Abstract

The literature on the impact of proximity dimensions on innovation has exponentially increased in the last decade. The number of publications and the variety of disciplines involved have both enriched the academic discussion and increased the level of ambiguity. To take the first steps towards re-conceptualizing the proximity framework, the main findings on proximity and innovation in the literature are reviewed, by selecting and analysing 202 articles from 62 top-ranked journals published between 1990 and 2017. Our analysis identifies 17 proximity dimensions, with geographical proximity being the most investigated. Seven clusters that make up the intellectual core of proximity and innovation studies are described through a bibliometric analysis, and linked to seven other clusters concerning the intellectual sub-structure. As a second step, 152 further research indications were collected from articles and conference papers published between 2016 and 2018, from which a call for a re-think of the proximity dimensions emerged.
Looking for the red thread:

A Systematic Literature Review on Proximity and Innovation

The literature on the impact of proximity dimensions on innovation has exponentially increased in the last decade. The number of publications and the variety of disciplines involved have both enriched the academic discussion and increased the level of ambiguity. To take the first steps towards re-conceptualizing the proximity framework, the main findings on proximity and innovation in the literature are reviewed, by selecting and analysing 202 articles from 62 top-ranked journals published between 1990 and 2017. Our analysis identifies 17 proximity dimensions, with geographical proximity being the most investigated. Seven clusters that make up the intellectual core of proximity and innovation studies are described through a bibliometric analysis, and linked to seven other clusters concerning the intellectual sub-structure. As a second step, 152 further research indications were collected from articles and conference papers published between 2016 and 2018, from which a call for a re-think of the proximity dimensions emerged.

Keywords: Proximity; Innovation; Literature Review.

1. Introduction

Proximity can be interpreted as a pre-condition for innovation, as it fosters knowledge and technology transfer among actors (Knoben and Oerlemans 2006; Gertler 1995). Many scholars have examined the relationship among proximity and innovation at different spatial levels: clusters (e.g.: Geldes et al. 2017; Ozer and Zhang 2015), regions (e.g.: Rodriguez-Pose and Crescenzi 2008; Vaz et al. 2014), and nations (e.g.: Andersson and Lööf 2012; Luintel and Khan 2017). Since the renowned contribution of Boschma (2005), the focus has shifted from solely spatial proximity to cognitive, organizational, social, and institutional dimensions. Then, other dimensional specifications have gradually been introduced (see, among others: Moodysson and Jonsson 2007; Cabrer-Borrás and Serrano-Domingo 2007; Caniëls et al. 2014). Today, these themes continue to attract the attention of scholars from several disciplines (e.g.: Capone and Lazzeretti 2018; Davids and Frenken 2018; Divella 2017; Presutti et al. 2017).

Although the multidimensionality of proximity is widely accepted in the literature, few studies investigate all of the aspects of proximity described by Boschma (see, among others: Fitjar et al., 2016; Lazzeretti and Capone 2016). In addition, the interrelationships of the disciplines that consider
the concept of proximity have increased the ambiguity and the definitions of the nature of proximity (Capone and Lazzeretti 2018). Moreover, empirical investigations on the role of proximity in the innovation process provide divergent results (see, among others: Crescenzi et al. 2016; Geldes et al. 2017; Lazzeretti and Capone 2016; Marrocu et al. 2013; Molina-Morales et al. 2014). Furthermore, new information and communication technologies mean that the role played by proximity in the innovation process should be re-assessed (Baycan et al. 2017).

The aim of the present study is to assess the diverse literature on proximity and innovation, and thus to investigate its (i) intellectual core in order to highlight the research themes developed until now; (ii) intellectual sub-structure to figure out relationships and affiliations with previous research streams; (iii) the future challenges of research. To the best of our knowledge, few reviews or critical assessments have been conducted (e.g., Boschma 2005; Knoben and Oerlemans 2006) and thus recent developments and changes of direction have not been considered.

The paper is structured as follow: section two provides an explanation of the methodology; section three provides the research findings on the types of proximities, the intellectual core, intellectual sub-structures, and future research topics; and section four provides conclusions and limitations of this research.

