0.17	0	1	0.085	0.493	1		
(4)	Sh_PRB	2364	0.76	0.18	0.2	1	−0.002	−0.476	−0.329	1	
(5)	P_Part	2364	1.64	0.96	1	8	0.025	−0.009	−0.044	0.002	1

probability of being awarded funding. In Model 2, the ordered log-odd (logit) coefficient estimated for TEC_D has a positive and significant value ($\beta_{TEC\_D} = 2.514$, $p = 0.000$). This means that SMEs with non-proximate technological linkages from their partners will have a significantly higher probability of being selected for funding. Similarly, organizational distance among partners in the network raises the probability of success, although the estimated coefficient for COG_D indicates a lower impact ($\beta_{COG\_D} = 0.832$, $p = 0.041$).

In Models 3 and 4, we test the hypothesized curvilinear relationships between TEC_D, ORG_D, and EVAL. The coefficient for the squared term of technological distance (TEC_Dˆ2) is negative but not significant, indicating a linear relationship between technological distance and the probability of success, so we find only partial support for hypothesis H1. However, the significant and negative coefficient for ORG_Dˆ2 ($\beta_{ORG\_D\hat{}2} = -4.089$, $p = 0.011$) strongly supports the hypothesis (H2) that organizational distance among partners has curvilinear relationship with the probability of being selected for funding.

To provide further evidence in support of this result we run a null hypothesis test for two slopes, one at the low range of COG_D (COG_D_L) and one at the high range of COG_D (COG_D_H). This test, originally proposed by Sasabuchi (1980) is considered appropriate to show evidence of an inverse U-shaped relationship when the relationship is increasing at low values of the COG_D interval (COG_DL) and is decreasing at high values of the COG_D interval (COG_D_H) and both the slopes are significant (Lind and Mehlum, 2010). Finally, an appropriate *U* test was run by estimating the 95 % confidence interval of the turning point of the relationship between EVAL and COG_D. The test shows evidence of a U-shaped relationship when the confidence interval is located within the range of the independent variable (COG_D).

Test statistics for the two slopes, the results of the Appropriate U-shaped test and the derived Fieller interval are reported in Table 5. Further robustness checks are reported in the Appendix.

Fig. 1 illustrates the predicted relationship between ORG_D and EVAL. To ease the interpretation of the results we separately report the estimated relationships between ORG_D and the predicted probabilities of being awarded the Seal of Excellence Pr(EVAL = 1) and to be awarded with funding Pr(EVAL = 2). The turning points of the relationship between ORG_D and the predicted probability of being awarded the Seal of Excellence (left side) and to be awarded with funding (right side) are quite close to ORG_D_H, and the slope of the curves at ORG_D_H are negative, steep and both statistically significant. We conclude that there is a significant U-shaped relationship over the range of the data, and that the results support H2.

Considering the geographical characteristics of the network, the estimated coefficient for RIPI in Model 5 is positive and significant ($\beta_{RIPI} = 1.092$, $p = 0.000$), providing support to the hypothesis (H3) that SMEs in regions with above-average innovation performance have a higher probability of benefiting from the program, as for RIPI indicating that the geographical characteristics of the partners' origin have an influence on the outcome variable.

Thus, in Model 6, REG_C is included to split the effects for geographically different networks (i.e. networks of partners from EU regions in different performance groups vs. networks of partners from regions in similar performance groups), considering networks composed of partners from above-average performance regions (i.e. innovation leaders and strong innovators) as the baseline. The estimated coefficient for REG_C assumes a negative and significant value for networks of partners from heterogeneous performance regions ($\beta_{REG\_C=2} = -0.452$, $p = 0.001$), and a negative and non-significant value for networks of partners from below-average performance regions. Our results therefore suggest that SMEs in below-average innovation performance regions are not likely to benefit from the policy instrument even if they join external networks of partners from above-average innovation performance regions. The negative coefficient of REG_C in geographically heterogeneous partnerships indicates, in other words, that despite attempting to enlarge the population of participating SMEs and first-time applicants, the policy instrument apparently fails to reward actors connected from different types of EU regions.

