Spatial Proximity Versus Social Distance: Partnership Development in the Cross-Border Cooperation

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Abstract
Since the 1990s, the European Commission has paid great attention to innovation processes and knowledge transfer, stimulating and financing several research and cooperation programs. Recent geopolitical transformations have shifted attention towards the integrations between the European Member States and the Neighboring Countries. Literature produced many contributions over the past two decades with a focus on knowledge sharing, space dimension, and the role played by each actor involved within networks analyzed, but a lack remains in the field of cross-border cooperation. This research gap is addressed in this paper by investigating the main dynamics that led to new partnerships and networks of collaboration. Spatial proximity, social distance, and the individual characteristics are analyzed taking into account the relations that influence the decision to cooperate. Data are collected considering the first call for proposal of the Interreg IPA CBC Italy Albania-Montenegro Programme, analyzing both the effects of social and geographical distance, beyond the effects of individual characteristics of each partner involved. The results suggest that network effects are present; social closeness is significantly associated with partners’ choice and this indicates that connections within a network are influenced by the position that each node assumes; consequently, the network effects are more relevant than the spatial one.

Keywords  Geographical distance · Centrality · Network dynamics · Cross-border cooperation · Collaboration choices · Spatial proximity · Individual characteristics

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Introduction

Cross-border cooperation is defined as institutionalized cooperation between regional and local authorities in the border area of neighboring countries. Therefore, thus cooperation within the EU and the EU’s external borders aims at managing issues that transcend the confines of individual communities — issues that include economic development, knowledge transfer, and more generally all the innovation processes (Perkmann, 2003; Popescu, 2008; Scott, 2015). The focus on innovation has influenced priorities and strategic objectives of EU Cohesion Policy in the last decade, directing attention to new tools aimed at creating new collaborative models (Hassink & Klaerding, 2012; Knoben & Oerlemans, 2012; McCann & Ortega-Argiles, 2013). Many of these models are implemented through funding programs, in which the actors of the network (public or private beneficiaries) cooperate for common outputs realization. If, however, cooperation, on the one hand, allowed beneficiaries to expand the network of relationships (Burt, 1992; Granovetter, 2018; Fagerberg et al., 2004), on the other produced problems of information asymmetries due to the fragmentation of knowledge and capabilities among network actors (Das & Teng, 1998, 2001; Huggins et al., 2008; Huggins, 2008; Johnston & Huggins, 2016; Lokshin et al., 2011). Literature on cooperation and interaction among actors of networks has been growing stronger over the last decades putting particular attention to the link between knowledge production and the number and typology of actors involved (Lee et al., 2019; Wagner et al., 2019). These studies mainly focused on the spillovers that individual characteristics of actors like size, absorptive capacities, or appropriability conditions have on the incentives to cooperate. With this regard, the position of an actor within the network is considered a key determinant of cooperation (Bala & Goyal, 2000) and it is an important driver to understand the “network effects” (Buhai & Van der Leij, 2006). Another key factor widely studied in the literature concerns the role of the “space” dimension. Several authors stated that geography matters can influence the innovation process and consequently, the way knowledge is exchanged among actors of a network due to the interpersonal relationships and face-to-face contacts (Ahuja, 2000; Almeida & Kogut, 1999). Cooperation processes between individuals can also be favored by spatial proximity and spatial concentration of activities reinforcing the concept that innovation processes can be influenced by denser local networks of collaboration (Breschi & Lissoni, 2003). Another important aspect, widely discussed in the literature, is the fact that within a network, actors are not all equal, and an investigation of the different types of partners involved in joint innovation activities may contribute to explaining how the network was born and above all what outputs and results from this will produce over time (Ardito et al., 2019; Capaldo & Messeni, 2015). The beneficiaries’ internal knowledge — resulting from R&D activities, from processes of learning by doing and by using, and from formal and informal interaction among individuals within the organization, represents leverage for acquiring new collaboration. Even if the literature, in recent years, has provided multiple contributions on inter-firm collaborations, with particular attention to innovative performances generated by R&D alliances, the dynamics underlying the generation of
networks in cross-border cooperation are still little explored. The objective of this paper is, therefore, to provide initial ideas on the choices and motivations that lead public and private entities to join in a new partnership to develop specific thematic projects, through EU-funded cross-border activities. Thus, by integrating the streams of research on innovation processes, knowledge transfer, and network collaborations, the paper aims to answer the following research question:

**How Can the Individual Characteristics of a Beneficiary Influence Cross-Border Cooperation?**

The combination of internal knowledge with external complementary knowledge is particularly important to develop innovation. Knowledge can be considered a collective good since its generation is the result of a process that combines pieces of information and knowledge that are owned by different actors and cannot be traded as such (Ardito et al., 2019). At the level of regions, regional economists and geographers have stressed that co-localization provides a fertile context for an innovation-based economy, because of localized learning processes and “sticky” knowledge founded on social interaction. However, these studies have also highlighted the importance of knowledge sources external to the regions, because they can sustain regional innovative capability and avoid lock-in by opening regions to the outside through the establishment of global relationships (Lechner & Dowling, 2003). Several studies have pointed out that proximity dimensions are crucial to elucidate the innovative outcomes of partners collaboration because they alter the effectiveness with which knowledge, problem-solving approaches, and objectives are shared among partners. However, barriers (Ardito et al., 2019) that emerge in partner relationships cannot be underestimated. In many cases, there is a tendency to develop strong and trustworthy relational ties with local partners, as well as to generate environmental knowledge that is sticky and, in turn, hard to transfer to geographically distant nodes (Jaffe et al., 1993). More in detail, geographical distance limits partners’ ability to interact repeatedly and, hence, develop, learn, and adjust over time the idiosyncratic languages needed for sharing and retaining fine-grained and tacit information, as environmental knowledge. The resulting cognitive barrier is exacerbated by differences in cultures and values, which further undermine the ability to establish effective interactions and pursue common environmental objectives. The considerations previously presented lead us to propose a second research question:

**How Can the Network Characteristic and Spatial Effects Influence Cross-Border Cooperation?**

To answer our research questions, we develop hypotheses and test them based on a sample of 152 program beneficiaries, within 32 projects, financed during the first call for proposal of the Interreg IPA CBC Italy-Albania-Montenegro Programme in the 2014/2020 period, funded by the European Commission and managed by Puglia Region (Italy). The paper analyzes some factors, including individual characteristics of public and private territorial actors, spatial effects, and network dimension, that
influence the decision to cooperate and ensure that the transition of territory from its state of “periphery” to that of “center” is subordinated to a combination of methodological contents and actions including skills, mobility, and attention to supply chains and partnerships. Results reveal that social proximity is significantly associated with partner choice and some partners play an intermediate role among central and peripheral nodes thanks also to their specific individual characteristics. The paper is structured as follows: in the next section, the theoretical background is presented. In detail, the analysis looks at the individual characteristics of the partners as facilitators of collaborative links. Then, spatial and network effects are presented as key factors to understand links among actors of a network and the way geographical proximity can influence collaboration choice (Ponds et al., 2007). Afterward, the methodology and results are presented. Finally, we discuss the main findings, implications, and future research directions.