2. Methodology

The methodology used in this research consists of four steps: (1) data collection and database preparation, (2) bibliographic coupling analysis (BCA) and co-citation analysis (CCA), (3) a BCA-CCA matrix, and (4) future research topic collection.

*Data Collection and Database Preparation.* We obtained relevant articles from the Scopus database. We entered the words “proximity” AND “innovation” to be searched among “Article title, Abstract, Keywords”, and limited the research to “articles” published until 2017. At this stage we obtained 843 articles from 504 journals. To obtain the key contributions only, we then selected articles from top ranked journals using the Academic Journal Guide 2018 (rank: 3, 4, 4*) or the Scimago Journal and Country Rank 2017 (rank: Q1; journals subject areas: “Business, Management, and
Accounting” and “Economics, Econometrics and Finance”). After this screening we obtained 281 articles from 102 journals. We then conducted relevance and consistency checks by reading the abstract of each paper and when necessary the whole article (c.f. Lazzeretti et al. 2013). After this final screening we obtained 202 articles from 62 journals published from 1990 to 2017. Table 1 shows the top 10 journals in terms of the number of relevant articles published.

Table 1. Top 10 sources of the 202 articles dataset

<table>
<thead>
<tr>
<th>N</th>
<th>Journal</th>
<th>Documents</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regional Studies</td>
<td>33</td>
<td>4175</td>
</tr>
<tr>
<td>2</td>
<td>Research Policy</td>
<td>26</td>
<td>1939</td>
</tr>
<tr>
<td>3</td>
<td>Economic Geography</td>
<td>11</td>
<td>1021</td>
</tr>
<tr>
<td>4</td>
<td>Industry and Innovation</td>
<td>10</td>
<td>308</td>
</tr>
<tr>
<td>5</td>
<td>Journal of Economic Geography</td>
<td>9</td>
<td>1304</td>
</tr>
<tr>
<td>6</td>
<td>The Journal of Technology Transfer</td>
<td>9</td>
<td>169</td>
</tr>
<tr>
<td>7</td>
<td>Technovation</td>
<td>9</td>
<td>388</td>
</tr>
<tr>
<td>8</td>
<td>Small Business Economics</td>
<td>7</td>
<td>381</td>
</tr>
<tr>
<td>9</td>
<td>Entrepreneurship and Regional Development</td>
<td>6</td>
<td>196</td>
</tr>
<tr>
<td>10</td>
<td>Journal of Business Research</td>
<td>5</td>
<td>67</td>
</tr>
</tbody>
</table>

The references of the selected articles were all checked so we could delete mistakes or merge dissimilar formatting styles.

Table 2 shows the top 10 cited works in the 202 articles.

Table 2. Top 10 cited references by the 202 articles dataset (“citations” refers to intra-database citations)

<table>
<thead>
<tr>
<th>N</th>
<th>Cited Reference</th>
<th>Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Boschma (2005)</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>Jaffe et al. (1993)</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>Audretsch and Feldman (1996)</td>
<td>59</td>
</tr>
<tr>
<td>4</td>
<td>Cohen and Levinthal (1990)</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>Saxenian (1994)</td>
<td>53</td>
</tr>
<tr>
<td>6</td>
<td>Bathelt et al. (2004)</td>
<td>41</td>
</tr>
<tr>
<td>7</td>
<td>Marshall (1920)</td>
<td>39</td>
</tr>
<tr>
<td>8</td>
<td>Jaffe (1989)</td>
<td>36</td>
</tr>
<tr>
<td>9</td>
<td>Porter (1990)</td>
<td>35</td>
</tr>
</tbody>
</table>
**Bibliographic Coupling Analysis (BCA) and Co-Citation Analysis (CCA).** The visualization of bibliometric networks allows researchers to analyse citation, co-authorship, and co-occurrence relationships (Van Eck and Waltman 2014). Through the VOSviewer 1.6.8 software, we focused on citation analyses that conduct both BCA and CCA, using a fractional counting methodology. By using a weighting strategy, this methodology decreases the impact of both highly cited articles and publications with long reference lists (such as review articles). BCA focuses on the similarities in the reference lists, thus combining articles that share significant numbers of cited references (Appio et al. 2017). Therefore, the bibliographic relation of two articles is greater with the increase of the references shared (Van Eck and Waltman 2014). In our case, the 202 articles are grouped in 8 clusters. However, the last cluster is made up of 5 articles published between 1990 and 2001, thus giving a reference list composed mainly of old contributions and belonging to different thematic categories. Therefore, we decided to exclude cluster 8 from our analysis of the results. CCA focuses on the number of times two publications are cited together, thus revealing the intellectual sub-structures (Appio et al. 2017; Van Eck and Waltman 2014). To show the evolution over time of the intellectual sub-structures, we conducted the CCA with the lower-bound of citations of a cited reference set at 2, giving 1602 articles meeting the threshold. To effectively interpret the content of these sub-structures, we decided to set the threshold at 3, thus obtaining 740 references divided into 7 clusters.