Models 7–8 test the moderating effects of REG_C on the predicted relationship between the network characteristics (TEC_D and ORG_D) and the outcome variable (EVAL). While the main effects confirm that TEC_D and ORG_D retain a strong and positive influence on the probability of success, only the interaction term between ORG_D and REG_C is statistically significant for geographically heterogeneous partnerships, with a positive value of the coefficient ($\beta_{REG\_C=2}\#ORG\_D = 2.379$ $p = 0.007$). This result indicates that, when SMEs and other actors from different types of regions are involved in the network, a higher organizational distance does not have decreasing returns and can enhance the likelihood of success.

Fig. 2 illustrates this relationship, showing that when partners from above-average and below-average innovation performance regions (REG_C = 2) are involved in the network both the probability of being awarded the Seal of Excellence (left side) and to be awarded with funding (right side) will be higher at higher levels of ORG_D. Finally, no evidence is found in support of the non-linear moderating effect of REG_C on the relationship between ORG_D and EVAL (H4). Model 9 shows a non-significant coefficient for both the linear and the quadratic interaction terms. This result reinforces the contention that the positive effect of organizational distance on the likelihood of success will be strengthened (increasing benefits from partners' diversity) when SMEs join networks of heterogeneous regions.

Table 6 summarizes the hypotheses and the findings of the study.

Table 5
Tests of the inverse U-shaped relationship between ORG_D and EVAL.

Dependent variable: EVAL		
Slope at ORG_D_L	$\beta + 2\beta_2\ ORG\_D_L =$	6.695 (0.00)
Slope at ORG_D_H	$\beta + 2\beta_2\ ORG\_D_H =$	−2.765 (0.01)
Appropriate U test	t-value	2.18 (0.01)
Turning point	$-\beta/(2\beta_2) =$	0.708 (0.00)
95 % confidence interval for the extreme point, Fieller method		[0.601; 0.814]

Note: p-values in parentheses, confidence interval in squared brackets.

Table 4
Ordered logistic regression (dep. variable: EVAL).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TEC_D		2.514***	4.594	2.755***	2.707***	2.771***	2.895***	2.853***	2.875**
ORG_D		0.832**	0.884**	6.162***	6.351***	6.695***	6.644***	3.967*	3.575
TEC_D^2			−1.516						
ORG_D^2				−4.089***	−4.297***	−4.730***	−4.696***	−3.817**	−3.403
RIPI					1.092***	0.747**	0.746**	0.770**	3.540
REG_C: *(base: REG_C = 3)*									
REG_C = 1						−0.091	0.801	−0.210	1.873
REG_C = 3						−0.483***	−0.479	−2.253***	−2.796
Linear moderating effects									
REG_C#TEC_D							−1.117		
REG_C = 1							−0.005		
REG_C = 3									
REG_C#ORG_D									
REG_C = 1								0.152	−6.318
REG_C = 3								2.379***	4.099
Non-linear moderating effects									
REG_C#ORG_D^2									
REG_C = 1									4.713
REG_C = 3									−1.281
Sh_Prb	−0.174	0.945**	0.863**	1.012***	0.920**	0.818**	0.821**	0.855**	0.867**
Coord	0.056	−0.046	−0.042	−0.016	−0.027	−0.042	−0.039	−0.036	−0.036
P_Part	0.371***	0.384***	0.383***	0.397***	0.395***	0.404***	0.407***	0.418***	0.418***
Industry dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
Panel dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES
cut1	2.268	5.806	6.448	7.668	8.205	7.571	7.673	6.224	6.134
cut2	3.117	6.665	7.308	8.528	9.069	8.441	8.542	7.095	7.005
Number of obs.	2306	2306	2306	2306	2306	2306	2306	2306	2306
Pseudo r-squared	0.051	0.066	0.066	0.068	0.073	0.078	0.078	0.081	0.081
Chi-square	163.75	193.68	194.13	191.29	209.59	204.79	205.47	205.90	211.07
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Akaike crit. (AIC)	2466.70	2433.60	2435.17	2429.59	2419.39	2411.80	2415.33	2408.03	2411.05
Bayesian crit. (BIC)	2644.74	2623.12	2630.44	2624.86	2620.401	2624.30	2639.32	2632.01	2646.52

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6
Summary of hypotheses and findings.