Theoretical Background and Hypotheses

Successful implementation of cross-border cooperation not only depends on the state institutions’ capacity to guide and coordinate activities during the program implementation but it also depends on the potential user’s ability to generate effective cross-border projects. Cross-border cooperation is therefore reflected in the joint activities and harmonized coordination of appropriate partnerships. For this reason, it is important to carefully evaluate the actors to be involved taking into account, the characteristics and skills of each one, the geographical location, in which activities are carried out, and the number and types of relationships made available to the network (Ardito et al., 2019; Petruzzelli, 2008, 2011).

The Effects of Individual Characteristics

To understand the emergence of new partnerships is necessary to take into account the individual characteristics of each partner and the relations that influence the decision to cooperate. Cooperation is based on heterogeneous organizations, varying widely in terms of specialism, research intensity, and quality, that decide to put their knowledge in common (Geuna & Muscio, 2009). Consequently, the characteristics of a partner involved in collaborative partnerships may have an important bearing on the development and nature of these links. The degree to which a partner can share the knowledge it creates is also attractive to potential collaborative partners (Huggins et al., 2008. Consequently, the reputation and the quality of its outputs are potentially important drivers of collaborative linkages, acting as a signal of quality and highlighting the fact that they are likely to be reliable and effective partners (Ardito et al., 2019; Capaldo & Petruzzelli, 2014; Hewitt-Dundas, 2012; Huggins et al., 2008; Laursen et al., 2011). Starting from the considerations, the first research question (RQ) this paper aims to addresses is:
In a Cross-Border Cooperation Programme, The Probability of Collaboration Depends on the Individual Characteristic

Literature assumed that in bilateral collaborations, the benefits, in some cases, result from the individual characteristics of the involved actors, in others, the network formation theory suggests, that, to assess the benefits from a bilateral relationship, it is crucial not only the individual partner’s knowledge but also the knowledge that each partner can access through the own network of collaborations. The characteristics of a partner are also important in moderating the uncertainty associated with establishing linkages as these provide clear signals as to the competencies and capabilities of each institution. Hence, the process of partner selection concerns searching for an appropriate partner rather than a nearby partner. The characteristics of the partner in terms of its ability to collaborate and share the appropriate knowledge may increase the propensity for links that may or may not be aided by the geographic proximity of the two.

Network Effects and Centrality Analysis

According to Burt (Burt, 2009), a social network is a group of collaborating entities (i.e., actors) that are related to one another. Mathematically, a network can be represented as a graph, wherein each participant is called an actor and depicted as a node in the network. Actors can be people, organizations, groups, or any other set of related entities. Relations between actors are depicted as links between the corresponding nodes. The creation of new program partnerships may be due to network effects that are created among the partners. The position of the partners in the network of inter-company partnerships is important. The centrality analysis of partners is therefore interesting because the concept of centrality is linked to the sociological concept of power (Messeni Petruzzelli & Murgia, 2020). Social power is, in itself relational, based on the power of ego and the dependence of alter from ego. Power can therefore be studied as a consequence of certain patterns or relationships patterns, variable in time, and space. To study power about its distribution in a network, both micro-based measures are used, based on the relationships that exist among the actors in a given neighborhood of ego, and macro-type measurements by looking at the entire network as a whole. In particular, the centrality degree, according to Freeman’s approach (Freeman, 1977), identifies and quantifies the direct links that connect the partners within the network. According to the meaning generally attributed to this index, the partner with the highest grade represents the center of the network, on the contrary, the actors with the lowest degree represent the peripheral portions of the system being studied. Nevertheless, the limit of this indicator is that it considers only the adjacent nodes and does not isolate those positions that, despite being peripheral, allow to convey several relevant information coming from indirect links. On the other hand, the Bonacich approach (Bonacich, 1987), based on an iterative process of simultaneous equations, aims to introduce a corrective to Freeman’s measure, called beta centrality. Bonacich does not consider centrality synonymous with
power a partner can be central but not have power. Power grows when a partner is connected to other partners who are not connected to others, this increases the power of the main partner and makes others dependent on him. Other centrality measures, based on the concept of proximity made operational through the calculation of the distances between the nodes of the network (indirect paths), have been calculated. In particular, centrality as closeness, called closeness centrality (Freeman, 1978; Valente & Foreman, 1998), is the sum of the geodetic distances of each actor from all others. Consequently, a node is more central if it is at the shortest distance from many other nodes, i.e., it is close to many of the other points, in this sense, we can say that proximity is the reciprocal of the sum of distances. On the other hand, the measure of proximity/similarity based on reachability is calculated as a proportion of other nodes that ego can reach with the $k$ step. $K$-step reaches centrality is defined as the number of distinct nodes within $k$ links of a given node (Borgatti, 2006), therefore counting the number of nodes, each node can reach in $k$ or fewer steps. One issue with interpreting $k$-step reach in terms of the ability to receive/send from/to other nodes is that it assumes that paths of length $k$ are just as certain and as high quality as paths shorter than $k$. A better approach might be to weight the nodes being counted inversely by how far away they are. This measure (or one proportional to it) is referred to as average reciprocal distance (ARD). This measure which avoids the problems associated with disconnected networks is the reciprocal distance between all actors. ARD is attractive because it can be used without special considerations for transforming disconnected networks or modifying the algorithm in the presence of undefined distance (Borgatti, 2006). Alternatively, eigenvector centrality is a measure of the importance of a node in a network. It assigns relative scores to all nodes in the network based on the principle that connections to high-scoring nodes contribute more to the scores of the node in question than equal connections to low-scoring nodes (Bonacich, 1972). Finally, betweenness centrality is an important centrality measure that allows identifying the nodes that act as a bridge by analyzing the possibility of interacting with non-adjacent actors through collaboration with other nodes (Ardito et al., 2019; Freeman, 1978). The betweenness allows therefore to highlight the function of the nodes that act as intermediaries and which, consequently, play an important role and cover a delicate position that allows them to exercise a power of control over the information flow they convey. The concept of betweenness recalls the geodesics, or the shorter distances present within the network, and is based on the calculation of the number of times each node is on the paths that connect other nodes of the graph. This indicator, therefore, regards the degree of the interposition of an actor on the paths that connect the pairs of nodes belonging to the network and provides the degree of control of the information conveyed by the relationships. Therefore, this metric measures how much a partner is an intermediary between two other partners within a network. For this reason in the second domain of analysis, the centrality of an actor and social network analysis is analyzed through 3 research questions:
(H2) — In a Cross-Border Cooperation Programme, The Probability of Collaboration Depends on the Social Distance (Distances 1, 2, and 3)