**BCA-CCA Matrix.** To link the 7 clusters representing the intellectual sub-structure (CCA) with the 7 characterizing the intellectual core (BCA), the following steps were conducted. First, we exported the complete reference list of each cluster from the BCA to Excel 16.17 using VOSViewer. Second, we assigned the corresponding CCA cluster number to each reference. Third, for each BCA cluster, we added all citations received by each CCA cluster and weighted them over the total citations received by the 7 CCA clusters in the BCA cluster under analysis. We then created a matrix of the weighted links [0,1] among BCA-CCA. Last, we created two network maps using both UCINET 6.652 and VOSViewer.
**Further Research Topics Collection.** To create a database suitable to detect future streams of research, we conducted a second round of research on Scopus. We entered the words “proximity” AND “innovation” to be searched among “Article title, Abstract, Keywords”, limiting the research to “articles”, “articles in press” and “conference paper” and to the years 2016-2018. At this stage we obtained 74 Conference Papers and 263 Articles. We then included only articles in top ranked journals by the Academic Journal Guide 2018 (rank: 3, 4, 4*) or by the Scimago Journal and Country Rank 2017 (rank: Q1; journals subject areas: “Business, Management, and Accounting” and “Economics, Econometrics and Finance”). We obtained 89 suitable articles, which were further checked for consistency and relevance, and excluded 12 articles. Similar consistency and relevance checks were conducted for Conference Papers. The final database was composed of 77 Articles from 38 Journals and 22 Conference Papers. Table 3 shows the most represented journals in this database:

<table>
<thead>
<tr>
<th>N</th>
<th>Journal</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regional Studies</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Research Policy</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Industry and Innovation</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Journal of Technology Transfer</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>Small Business Economics</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>Journal of Business Research</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>Journal of Cleaner Production</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Urban Studies</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Technological Forecasting and Social Change</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Journal of Small Business Management</td>
<td>2</td>
</tr>
</tbody>
</table>

After the database creation, we downloaded all articles and read through them, and collected 152 “further research” indications.

**3. Findings**

**3.1 What Kind of Proximities?**
We read through the 202 articles constituting our intellectual core to establish the similarities/differences in the (i) definitions and (ii) operationalizations of proximity. As Table 4 shows, while geographic proximity has been used in almost all articles, other forms of proximity are far less investigated.

Table 4. Percentage of usage of proximities

<table>
<thead>
<tr>
<th>Proximities</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geographic</td>
<td>93,1%</td>
</tr>
<tr>
<td>Organizational</td>
<td>16,8%</td>
</tr>
<tr>
<td>Cognitive</td>
<td>14,4%</td>
</tr>
<tr>
<td>Social</td>
<td>13,9%</td>
</tr>
<tr>
<td>Institutional</td>
<td>13,4%</td>
</tr>
<tr>
<td>Technological</td>
<td>9,9%</td>
</tr>
<tr>
<td>Other</td>
<td>16,8%</td>
</tr>
</tbody>
</table>

\(N = 202\) articles

Table 5 summarizes the main findings regarding definitions and variable operationalizations. As the most studied, geographical proximity shows a wide variety in terms of both definitions and operationalizations. However, more recent or less investigated forms of proximities, such as personal, vision or commercial proximity are only loosely outlined, both theoretically and empirically.