Hypotheses		Findings
H1	At the network level, the degree of technological distance between an SME and its partners is curvilinearly related to the probability of being selected for funding (taking an inverted U shape).	Partially supported
H2	At the network level, the degree of organizational distance between an SME and its partners within the network is curvilinearly related to the probability of being selected for funding (taking an inverted U shape).	Supported
H3	At the firm level, the stronger the innovation performance of the region where an SME is located, the greater the probability of being selected for funding.	Supported
H4a	At the network level, geographical heterogeneity in the composition of the network is negatively related to the probability of being selected for funding.	Supported
H4b	A flattening in the curvature of the inverted U-shaped relationship between organizational distance among partners and the probability of being selected for funding will occur when partners from above-average and below-average innovation performance regions are involved in the network.	Not supported

5. Discussion

This study explored the award outcomes of the FTI scheme, one of the most recent EU innovation policy initiatives under the Horizon 2020 program, explicitly targeting the formation of OI networks between SMEs and other organizational actors across EU regions. By considering the technological, organizational and geographical characteristics of European SMEs' OI networks, we examined whether and to what extent SMEs' strategic choices influence the probability of being awarded with funding by a recent OI-oriented policy initiative.

The distinctive characteristics of the FTI scheme as a case study program, along with the original dataset used for the analysis, enabled us to examine and empirically test the geographical, technological and organizational aspects of European SMEs' OI networks, and provide evidence of the influence of each dimension and their intersection on the effectiveness of such networks.

Our findings indicate that both the attributes of SMEs and their partners' locations across regions and the characteristics of SMEs knowledge-related links with other actors at the network level are significantly related to the allocation of funds through the program.

Regarding the geographical dimension, a positive and significant association is found between the innovation performance index of the EU region where SMEs are based and the likelihood of being selected for funding. In line with the notion of systemic innovation mechanisms (Cooke, 2001), introduced to explain regional heterogeneity in SMEs innovation, this result reinforces the contention that regional heterogeneity and SMEs' innovation are linked in a two-way relationship. Regional context specificities, such as the degree of development of technologies, institutions, and infrastructure, are connected to the performance of local firms in a mutually reinforcing manner (Hervás-Oliver et al., 2021b; Parrilli et al., 2020). Thus, these results support the idea that the quality of the local regional innovation systems, particularly the technological and institutional context, has an influence on the innovation capacity of EU SMEs within OI networks. Further, these results reinforce the contention that the interaction of systemic factors and local knowledge bases for entrepreneurship and SMEs, also extends to the formation and effectiveness of OI networks (Radziwon and Bogers, 2019).

However, contrary to the expectation that SMEs in more innovative regions would have a higher likelihood to be funded by the FTI program, we find that this probability becomes significantly negative when the OI network includes actors from lagging-behind EU regions.