It is assumed that cooperation among partners may increase as the number of direct and indirect links\(^1\) with other partners in the funding program increases. However, in cooperation contexts between multiple partners, it is necessary to take into account the problems of appropriability of knowledge that may arise (Capaldo & Petruzzelli, 2014; Petruzzelli, 2008). In particular, in such situations, it is necessary to find a compromise between the need to increase direct partners and consequently also indirect partners, to absorb the greatest number of knowledge. On the other hand, there is a need to reduce the number of partners, to control the dissemination of one’s knowledge. In this case, the effect of the number of direct and indirect connections could be negative.

(H3) In a Cross-Border Cooperation Programme, The Probability of Collaboration Depends on the Social Proximity (Centrality Measure)

In general, collaborative connections can and do develop over significant distances, and in trying to explain this result, scholars emphasize the importance of non-spatial closeness in link development. Typically, non-spatial proximity is conceptualized as network effects seen as the degree of closeness of a partner to other network partners. The collaboration among partners could be favored by the presence of network effects, consider for example two partners \(i\) and \(j\) connected, think also of the connection between the \(j\) and \(k\) partners, then it is possible to hypothesize that also \(i\) and \(k\) partners are connected indirectly and this can lead to greater ease of dissemination of knowledge within the network (Johnston & Huggins, 2016).

(H4) In a Cross-Border Cooperation Programme, The Probability of Collaboration Is Inversely Proportional to the Number of Links with Indirect Partners

Network effects are based on network opportunities that can develop among partners. Often, companies set limits to the dissemination of the knowledge acquired for fear that other companies could appropriate it. However, this represents a limited situation. Very often, however, there are intermediate situations, where information about possible partners spread through previous knowledge (Barabási et al., 2002; Newman, 2004). In literature, it is possible to find numerous contributions in which it is shown that previous collaborations in common favor the circulation of information by reducing the cost that would be incurred by activating new collaborations (Fafchamps et al., 2006; Granovetter, 2018).

\(^1\) A link is defined direct when is established between two actors of the network, indirect when between two actors there are one or more other actors.
Spatial Effects

Finally, the emergence of new partnerships may depend on the geographical location of the partners. This may affect the incentives to cooperate, for example, a greater spatial distance can increase the coordination costs and reduce the emergence of relations among the partners. In this context, the last research question this paper aims to addresses is:

(H5) — In a Cross-Border Cooperation Programme, The Probability of Collaboration Depends on the Geographical Distance

The composition of the partnership could also be influenced by the geographical location of the partners (Morgan, 2004; Muscio, 2013; Ponds et al., 2007; Sonn & Storper, 2008. The greater spatial distance between partners can increase coordination costs and reduce the dissemination of knowledge. As a result, there could be spatial concentration among the partners. On the contrary, geographical proximity improves knowledge transfer (Wood & Parr, 2005). Indeed, geographic proximity may be an important factor in moderating the uncertainty that surrounds developing collaborative linkages. As the result, geographical proximity among partners allows to observe the actions and promotes trust between the two parties, improving knowledge transfer (Johnston & Huggins, 2016; Owoo & Naudé, 2017). Despite the advantages of geographical proximity highlighted in the literature, scholars are increasingly emphasizing the global nature of inter-organizational networks (Bathelt, 2005; Bathelt et al., 2004; Maskell et al., 2006). In some studies, indeed, the geography of innovation (Breschi & Lissoni, 2003) refers to the spatial effects which result in network effects (Capaldo & Messeni Petruzzelli, 2015). On that occasion, knowledge would spread locally because the networks of interpersonal relationships would be facilitated by geographical proximity (Gallié, 2009). For this reason, in the present, research will be verified whether some specific effects due to geographical proximity occur or not. In particular, it will be tested if geographical proximity favors the formation of a partnership.

Methodology

The Border of the Empirical Analysis: The Program Characteristics and Constraints

The empirical analysis undertaken in this document falls within the European Territorial Cooperation (ETC) with a focus on cross-border cooperation (CBC). The specific Programme analyzed is the Interreg IPA CBC Italy-Albania-Montenegro, co-funded by the European Union through the Instrument for Pre-Accession (IPA II) and managed by Puglia Region (Italy). The overall objective of the Programme is to enhance strategic cross-border co-operation for smart and more sustainable development of the Programme area, mainly across the maritime border, facilitating the exchange of knowledge and experience among regional and local stakeholders from the three countries, developing and implementing pilot actions, supporting
investment in the areas of interest. The program’s total budget is 92,707,558.00 euros (including 15% national co-financing) and eligible territories are Puglia and Molise Region and all Albanian and Montenegrin territories. The program provides, ex-ante, specific constraints and limitations to the partnership and collaboration formation, in particular: the Programme eligible area covers territories of 1 EU Member State (Italy) and 2 IPA Countries (Albania and Montenegro), and the minimum eligible partnership must involve at least one partner from each participating country, in other words, at least 1 partner from EU Member State (eligible territories of Italy) and at least 1 partner from each IPA Countries (1 partner from Albania and 1 partner from Montenegro). Furthermore, the total number of partners must not exceed the number of six partners, including the lead partner (LP), that is responsible for the management, communication, implementation, and coordination of activities among the involved partners.