Table 5. Proximities definitions and operationalizations
Geographic proximity “indicates the positioning of agents within a predetermined spatial framework. This type of proximity must therefore remain distinct from a physical proximity which would represent the outcome of ‘natural’ constraints in that it is a social construction, built as much by the installation and development of transportation and communication infrastructure as by architectural aspects and technical imperatives” (Kiriat and Lung 1999, 29)

Geographic proximity concerns "spatial separation between economic actors (in reference to physical factors but also to social constructions such as transport infrastructures or telecommunication technologies)” (Torre and Gilly 2000, 178)

"It refers to the spatial or physical distance between economic actors, both in its absolute and relative meaning” (Boschma 2005, 69)

Geographical proximity, “needs to be understood in more nuanced and multidimensional terms...local social ties have to be actively constructed rather than assumed to arise automatically, which means that geographical proximity must necessarily include a relational dimension” (Healy and Morgan 2012, 1047)

"...geographical proximity is not just a near-far dichotomy but involves choices concerning real places to access knowledge...Geographical distance is thus more accurately seen as a dynamic trade-off between effort, preference and dependency” (Rutten 2017, 169)

"(1) the needs for geographical proximity can be fulfilled temporarily through travelling; and (2) they can be fulfilled without the interaction leading to the permanent co-location of the partners. It is this mechanism that is called here temporary geographical proximity (Torre and Rallet, 2005). It corresponds to the possibility of satisfying certain needs for face-to-face contact between actors by travelling to different locations.” (Torre, 2008, 881)

“Temporary geographical proximity in the form of business trips or meetings in conferences may be sufficient to establish relationships that may be maintained over longer distances afterwards” (Weterings and Ponds, 2009, 13)
Organizational Proximity

“Organizational proximity consists of shared organizational principles, rules, and codes, including a corporate identity and a corporate philosophy (Blanc and Sierra 1999, 196), to promote a certain coherence within a firm and compatibility among collaborating firms.” (Zeller, 2004, 88)

Organizational proximity “involves the rate of autonomy and the degree of control that can be exerted in organizational arrangements” (Boschma, 2005, 65)

“organized proximity is relational in essence. By this, the author refers to the ability of an organization to make its members interact” (…) “Two main reasons explain this fact: Belonging to an organization translates into the existence of interactions between its members that are inscribed in the genes or routines of the organization” [logic of belonging] (…) “The members of an organization are said to share a same system of representations, or set of beliefs, and the same knowledge” [logic of similarity] (Torre, 2008, 877-878)

“Organizational proximity refers to the relations within the same group or organization which influence the individual capacity to acquire new knowledge coming from different agents” (…) “it provides an area of definition of practices and strategies within a set of rules based on organizational arrangements” (Marroc et al., 2013, 1486)

Proxies:

• Similarity of legal forms of enterprises (Marek et al. 2017)
• Work(ed) in the same organization (Crescenzi et al. 2017) or same legal entity (Hansen 2015)
• Years of collaboration experience (Lazzereetti and Capone 2016)
• R&D cooperation and external contributions to the innovation process (Oerlemans and Meeus 2005)
• Ratio of knowledge created through interaction among district members over the total knowledge created in the district (Dangelico et al. 2010)

Self-Assessed:

• Self-assessment on arrangements with partners (Fitjar et al. 2016)
• Construct composed by similarity on: organizational culture, organizational structure, inter-organizational relationships, technologies (Geldes et al. 2017)

Cognitive Proximity

“With the notion of cognitive proximity, it is meant that people sharing the same knowledge base and expertise may learn from each other” (Boschma, 2005, 63)

“[Cognitive] proximity can be associated to the similarity in the way that actors perceive, interpret, understand, and evaluate the world (Wuys et al. 2005). In our view, elements such as common culture, values, customs, norms, routines, visions, goals and objectives determine the way the environment is approached and known, and also organizational behavior itself (Inkpen and Tsang 2005).” (Molina-Morales et al., 2014, 234)