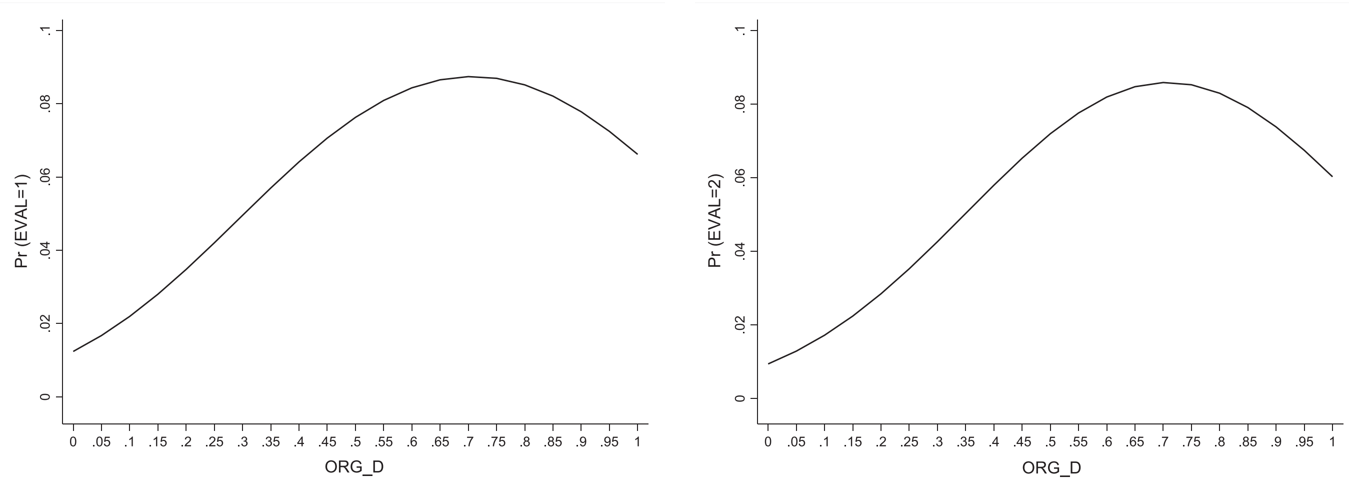

Fig. 1. Predicted relationship between ORG_D and EVAL.

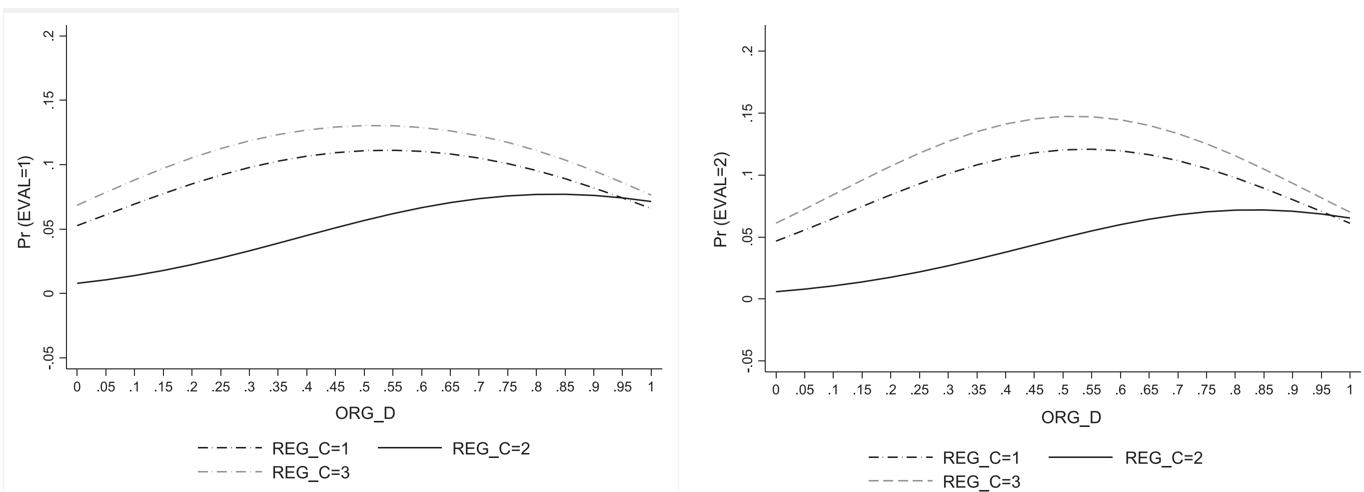

Fig. 2. Moderation effect of REG_C on the relationship between ORG_D and EVAL.