Sample and Data

The proposals generated for the Interreg IPA CBC IT-AL-ME program were about 347, but only 185 were submitted. After eligibility and quality control, 32 projects were approved by the Joint Monitoring Committee (JCC) for funding with a budget distribution by priority axis consistent with the number of eligible projects:

- 24% for the first axis, out of 57 proposals submitted, 7 projects were funded;
- 40% for the second axis, out of 79 proposals submitted, 14 projects were funded;
- 22% for the third axis, out of 39 proposals submitted, 7 projects were funded;
- 14% for the fourth axis, out of 10 proposals submitted, 4 projects were funded.

Being the collaboration our main unit of analysis, to test the proposed hypotheses, we relied on the entire population of 159 private and public actors (program beneficiaries), operating through 32 project partnerships, financed during the first call for proposal of Programme, during the period 2018/2021.

Variables

Table 1 shows the description of each variable included in the analysis coming both from the Interreg IPA CBC Italy-Albania-Montenegro Programme database and from the elaboration of SNA software UCINET 6 for Windows (Borgatti et al., 2002), which calculates quantitative measures of network structure.

The frequency with which one partner participated in a project within the Interreg IPA Cross-border Cooperation Italy-Albania-Montenegro Programme represents the dependent variable of our model.

The study considers as independent variables the individual characteristics, priority axis of each partner, the network effects, and the spatial effects. Firstly, the individual characteristics are included through financial and structural variables. The financial variables include the total budget founded per partner, the average financial support obtained on the projects for each partner, and the gap
### Table 1: Description of the variables

| Hypothesis          | Variable name     | Variable description                                                                 |
|---------------------|-------------------|--------------------------------------------------------------------------------------|
| Individual characteristics | NProject          | Number of projects submitted by each partner (MProject)                              |
| TotBudget           | Total amount of financial support received per partner (MShareBud)                     |
| MeanBudget          | Average financials support of projects per partner (MBudget)                           |
| GapBudget           | Gap total amount of financial support obtained on projects by each partner (DBudget) |
| PartnerRoleLP       | Dummy variable indicating whether partner is a Lead Partner (1), 0 otherwise         |
| PartnerRolePP       | Dummy variable indicating whether partner is a Project Partner (1), 0 otherwise       |
| PartnerRoleLPandPP  | Dummy variable indicating whether partner is a Lead Partner and Project Partner (1), 0 otherwise |
| PartnerRoleAP       | Dummy variable indicating whether partner is a Associated Partner (1), 0 otherwise  |
| PartnerType         | Classification of partners by sector of economic activity                             |
| LegalStatus         | Legal status of the partners                                                          |
| Priority axis       | SO1 Frequency of partner participation in SO projects 1.1 Enhance the framework conditions for the development of SMEs cross border market |
|                     | SO2 Frequency of partner participation in SO projects 2.1 Boost attractiveness of natural and cultural assets to improve a smart and sustainable economic development |
|                     | SO3 Frequency of partner participation in SO projects 2.2 Increase the cooperation of the relevant key actors of the area for the delivery of innovative cultural and creative |
|                     | SO4 Frequency of partner participation in SO projects 3.1 Increase cross-border cooperation strategies on water landscapes |
|                     | SO5 Frequency of partner participation in SO projects 3.2 Promoting innovative practices and tools to reduce carbon emission and to improve energy efficiency in public sector |
|                     | SO6 Frequency of partner participation in SO projects 4.1 Increase coordination among relevant stakeholders to promote sustainable cross border connections in the Cooperation |
| Hypothesis         | Variable name         | Variable description                                                                 |
|--------------------|-----------------------|---------------------------------------------------------------------------------------|
| Network effects    | Distance1             | Number of direct partners for partner, at distance 1                                  |
|                    | Distance2             | Number of indirect partners for partner, at distance 2                                 |
|                    | Distance3             | Number of indirect partners for partner, at distance 3                                 |
|                    | RatioPartners         | Ratio of the number of indirect partners to the number of direct partners              |
|                    | NormalizedCloseness   | Degree of closeness of a partner to other network partners                              |
|                    | Normalized degree     | Degree of connectivity of a partner compared to other network partners                  |
|                    | Normalized beta centrality | Degree of connectivity of a partner compared to other network partners with a parameter $\alpha$ used for adjusting the importance of a partner’s degree versus a parameter $\beta$ for adjusting the importance of the neighbor’s centrality |
|                    | Normalized Avg. Recip. distance (N-ARD) | Shortness of path lengths among partners                                               |
|                    | Normalized Eigenvector | Degree of importance of a partner compared to other network partners                   |
|                    | Normalized Betweenness | Number of times a partner is along the shortest path among the other pairs of network partners |
| Spatial effects    | Average Geographical Proximity | Average physical distance between partners expressed in Km on the road               |
of the total amount of financial support obtained on projects by each partner. On the other hand, the structural variables include the role that the partner plays in the projects, distinguishing the case in which the partner is only lead partner, only project partner, and only associated partner, from the case in which the partner is both lead partner and project partner.

To enrich the analysis, individual characteristics were also considered the frequency with which a partner participated in a project related to the six different priority axis.

The network effects were studied by calculating the direct distance (k step 1) and indirect distance (k-steps 2 and 3) between partners, the ratio between independent partners on direct partners, and some centrality measures, such as degree, closeness, beta centrality, average reciprocal distance, eigenvector, and betweenness.

Finally, the spatial effects are measured by the average of physical distance between partners expressed in km on the road.

Method

The information deriving from the Interreg IPA CBC Italy-Albania-Montenegro Programme allows to represent the resulting network from collaboration among partners and therefore to verify the existence of network effects (Cantner & Graf, 2006).