“Cognitive proximity is associated with differences and similarities in capabilities of economic agents. Capabilities at the firm level derive from learning processes by which additional technical and non-technical skills are acquired by individuals and through them by the organization.” (Hansen, 2015, 1674)

Proxies:

• Similar/dissimilar scientific domain (Lazzereetti and Capone 2016) or patents in similar/dissimilar technology field (Crescenzi et al. 2016)
• Number of employs working in a sector over total regional employee (Marek et al. 2017) or knowledge created through imitation or interaction inside the district over total knowledge created in the district (Dangelico et al. 2010)
• Correlation coefficient to measure structural equivalence among industries based on firm level data (Enkel and Heil 2014)

Self-Assessed:

• Similarity/dissimilarity in the educational background (Hansen 2015) or in the knowledge base and expertise (Fitjar et al. 2016) with partners
• Construct composed by similarity on: knowledge base, level of experience, language, educational level, and cultural level (Geldes et al. 2017)
Social Proximity

“Social proximity is defined here in terms of socially embedded relations between agents at the micro-level. Relations between actors are socially embedded when they involve trust based on friendship, kinship and experience” (Boschma 2005, 66)

“Social proximity comes about as a result of shared personality characteristics, personal interaction and a sense of familiarity between individual actors. In its mode of creating mutuality among actors, it is closely related to institutional proximity, but takes place at the micro-level and occurs in the form of friendship or kinship or also based on past interactions” (Mattes 2012, 1089)

“Social proximity refers to the strength of social ties between agents at the micro-level resulting from friendship, family relations or previous work-related interactions. Again, this proximity influences the risk of opportunism, however here through mechanisms of trust” (Hansen 2015, 1674)

Proxies:
- Co-inventorship (Marrocu et al. 2013), worked for the same company in the same period, have a shared co-inventor (Crescenzi et al. 2017), sometimes assuming a time decay threshold (Crescenzi et al. 2016)
- Inverse of the path length between inventors in the co-invention network (Ter Wall 2014) or the opposite of the number of actor pairs at distance 2 (Lazzeretti and Capone 2016)

Self-Assessed:
- Perceived social interaction with partners (Fitjar et al. 2016)
- Construct composed by: friendship, confidence (trust), previously known, common experiences, reputation (Geldes et al. 2017)

Institutional Proximity

“Institutional proximity, by contrast, implies a degree of congruence between, and acceptance of the legitimacy of, the institutional infrastructure in which agents operate. And, in turn, the impact the institutional framework has upon the development of cognitive models” (Freel 2003, 754)

“Institutional proximity refers to the institutional framework in countries and regions, such as legislative conditions, labor relations, business practices and accounting rules, dominant workplace practices, and the training system, which are all outcomes and elements of the evolution of political power relations that contribute to a “cultural affinity” (Zeller 2004, 88)

“The notion of institutional proximity includes both the idea of economic actors sharing the same institutional rules of the game, as well as a set of cultural habits and values (Zukin and DiMaggio 1990)” (Boschma 2005, 68)

“Institutional proximity refers to the social and cultural norms that regulate the business and non-business relationships in a specific context” (Ben Letaifa and Rabeau 2013, 2072)

Proxies:
- Regions are from the same/different country/ies (Marrocu et al. 2013)
- Inventors belong to the same institution: university vs private sector (Crescenzi et al. 2017)
- Similar/Dissimilar actor typology: research center, public institution, small and large firms, and universities (Lazzeretti and Capone 2016)

Self-Assessed:
- Similarity/Dissimilarity with partners culture, in terms of norms, habit and values (Fitjar et al. 2016; Hansen 2015)
- Construct composed by similarity on: laws and regulations, cultural norms, values, habit and routines (Geldes et al. 2017)
### Technological Proximity

"Technological proximity is based on shared technological experiences, bases, and platforms. It facilitates shared perceptions, as well as the anticipation of technological developments." (Zeller 2004, 88)