Beyond the established benefits of inter-regional collaborative networks in enhancing inventors' capacity to jointly create new knowledge for innovation (De Noni et al., 2018; De Noni and Belussi, 2021), when innovation networks include SMEs and other organizational actors in an OI setting, the capacity to translate scientific and technological advances into products, processes, and services with high potential impact may be influenced by relational, and context-related factors associated with the peculiarities of innovation modes in diverse EU regions (Hervás-Oliver et al., 2021b).

Adding to the geographical dimension, our hypotheses probe the composition of OI networks, to unravel the significance and the influence of different types of knowledge-related links between SMEs and their partners on the formation of successful partnerships. We specifically investigate the role of non-proximate linkages in technological and organizational knowledge among actors at the network level, and uncover distinct effects for each aspect.

First, our results indicate that the degree of technological distance among partners has a positive and significant association with the likelihood of receiving funding from the FTI program, partially offsetting the negative impact of other local factors. Regardless of their location, SMEs that join networks with technologically distant partners have a higher probability of success in the FTI program, and no cost-increasing (curvilinear) effects are observed in this regard.

In alignment with recent research demonstrating the positive impact of variety in the mix of industry/region pairs in networks of inventors on breakthrough invention performance (De Noni and Belussi, 2021), our results confirm the positive effects of technological distance between SMEs and other actors in OI networks spanning across EU regions. Specifically, in the context of the FTI scheme, our study suggests that the capacity of advanced regions to broaden their technological core across a wider technological spectrum results in a higher probability of deploying innovative concepts, even when the partnership involves actors from lagging-behind regions. This leads to a greater likelihood of receiving a positive evaluation in terms of technological excellence.

Second, we find that organizational distance among partners has a positive impact on the likelihood of being awarded with funding, as a result of a higher perceived network capacity. However, the benefits of organizational distance between SMEs and their partners across regions are subject to decreasing returns, suggesting that there is a point beyond which engaging with a variety of external organizations leads to increased coordination costs and communication problems when designing an OI project (Marullo et al., 2020). Interestingly, and adding to the large available evidence of the cost-increasing effects of "openness" (see, e.g. Faems et al., 2010; Laursen and Salter, 2006), we find robust evidence that when the network involves partners from polar types of EU regional innovation systems (i.e. above-average and below-average innovation performance regions), the benefits of organizational distance in supporting SMEs' innovation capacity are evaluated to outweigh costs.

In line with the discussion on the heterogeneity of the drivers and the effects of SMEs' collaborative innovation modes in EU regions (Audretsch et al., 2023; Hervás-Oliver et al., 2021a, b), our results indicate that different systemic mechanisms and institutional contexts regulating the interaction between SMEs and other organizational actors across EU regions do not conflict when the OI network is designed to support the positive influence of different types of innovation modes (Parrilli et al., 2020).

While SMEs and other organizations embedded in lagging-behind regions may encounter challenges related to knowledge exchange and transfer due to a lack of local knowledge spillovers and weak institutional contexts (De Noni et al., 2018), their efforts to develop and exploit OI projects with actors from advanced regions seem to positively contribute to supplementing and integrating knowledge available locally with innovation assets acquired from external sources through informal interaction mechanisms facilitated by an OI setting. Thus, our results support the hypothesis that, irrespective of regional specificities, the use of doing-using-interacting (DUI) innovation modes, typical of less advanced EU regions appears also crucial in supporting cross-regional OI networks (Parrilli and Radicic, 2021).

Accordingly, another novel aspect of this study is the discussion of the interaction between geographical factors at the regional level and relational factors at the network level, along with the evidence of their combined influence on the formation of successful SMEs' OI networks across Europe.

The findings have implications for both management and policy, and suggest directions for future academic research.

From a managerial perspective, the study underscores the significance of geographical, technological and organizational aspects within SMEs' OI networks. It does so by examining the impact of each dimension and their interactions on the allocation of EU funds through the FTI program. These aspects hold high relevance in guiding SMEs' strategic decisions when they participate in publicly-funded OI networks.

Notably, the establishment of non-proximate technological and organizational linkages with external partners enables SMEs to partially offset regional imbalances in terms of innovation capacity and the quality of the internal institutional context.