It should be noted that two actors are considered to be connected if they have submitted a collaborative project together. This seems to be a reasonable definition of scientific knowledge and allows to identify direct and indirect partners and to calculate the social distance that separates the partners. Furthermore, the address of each participant is provided in the database of the Interreg IPA CBC Italy-Albania-Montenegro Programme, therefore the geographical distance, to evaluate the impact on the cooperation choices, can be calculated. Considering the above, the focus of this article is on the factors influencing the selection of partners in the projects related to the Interreg IPA CBC Italy-Albania-Montenegro Programme. First, the analysis looks at the individual characteristics of the partners as a facilitator of collaborative links. Secondly, spatial effects may play an important role in terms of moderating the uncertainty of entering into collaborative links (Storper & Venables, 2004). Finally, network effects may also be an important determinant of links between partners, and in some circumstances, it may integrate geographical proximity (Ponds et al., 2007). To assess which characteristics influence the composition of partnership in the Interreg IPA Cross-border Cooperation Italy-Albania-Montenegro Programme, a multiple regression model is used.
Results

Descriptive Statistics

The Interreg IPA CBC Italy-Albania-Montenegro Programme registered the participation of 159 partners for 32 funded projects, including 22.70% of private partners and 77.30% of public partners, as shown in Table 2. Moreover, in compliance with the minimum requirements for the partnership composition, most of the partners are project partners, while the associated partners are only 18.30%, respecting the constraint no more than one per partner. With reference, instead, to the type of partner that has participated most frequently in Interreg IPA CBC Italy-Albania-Montenegro Programme, there are interest groups including NGOs/no-profit organizations, municipality, and higher education/research center/universities, con 15.70%, 15.20%, and 14.70% respectively. On the other hand, concerning the priority axis, from the analysis of the results, it emerged that most of the projects were presented in the SO 2.1 “Boost attractiveness of natural and cultural assets to improve a smart and sustainable economic development” and followed in the SO 1.1 “Enhance the framework conditions for the development of SMEs cross border market,” with 28.90% and 21.56% respectively. The SO 3.2 “Promoting innovative practices and tools to reduce carbon emission and to improve energy efficiency in the public sector” recorded the lowest presence of projects registered with 5.05%.

In order to assess more precisely the role of the connected partners, the local network around them has been drawn (see Fig. 1). Note that, the network of relations between the partners of the projects funded in the Interreg IPA CBC Italy-Albania-Montenegro Programme was represented by using Gephi 0.9.2 (Bastian et al., 2009), an open source network visualization software, and using the Force Atlas 2 layout 2 (Jacomy et al., 2014). The partners most present in the various projects of the Interreg Programme are represented by a circle of greater diameter. Moreover, the strongest connections, highlighted by a greater line thickness, correspond with the links that are repeated several times within the program between the partners.3 Finally, the different colors of the lines connecting the nodes represent the 32 projects being examined.

Interestingly, it is also the centrality analysis of partners. According to Freeman’s degree centrality, the partners with major connections are the partners 142 (Puglia Region), 158 (Univerzitet Crne Gore), and 56 (Dhoma and Tregtisë dhe Industrisë, Tiranë) with 35, 31, and 29° (norms 22.2%, 19.6%, and 18.4%) respectively.

On the other hand, according to beta centrality, it can be deduced that, in addition to the partners with greater connections [142 (Puglia Region) and 158 (Univerzitet Crne Gore)] as emerged from the analysis of degree centrality, also the partner 154 (University of Salento) is a powerful actor due to the connection with other actors network and their mutual connections. This means that this actor has power in the network not for the greatest number of ties, but for the quality of the ties since this actor is connected to partners not connected to others and therefore dependent on him.

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2 Force Atlas 2 is a visual optimization algorithm that acts on the distance between nodes, aggregating those that are directly related.

3 Repeated links occur between partner 32 and 132, 32 and 56, 56 and 132, 33 and 105, 120 and 28, 115 and 104, 115 and 142, 158 and 157, and 158 and 129.
Table 2  Descriptive statistics of individual characteristics

| Indicator                                                                 | Network of project partners |
|---------------------------------------------------------------------------|-----------------------------|
| Role of partner:                                                          |                             |
| Lead partner                                                              | 14.70%                      |
| Project partner                                                           | 67.00%                      |
| Associated partner                                                        | 18.30%                      |
| Legal status of partner:                                                  |                             |
| Public                                                                    | 77.30%                      |
| Private                                                                   | 22.70%                      |
| Type of partner:                                                          |                             |
| Agency (national/regional)                                                | 10.60%                      |
| Business support organization                                             | 4.60%                       |
| Higher education/research center/university                                | 14.70%                      |
| Interest groups including NGOs/no profit organization                     | 15.70%                      |
| International organization, EEIG under national law                       | 0.90%                       |
| Local public authority                                                    | 11.10%                      |
| Ministry                                                                  | 2.30%                       |
| Municipality                                                              | 15.20%                      |
| National public authority                                                 | 12.40%                      |
| Other—Body governed by Public Law                                         | 1.40%                       |
| Other—Management body of protected area                                   | 0.90%                       |
| Other—National Technology Cluster acknowledged by the Puglia Region and MIUR; it is a non-profit organization | 0.50%                       |
| Other—Public institution in the field of culture, being the first (and only) public theater established in Montenegro |                             |
| Other—Science and Technology Park                                         | 0.50%                       |
| Regional public authority                                                 | 0.50%                       |
|                                                                             | 8.80%                       |
| Priority axis:                                                            |                             |
| SO 1.1 Enhance the framework conditions for the development of SMEs cross border market | 21.56%                      |
| SO 2.1 Boost attractiveness of natural and cultural assets to improve a smart and sustainable economic development |                             |
| SO 2.2 Increase the cooperation of the relevant key actors of the area for the delivery of innovative cultural and creative | 28.90%                      |
| SO 3.1 Increase cross-border cooperation strategies on water landscapes   |                             |
| SO 3.2 Promoting innovative practices and tools to reduce carbon emission and to improve energy efficiency in public sector | 13.30%                      |
On the other hand, partner 56 (Dhoma and Tregtisë dhe Industrisë, Tiranë), despite having a high degree of centrality, does not appear to be among the actors who have quality ties. Concerning closeness centrality, the most central partners are those with the highest closeness value, such as 142 (Puglia Region) and 105 (Ministarstvo Poljoprivrede I Ruralnog Razvoja). The results obtained from the calculation of the $K$-step reach centrality suggest instead that partners 142 (Puglia Region) and 158 (Univerzitet Crne Gore) can reach 20.9% and 18.4% respectively of all the nodes of the network with only 1 step. This is a very important index of centrality.