"interactions can be based on similarities related to the way in which actors perceive, interpret, understand, and evaluate the world (Wuyts et al. 2005), as emphasized by cognitive proximity. This relational attribute refers to how actors interact, whereas technological proximity – which refers to shared technological experiences and knowledge – is based on what they exchange as well as the potential value of these exchanges (Knoben 2008, 55)” (Cantù 2010, 888)

**Proxies:**
- Differences on technological classes of patents (Rosenkopf and Almeida 2003)
- Distance as the shortest path on the technological circle (Wersching 2007)
- Same/Different industry on different levels of Sic-code aggregation (Isaksson et al. 2016)
- Knowledge spillovers and research overlap (Fung 2003)

**Personal Proximity**

"personal distance felt between individuals in an organization can prevent knowledge transfer from occurring. Person-related distance can give rise to faultlines in an organization (Bezrukova et al. 2009)” (Dolfsma and van der Eijk 2016, 273)

“Caniëls, Kronenberg, and Werker (2014) use the concept of personal proximity” (…) that “encompasses the degree of similarity in partners’ personal features, characteristics and behaviours.” (Capone and Lazzeretti 2018, 900)

**Self-Assessed:**
- Strong/weak working relationship with alters (Dolfsma and van der Eijk 2016, 279)

**Proxy:**
- Path overlap: overlap between a dyad’s functional zones (Kabo et al. 2014)

### Functional Proximity

"Functional proximity refers to physical distance affected by mobility. An alternative conception associated with functional proximity is therefore accessibility. It is hence not only bare Euclidean physical distance, but also includes time and cost dimensions” (Moodysson and Jonsson 2007, 118)

“Functional distance (Maggioni and Uberti 2007) refers to differences between regions in innovation performance. Maggioni and Uberti (2007) showed that knowledge does not flow easily between areas if they differ strongly in their innovation capacity. Consequently, a strong asymmetry in performance and capability (that is, too much functional distance) will limit the opportunities for mutual advantages of integration” (Lundquist and Tripl 2013, 453)
“To develop a truer measure of functional proximity, we must incorporate a sense of how human behavior interacts with spatial layout to produce proximity.” (Kabo et al. 2014, 1471)

### Cultural Proximity

“Cultural proximity is interrelated with institutional proximity and is expressed by a common cultural background, which facilitates the understanding of information and the establishment of norms of behavior between innovative actors and researchers (Lundvall 1988, 355)” (Zeller 2004, 88)

“Cultural–ethnic (whether co-patenting inventors share the same national, cultural, and/or ethnic background)” (Crescenzi et al. 2016, 178)

### Commercial Proximity

“In an industrial context, the innovative contiguity between productive sectors, $w_{ij}$, is often set equal to 1 if the intensity in their commercial relationships is higher than the average. If we follow this idea, we can define the proximity between regions from a commercial perspective. In this case we can use the intensity of bilateral trade flows as the bilateral weights, $w_{ij}$, to approximate the intensity of regional interdependences” (Cabrer-Borrás and Serrano-Domingo, 2007, 1363)

### Relational Proximity

“Relational proximity is expressed by informal structures that reinforce or counteract the effects of the formal organization. Knowledge, especially knowledge produced outside the firm, cannot be acquired, transferred, and transformed without continuing personal relationships (Sierra 1997, 25). An innovative firm must participate in the localized social capital” (Zeller 2004, 88)

“The notion of relational proximity could be used as an umbrella term for a number of non-tangible dimensions discussed in the literature” (…) and it “is associated with the structures, relations and processes that originate, for instance, from the social dynamics, governance structures, regulation and cultural identities that together comprise the embeddedness of social action (Granovetter, 1985)” (Lundquist and Trippl 2013, 453)

### Temporary Relational Proximity

“firms that engage in partnerships share a temporary relational proximity. When two firms launch a partnership, they establish a non-disclosure agreement for a specific period of time (Bathelt et al. 2004). When the specific partnership is terminated, social strands are built between actors in the firms” (Ramirez-Pasillas 2010, 160)