Regardless of their location, SMEs that join OI networks characterized by significant technological distance between partners will have a greater probability of success. The diversity in in the technological knowledge base enhances their opportunities to expand the collaboration space and access new relevant knowledge from larger interdisciplinary networks.

Similarly, organizational distance from partners in the network is a success factor for SMEs joining OI networks, especially those based in lagging-behind regions.

This may reflect the perception that establishing non-proximate linkages among organizations facilitates the creation of value chain effects, integrating R&D, manufacturing, support services, and commercialization, which positively influences the probability to be awarded with funding.

However, SMEs should be aware that, even if organizational distance enhances the positive effects of complementarities among actors, this effect is not limitless. We find evidence of diminishing returns over a certain degree of organizational distance between partners. At this point, challenges in communication and the emergence of coordination costs may outweigh the benefits of creating and maintaining diverse knowledge-based links.

Given the observed heterogeneity in the population of European SMEs, such findings can help SMEs evaluate the costs and benefits of participating in a diverse OI network and determine optimal positions that balance benefits and costs.

However, these findings also suggest that, despite encouraging the formation of OI networks among actors from different European countries, the FTI program was not particularly effective in connecting SMEs with other organizations across heterogeneous regions in Europe.

This topic holds relevance in the ongoing debate on European innovation policies, because the FTI represents the first policy instrument explicitly built around the concept of OI, with the aim of targeting a broader population of EU SMEs and first-time applicants compared to prior measures (e.g., the SMEI), where EU funds were mostly awarded to individual beneficiaries. In this context, the study provides an initial evidence base regarding the effectiveness of SMEs OI networks across EU regions.

From a public policy perspective, these results suggest that a one-size-fits-all approach, as witnessed in the examined EU innovation policy, may not be adequate in addressing the unique challenges and opportunities that SMEs face when building OI networks across the various regions of the EU.

Such an approach may fail to recognize the specificities of the regions where SMEs operate and the different types of external linkages they need to develop for innovation (Hervás-Oliver et al., 2021a).

In light of these findings, policymakers should consider a more nuanced and place-based approach to innovation policy. This approach would acknowledge that EU regions largely vary in terms of their innovation capacity, institutional contexts, and relational mechanisms. Therefore, designing targeted policy instruments that can effectively support the diversity of SMEs and the regions they are located in is crucial.[1]

Policymakers should acknowledge the unique strengths and weaknesses of different EU regions in terms of innovation, and support the formation of synergies between different innovation modes. Recognizing that SMEs in less advanced EU regions require different types of external linkages to thrive, policies should encourage and facilitate connections with external partners, located outside their immediate region, which can bring valuable knowledge and resources. This could involve providing resources for technology transfer, innovation hubs, or mentorship programs that connect SMEs with experienced innovators in advanced regions.

6. Conclusions and future research

The study represents an exploration of the allocation of EU funds by the FTI scheme, targeting SME OI networks across EU regions in the period 2018–2020. Adopting a standpoint that seeks to explain the factors influencing the success of SME applications to the program, it represents a contribution towards understanding the significant characteristics that shape success in the formation of EU OI networks and provides an empirical basis for the planning and evaluation of future programs and policies impact.

From a conceptual perspective, the study tested whether factors in the OI and economic geography literature viewed as being important in SME innovation processes were also reflected in the FTI program funding decisions.

The study highlighted the relevance of geographical elements as one of the primary factors that should be considered in the design of policy instruments promoting the formation of OI networks among SMEs and other organizational actors. These elements were somewhat underemphasized among the FTI evaluation criteria. Evidence is provided of the relationship between the “innovation strength” of the regional systems where SMEs and their partners operate and the likelihood of

[1] In February 2023, the 2023–2024 Interregional Innovation Investments (I3) instrument Work program was released by DGREGIO, the European Innovation Council and SMEs Executive Agency (European Commission, 2023). Starting from the second quarter of 2023 the program will support cooperation in shared or complementary smart specialization areas of EU countries for innovation addressing societal challenges. The program is intended to support innovation and the development of value chains in less developed regions by promoting interregional cooperation.

success in the program. Thus, innovation policies aiming to expand the target population of recipient SMEs without considering the influence of regional differences may effectively be pursuing a strategy that reinforces existing regional inequities. This could result in favoring SMEs in stronger innovation systems while overlooking capable SMEs in weaker regions (Cantner and Kösters, 2012; Hervás-Oliver et al., 2021b).