**Table 2 (continued)**

| Indicator | Network of project partners |
|-----------|-----------------------------|
| SO 4.1 Increase coordination among relevant stakeholders to promote sustainable cross border connections in the Cooperation | 17.89% |
| Cooperation | 5.05% |

13.30%

On the other hand, partner 56 (Dhoma and Tregtisë dhe Industrisë, Tiranë), despite having a high degree of centrality, does not appear to be among the actors who have quality ties. Concerning closeness centrality, the most central partners are those with the highest closeness value, such as 142 (Puglia Region) and 105 (Ministarstvo Poljoprivrede I Ruralnog Razvoja). The results obtained from the calculation of the $K$-step reach centrality suggest instead that partners 142 (Puglia Region) and 158 (Univerzitet Crne Gore) can reach 20.9% and 18.4% respectively of all the nodes of the network with only 1 step. This is a very important index of centrality.
On the other hand, with two steps, the partners 105 (Ministarstvo Poljoprivrede I Ruralnog Razvoja), 142 (Puglia Region), and 41 (Municipality of Lecce) can reach 66.5%, 62.0%, and 22.6% of all the nodes in the network respectively.

With 3 steps, instead, the partners 142 (Puglia Region), 105 (Ministarstvo Poljoprivrede I Ruralnog Razvoja), and 79 (Inovaciono Preduzetnicki Centar TEHNOPOLIS) reach all the nodes of the network. K-step reaches interpretation problems led to the calculation of the ARD, according to which the partners with a greater ARD are the partners 142 (Puglia Region) and 150 (Ministarstvo Poljoprivrede I Ruralnog Razvoja), with 54.1% and 52% respectively. Alternatively, partner 142 (Regione Puglia) ranked first with 31.3% of the score and partner 105 ranked second with 28.6%.

Finally, the partners with higher value betweenness centrality, because they are on numerous geodesics paths connecting other partners, are the partners 142 (Puglia Region) and 56 (Dhoma and Tregtisë dhe Industrisë, Tiranë).

Fig. 2 Placement map of Interreg IPA Cross-border Cooperation Italy-Albania-Montenegro Programme
Spatial Analysis

The spatial distribution of the project partners participating in the Interreg IPA CBC IT-AL-ME Programme is shown in Fig. 2.

Note that, this spatial representation was obtained by georeferencing the partners adhering to the Programme. In particular, the points on the map represent the project partners classified according to the role played in the project, these partners are classified into: lead partner (red); project partner (green), and associated partner (blue).

Regarding the geographical dimension and considering the number of partners involved, Italy has a predominant role of 42.2%, followed by Albania (32.1%) and Montenegro (25.7%), as shown in Table 4.

Analyzing for each country the role played by the partners, as shown in Table 5, it emerges that in Albania, about 17.14% reuse to be lead partner; 67.14% are project partner, while 15.71% are associated partner.

Similarly, in Italy, about 16.30% of the partners are lead partner, 61.96% are project partner, and 21.74% are associated partner. Therefore, the distribution of the roles of the partners between Italy and Albania is quite homogeneous. In contrast, in Montenegro, only 8.93% of the partners are lead partners, 75% are project partners while 16.07% of the partners are associated partners.

Finally, concerning the priority axis as shown in Table 6, in Albania and Italy, the SO 2.1 “Boost attractiveness of natural and cultural assets to improve a smart and sustainable economic development” was more funded, with 28.57% and 30.43% respectively, while in Montenegro, the most financed projects belong to the SO 1.1 “Enhance the framework conditions for the development of cross-border SMEs” and SO 2.1 “Boost attractiveness of natural and cultural assets to improve with smart and sustainable economic development,” with 26.79%. On the other hand, in SO 3.2 “Promoting innovative practices and tools to reduce energy efficiency,” there are fewer projects funded.

Regression Analysis

Estimates from the multiple regression model are presented in Table 7. Model 1 includes only the variables examining individual characteristics as regressors to establish a baseline. Model 2 adds the priority axis and models 3 and 4 test the network effects. The distance variable (1, 2, and 3) and RatioPartners are introduced

| Table 4 | Spatial distribution of Interreg IPA Cross-border Cooperation Italy-Albania-Montenegro Programme |
|--------|-------------------------------------------------|
| Country | Frequency of partners |
| Albania | 32.1% |
| Italy   | 42.2% |
| Montenegro | 25.7% |
alternately in models 3 and 4, respectively. Finally, model 5 adds the interaction terms to examine the effect of geographic proximity.4

From looking at our different estimated specifications, it is possible to test the research questions. Concerning H1, from the analysis of the results, it emerged that not all individual characteristics influence partnership formation. The only positively significant coefficient is the total budget that each partner has received from the projects in which it participates, which highlights a positive relationship with the probability of a collaborative relationship occurring, therefore with increasing financial size, the probability of collaboration increases. By contrast, a negative effect is associated with the lead partner variable. In other words, the probability of collaboration is higher when the partner is not a leader. The negative effect associated with lead partner may reveal no preference for this role, due to the fear of knowledge appropriability by the other companies participating in the project.

The estimates obtained from the models show that the priority axis are an important factor in the choice of partners, with a significant and positive coefficient observed on the SO variables for the respective themes. This means that the probability of two partners working together will depend on the greater number of projects they participate in together and the priority axis. Testing H2, it emerges that the social distance among the partners, both direct (distance 1) and indirect (distances 2 and 3), negatively affects the probability of cooperation between the partners. Consequently, the greater the social distance between the partners, the less is the probability that a collaboration relationship will be established between them.

According to H3 proximity, centrality significantly increases the probability of collaboration among the partners. Indeed, network effects are important. The most noticeable effect is the positive impact of the relational proximity, measured by betweenness centrality, degree, and beta centrality. Hence, partners are more likely to cooperate when a partner performs an intermediary function, i.e.,

| Country          | Role of partner | Frequency of partners |
|------------------|-----------------|-----------------------|
| Albania          | Lead partner    | 17.14%                |
|                  | Project partner | 67.14%                |
|                  | Advisory partner| 15.71%                |
| Italy            | Lead partner    | 16.30%                |
|                  | Project partner | 61.96%                |
|                  | Advisory partner| 21.74%                |
| Montenegro       | Lead partner    | 8.93%                 |
|                  | Project partner | 75.00%                |
|                  | Advisory partner| 16.07%                |

Table 5 Classification of the roles of the partners, distinguished by country, for Interreg IPA Cross-border Cooperation Italy-Albania-Montenegro Programme

4 The total budget is the sum of the FESR quota, national co-financing (equal to 15% of the total budget expected only for Italian public partners), private co-financing (equal to 15% of the total budget), IPA quota (equal to 85% of the total budget) and ENI quota.
| Country      | Priority axis                                                                 | Frequency of partners |
|-------------|-------------------------------------------------------------------------------|-----------------------|
| Albania     | SO 1.1 Enhance the framework conditions for the development of SMEs cross border market | 26.86%                |
|             | SO 2.1 Boost attractiveness of natural and cultural assets to improve a smart and sustainable economic development | 28.57%                |
|             | SO 2.2 Increase the cooperation of the relevant key actors of the area for the delivery of innovative cultural and creative | 14.29%                |
|             | SO 3.1 Increase cross-border cooperation strategies on water landscapes        | 15.71%                |
|             | SO 3.2 Promoting innovative practices and tools to reduce carbon emission and to improve energy efficiency in public sector | 5.71%                 |
|             | SO 4.1 Increase coordination among relevant stakeholders to promote sustainable cross border connections in the cooperation | 12.86%                |
| Italy       | SO 1.1 Enhance the framework conditions for the development of SMEs cross border market | 17.39%                |
|             | SO 2.1 Boost attractiveness of natural and cultural assets to improve a smart and sustainable economic development | 30.43%                |
|             | SO 2.2 Increase the cooperation of the relevant key actors of the area for the delivery of innovative cultural and creative | 13.04%                |
|             | SO 3.1 Increase cross-border cooperation strategies on water landscapes        | 17.39%                |
|             | SO 3.2 Promoting innovative practices and tools to reduce carbon emission and to improve energy efficiency in public sector | 6.52%                 |
|             | SO 4.1 Increase coordination among relevant stakeholders to promote sustainable cross border connections in the cooperation | 15.22%                |
| Montenegro  | SO 1.1 Enhance the framework conditions for the development of SMEs cross border market | 26.79%                |
|             | SO 2.1 Boost attractiveness of natural and cultural assets to improve a smart and sustainable economic development | 26.79%                |
|             | SO 2.2 Increase the cooperation of the relevant key actors of the area for the delivery of innovative cultural and creative | 12.50%                |
|             | SO 3.1 Increase cross-border cooperation strategies on water landscapes        | 21.43%                |
|             | SO 3.2 Promoting innovative practices and tools to reduce carbon emission and to improve energy efficiency in public sector | 1.79%                 |
|             | SO 4.1 Increase coordination among relevant stakeholders to promote sustainable cross border connections in the cooperation | 10.71%                |
Table 7  Multiple regression model for partner choice

|                          | Model 1                          | Model 2                          | Model 3                          | Model 4                          | Model 5                          |
|--------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| TotBudget                | $-0.36^* (0.00)$                 | $2.12^* (0.00)$                  | $2.58^* (0.00)$                  | $2.44^* (0.00)$                  | $2.28^* (0.00)$                  |
| MeanBudget               | $0.36 (0.20)$                    | -                                | -                                | -                                | -                                |
| GapBudget                | $-0.36 (0.20)$                   | -                                | -                                | -                                | -                                |
| PartnerRoleLP            | $11.98^{***}$ (0.13)             | $-1.77^*$ (-0.06)                | $-1.77^* (0.04)$                 | $-1.78^* (0.02)$                 | $-1.65 (0.02)$                   |
| PartnerRolePP            | $-9.22^{***}$ (0.08)             | $-0.97 (-0.02)$                  | -                                | -                                | -                                |
| PartnerRoleL-P and PP    | $-1.54 (0.16)$                   | -                                | -                                | -                                | -                                |
| PartnerRoleAP            |                                  | -                                | -                                | -                                | -                                |
| PartnerType              | $0.52 (0.00)$                    | -                                | -                                | -                                | -                                |
| LegalStatus              | $-0.38 (0.08)$                   | -                                | -                                | -                                | -                                |
| SO1                      | $56.37^{***} (0.02)$             | $20.17^{***} (0.04)$             | $20.27^{***} (0.04)$             | $22.97^{***} (0.04)$             |                                  |
| SO2                      | $50.45^{***} (0.02)$             | $20.41^{***} (0.04)$             | $20.24^{***} (0.04)$             | $22.06^{***} (0.04)$             |                                  |
| SO3                      | $50.18^{***} (0.02)$             | $24.32^{***} (0.04)$             | $23.80^{***} (0.04)$             | $25.23^{***} (0.04)$             |                                  |
| SO4                      | $53.71 (0.02)$                   | $21.07^{***} (0.04)$             | $21.05^{***} (0.04)$             | $22.73^{***} (0.04)$             |                                  |
| SO5                      | $32.02 (0.03)$                   | $13.67^{***} (0.06)$             | $13.19^{***} (0.06)$             | $14.81^{***} (0.05)$             |                                  |
| SO6                      | $45.99 (0.02)$                   | $18.56^{***} (0.05)$             | $18.14^{***} (0.04)$             | $19.89^{***} (0.04)$             |                                  |
| Distance1                |                                  | $-1.71^* (0.02)$                 | $-1.66^* (0.02)$                 | $-1.13^* (0.02)$                 |                                  |
| Distance2                |                                  | $-0.49 (0.01)$                   | -                                | -                                | -                                |
| Distance3                |                                  | $-0.65 (0.00)$                   | -                                | -                                | -                                |
| RatioPartners            |                                  | -                                | $1.30^* (0.00)$                  | $1.66^* (0.00)$                  |                                  |
| NormalizedCloseness      | $0.37 (2.68)$                    | $-0.41 (2.04)$                   | -                                | -                                | -                                |
| Normalized degree        | $2.43^{**} (8.82)$               | $2.53^{**} (8.78)$               | $2.13^{**} (7.01)$               |                                  |                                  |
| Normalized beta centrality| $2.38^{**} (0.00)$               | $2.84^{**} (0.00)$               | $2.15^{**} (0.00)$               |                                  |                                  |
| Normalized Avg. Recip. distance (N-ARD) | $0.49 (2.93)$                  | $0.54 (1.84)$                    | -                                | -                                | -                                |
| NormalizedEigenvector    |                                  | $-1.31 (0.44)$                   | $-0.99 (0.42)$                   | -                                | -                                |
| NormalizedBetweenness    | $2.68^{***} (0.52)$              | $3.10^{***} (0.48)$              | $3.15^{***} (0.42)$              |                                  |                                  |
| AverageGeographicalProximity |                                  |                                  |                                  | $-0.73 (0.00)$                  |                                  |
| Intercept                | $8.656^{***} (0.23)$             | $2.01^{**} (0.02)$               | $-0.74^* (0.74)$                 | $-0.96^* (0.11)$                 | $-0.62^* (0.05)$                 |
| Number of observations   | 159                              | 159                              | 159                              | 159                              | 159                              |
| Log-likelihood           | $-74.37$                         | $181.72$                         | $195.65$                         | $196.22$                         | $195.13$                         |
| AIC                      | $166.74$                         | $-343.43$                        | $-355.31$                        | $-358.44$                        | $-360.27$                        |
| $R^2$                    | 0.8                              | 0.9                              | 0.9                              | 0.9                              | 0.9                              |