At the network level of analysis, knowledge linkages between SMEs and other actors in OI networks assume crucial relevance when the network includes partners based in regions with below-average innovation performance. The study demonstrates the positive influence of technological distance among actors in the network on EU funding allocation and the enhancing effect of organizational distance when OI networks involve actors from regions with varying performance levels. Thus, relational factors in OI networks appear to compensate for the effect of imbalances in EU regions on innovative success.

The study yields intriguing results at the intersection between the OI framework and the Science and Technology-based Innovation (STI) / learning by Doing-Using-Interacting (DUI) framework of regional innovation modes (Hervás-Oliver et al., 2021a, b). By explicitly addressing the substantial heterogeneity of regions across the EU geography, our results confirm the relevance of systemic factors to the formation of effective OI networks (Radziwon and Bogers, 2019).

To deliver the best outcome for a larger population of SMEs, especially those located in lower performance regions, our findings emphasize that EU innovation policies should explicitly encourage the integration of partners across technological, scientific, and organizational knowledge domains, to enable synergies between different innovation modes.

While the STI mode, typical of advanced regions, consistently enhances the probability of success by favoring SMEs access to broader knowledge networks, the DUI mode plays a crucial role in enabling SMEs to fully harness the advantages of organizational diversity. This dynamic is particularly relevant in the context of our study's findings, which highlight the significance of relational factors within OI networks and their ability to compensate for innovation performance imbalances in EU regional innovation systems.

This study has revealed significant synergies between the OI framework and the STI/DUI framework of regional innovation modes. In our analysis, we explore two dimensions within SMEs' OI networks—geographical and relational—which closely align with the key components of the STI/DUI framework, allowing for a regionalized analysis of various innovation modes.

Future research should delve deeper into the relationship between geographic elements (characteristics of the territorial contexts), regional innovation modes (STI and DUI drivers), and the success of OI initiatives. This could involve comparative studies across regions with varying innovation modes, particularly within the context of other EU funding programs. Research could also focus on exploring the geographical aspects of SMEs' OI initiatives, particularly in the context of innovation drivers and barriers. Given the observed heterogeneity in SMEs' OI motives, and the extensive literature on the opportunities and challenges of OI in SMEs, future research could investigate which specific factors at the territorial level may influence the formation of effective OI networks.

Finally, building on the idea that technological and organizational distance among partners in OI networks can compensate for regional innovation imbalances, future research could investigate how regional innovation policies can be designed to support SMEs in lagging-behind regions while still benefiting from OI networks that may include partners from more advanced regions.

The study is not exempt from limitations. Only one program, albeit a significant one, is examined, and the study is not able to estimate the effects of the funding allocations on participant SMEs. The study thus represents a first assessment of the FTI program outputs in terms of funding selection categories and not a long-term evaluation of effects of program participation and funding on the innovation performance of SMEs and their networks. Quantifiable factors that characterize the applicants, networks, regions and funding decisions are considered, but we are unable to assess qualitative evaluation factors.

CRediT authorship contribution statement

Cristina Marullo: Conceptualization, Methodology, Data curation, Formal analysis, Writing - Original draft, Writing - Review.

Philip Shapira: Conceptualization, Methodology, Writing - Original draft, Writing - Review.

Alberto Di Minin: Conceptualization, Data curation, Writing - Original draft.

Data availability

The data that has been used is confidential.

Appendix A. Supplementary data

Supplementary data for this article can be found online at https://doi.org/10.1016/j.techfore.2024.123207.

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