Standard errors are given in parentheses

***Significant at the 1% level; **Significant at the 5% level; *Significant at the 10% level
he has a strong power to control the information transmitted, or when the social distance between them is small enough. The partners’ position within the network also appears as a determinant of the decision to form a partnership. The higher the number of direct partners (normalized degree), the higher is the probability of collaboration. As a result, the probability of two partners working together will depend on the greater number of projects they participate in together and the number of partners to which they are directly connected. While the effect corresponding to the numbers of indirect partners is not significant. To deal with the simultaneous effects of positive network externalities and the risk of uncontrolled knowledge diffusion, the ratio of the number of indirect partners per direct partner (RatioPartners) is calculated and analyzed. According to H4, this ratio has a significantly positive effect. This is interpreted as a greater propensity of the partners to benefit from knowledge externalities through their partners, without taking into account the risk of uncontrolled knowledge dissemination. Finally, contrary to what has been assumed in H5, the spatial dimension does not seem to matter in the partnership decisions. Indeed, spatial distance, accounted for by the variable average geographical proximity, measured in kilometers, is not significant. In other words, this could be interpreted as if the partners nearby located do not collaborate more frequently than the distant partners do.

Discussion

Theoretical and Practical Implications

This study provides empirical results on the main factors influencing cross-border cooperation. The analysis is focused on Interreg IPA CBC Italy-Albania-Montenegro Programme, financed by UE and managed by Puglia Region (Italy). Cross border collaboration can be a valuable source of knowledge and innovation, and in so doing, of competitive advantage even if it is subject to several contingencies that have been only partly examined so far. To contribute in such a direction, first, the individual characteristics of the program partners were analyzed, then the spatial effects and their role in terms of moderating the uncertainty of entering into collaborative links (Storper & Venables, 2004); finally, the way the network effects may generate links among the involved partners (Ponds et al., 2007). What emerges from the global analysis is a potential information asymmetry can cause uncertainty problems related to the development of collaborative links. In particular, when forming a partnership, it is not possible to be certain that a potential partner will be appropriate to ensure the successful project implementation. With this regard, results clearly show that social proximity is significantly associated with partner choice and on the other hand, spatial proximity is not significant. The role of social proximity is a potentially important finding as it indicates that the formation of links is not always only the result of localization factors and spatial proximity but also collaborations with similar actors (Gulati, 1999, 2007; Gulati & Gargiulo, 1999; Ponds et al., 2007). Furthermore, the results show us that some of the partners have a key role in the network and others play an intermediate role among central and peripheral nodes. This leads to refuting another assumption established in the literature on a couple of cooperative links. In particular, a dynamic dimension of relationships
emerges often influenced by previous interactions which therefore lead to the creation of new and stable collaborations. The results also demonstrate that not all individual characteristics are important determinants of partner selection. Only with increasing financial dimensions does the probability of forming a partnership increase, but an important influence in the formation of partnership is given by the priority axis to which the project is submitted. These results tend to refute one of the main results of the literature on the geography of innovation, indeed geographical proximity as such can no longer be considered the main determinant in the formation of collaborative links. Another important aspect of creating collaborations is the project’s financial dimension and how the budget is divided among the various partners.

This is certainly an element of novelty compared to the results presented by the various studies in the literature, up to now, and is determined by a different application context.

The budget becomes a crucial element in cross-border cooperation to generate new knowledge. How this budget is divided among the various project partners can influence the type of collaboration and the number of collaborations that a beneficiary can aspire to. A significant and positive influence derives from the variable “priority axis.” This means that the probability of two partners working together will depend from the specific skills and the theme and objective to be pursued. Instead, a negative effect is associated with the lead partner variable. In other words, the probability of collaboration is higher when the partner is not a leader. The negative effect associated with lead partner may reveal no preference for this role, due to the fear of knowledge appropriability by the other companies participating in the project.

Some practical implications emerge from the study carried out and can represent a starting point for future strategic choices by the managing authority of the program.

An important aspect is certainly the possibility of mitigating the risk of unsuccessful partnerships by adopting a top-down methodology in the choice of proposals. In practice, in programs like this one in which the collaboration between beneficiaries is not consolidated by previous initiatives, valid support can be given by the structure that manages the funds through constant guidance in the creation of the proposal and in the balanced structuring of the partners who will carry out the activities.

Another important aspect, to mitigate the failure of the partnership, is to create targeted proposals based on a small number of partners and limit the financial budget allocated to each one; on the other hand, simplifying the reporting procedures, adopting, for example, simplified costs options and pre-financing mechanisms.

Limitations and Future Research Directions

This study has some limitations that should be considered when interpreting its results. First, there are temporal and spatial limitations; the analysis is restricted to a specific Cross-border Cooperation Programme (Interreg IPA CBC Italy-Albania-Montenegro) and the information and data used are related to the first call for proposal.
This model can be considered a preliminary analysis to be extended in other networks or another program. The Italy-Albania-Montenegro Programme has implemented a new call for proposal, so the aim, for future work, is to expand the sample of analysis and check the validity of the results already obtained.

Future research also may consider the way network effects and cooperation could be influenced by unexpected exogenous variables; this brings us to the current COVID-19 pandemic and the related social and economic consequences. Considering therefore that the European Recovery Strategy places the concept of the “ecosystem” concept at the center of cooperation and innovation support policies, it becomes crucial to understand how various financing measures can affect the partnerships and alliances creation.

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