### Proxy:

- Belonging or not to the same cultural, ethnic, or linguistic subgroup (Crescenzi et al. 2016)
- National score on the six cultural dimensions of Hofstede (Guann and Yann 2016)
- Intensity of bilateral trade (Cabrer-Borrás and Serrano-Domingo 2007)
- Firms engaging in partnership during an exposition fair (Ramirez-Pasillas 2010)
“cyberspace is not a paraspace, a separate realm to geographic space, but forms part of an experiential continuum in people's lives” (Dodge and Kitchin 2001). *Virtual proximity* may well be a surrogate for physical proximity in the context of standardized transactions, but not in the context of transactions which are high in complexity, ambiguity and tacitness” (Morgan 2004, 5)

“*Virtual proximity* can be produced by using communication and information technologies. An MNC can create virtual proximity to substitute partially for spatial proximity for a period of time on the condition that it disposes of organizational, cultural, and relational proximity among the members of its network, to allow real communication to be established (cf. Howells 1995)” (Zeller 2004, 88-89)

“Spatial proximity describes positions in space and changes whenever actors move in space” (…) “Network proximity describes the degree of separation and structural embedding between network positions. It changes when actors, even third actors, connect to new nodes” (Menzel 2015, 1899)

“Moreover a deeper development of long-term relationships is influenced by the shared vision and gradual convergence of objectives characterizing vision proximity. Meanwhile, an aggregation of organizations” (…) “cannot be limited by geographic proximity, but rather requires technological and cognitive proximities as well as proximity of vision. The latter allows for long-term relationships” (Cantù 2010, 896)

“Bouba-Olga and Grossetti (2008) suggest another typology based on more recent developments of sociological economy” (…) “They further divide socioeconomic proximity in two sub-categories:(1) Resource-base proximity based on both material (objects, tools …) and immaterial resources (information, knowledge, rules, norms …); (2) Coordination proximity which includes relational proximity (social network dimension i.e. the closeness of actors) and mediation proximity (institutional dimension as previously emphasized by Boschma, 2005)” (Crespin-Mazet et al. 2013, 1704)

<table>
<thead>
<tr>
<th>Proximity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Proximity</td>
<td>“cyberspace is not a paraspace, a separate realm to geographic space, but forms part of an experiential continuum in people's lives” (Dodge and Kitchin 2001). <em>Virtual proximity</em> may well be a surrogate for physical proximity in the context of standardized transactions, but not in the context of transactions which are high in complexity, ambiguity and tacitness” (Morgan 2004, 5)</td>
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</tr>
<tr>
<td>Vision Proximity</td>
<td>“Moreover a deeper development of long-term relationships is influenced by the shared vision and gradual convergence of objectives characterizing vision proximity. Meanwhile, an aggregation of organizations” (…) “cannot be limited by geographic proximity, but rather requires technological and cognitive proximities as well as proximity of vision. The latter allows for long-term relationships” (Cantù 2010, 896)</td>
</tr>
<tr>
<td>Socioeconomic Proximity</td>
<td>“Bouba-Olga and Grossetti (2008) suggest another typology based on more recent developments of sociological economy” (…) “They further divide socioeconomic proximity in two sub-categories:(1) Resource-base proximity based on both material (objects, tools …) and immaterial resources (information, knowledge, rules, norms …); (2) Coordination proximity which includes relational proximity (social network dimension i.e. the closeness of actors) and mediation proximity (institutional dimension as previously emphasized by Boschma, 2005)” (Crespin-Mazet et al. 2013, 1704)</td>
</tr>
</tbody>
</table>

1 For completeness, we added the contribution of Capone and Lazzeretti (2018) even though it is part of the future research topics and does not belong to intellectual core articles;

2 For these proximities we have not displayed the column “operationalization”, since we haven’t found operationalizations in our intellectual core articles

### 3.2 BCA – The Intellectual Core

This section gives the results of the BCA, and provides a short description for each of the seven clusters. Figure 2 shows the coupling results:

Figure 2. Bibliographic Coupling of the 202 articles database (fractional, no lower limits, 8 clusters)
“Beyond Geographical Proximity” (red) is the first cluster emerging from the BCA analysis and it is composed of 47 articles. The main topic of this cluster concerns the determinants of knowledge networks, thus changing the focus from basic co-location to other forms of proximity. Giuliani (2007) challenged the view of a pervasive and random diffusion of knowledge solely through spatial proximity, thus showing that knowledge networks do not randomly involve every industrial cluster member, but only those firms with capabilities to transfer and absorb knowledge. Similarly, Moodysson underlined that interactive knowledge creation arises from strategic and planned actions guided by ‘practical issues like time economy and flexibility’ (2008, 460) and not only by local embeddedness. Amin and Roberts (2008, 365) highlighted that ‘situated knowledge’ cannot be reduced to a simple co-location, but it is the result of a ‘tangled assemblage’ of heterogeneous forms of proximity. By viewing geographic proximity as a facilitator, the literature on social capital underlined the impact of social interactions and networking on knowledge diffusion (Hauser et al., 2007; Huggins and Johnston 2007; Molina-Morales and Martínez-Fernández 2010). Likewise, Mattes (2012) highlighted both geographical and social proximity as auxiliary mechanisms, reinforcing the effect of other forms of proximity. While being aware that permanent co-location is not necessary,
Torre (2008) introduced the concept of ‘temporary geographic proximity’, thus claiming that short/medium term visits may be sufficient for sharing the required information.

The “Scouts” cluster (green) is composed of 45 articles that first attempted to conceptualize the relationship among proximity dimensions and innovation. The shift from competition on price to competition on knowledge creation (Maskell and Malmberg 1999), the increasing importance of the institutional and productive environments of firms (Torre and Gilly 2000), and the paradoxical significance of geography despite the rising of digitalization and globalization (Morgan 2004), are the factors influencing the focus on closeness in the literature. ‘Because information diffuses rapidly across organizational and territorial borders, it wrongly assumes that understanding does too’ (Morgan 2004, 3). Therefore, closeness should be intended in a broader sense, and thus should include not only physical and socio-cultural factors (Maskell and Malmberg 1999), but also work practices and training cultures (Gertler 1995), the logics of belonging and similarity (Torre and Gilly 2000), and institutional contexts (Kirat and Lung 1999). The work of Boschma (2005) represents a comprehensive combination of all the attempts made to grasp the multidimensionality of proximity, thus highlighting both positive and negative effects.

The “Knowledge Spillovers” cluster (blue) is composed of 37 articles examining the effect of proximities on knowledge spillovers. The literature has extensively identified geographical proximity as a channel able to foster knowledge spillovers (Ponds et al. 2009; Rodríguez-Pose and Crescenzi 2008) and maintaining its positive effect over time (Sonn and Storper 2008). Moreover, spatial proximity to research institutions and to industrial innovative activities, together with technological capabilities, is able to determine the location choices of firms (Alcácer and Chung 2007). These consider spillover gains that can be obtained by inward spillovers, net of the cost related to outward spillovers. Social proximity can also act as a substitute for geographical proximity, and may enhance spillovers among social or professional networks (Agrawal et al., 2008). Last, technological proximity has been found to outperform geographical proximity in fostering knowledge spillovers (MacGarvie 2004; Marrocu et al. 2013).
The “Proximity vs. Distance” (yellow) cluster consists of 27 articles that focus on the trade-off between proximity and distance, and not only spatial, but also cognitive, organizational, and technological. Whittington et al. (2009) showed that being central in a regional knowledge network enhances firms’ access to tacit knowledge, while centrality in the global network avoids stacking obsolete knowledge, thus facilitating both access to vital resources and pursuit of novelty. Similarly, Guan and Yan (2016) showed that knowledge homogenization due to an excessive technological proximity may hinder re-combinative innovation. Rosenkopf and Almeida (2003) focused on the lock-in effect and showed that inventors’ mobility is an extremely useful mechanism for gaining new knowledge from a distant context, and particularly at a high level of technological distance. However, in cases of high technological distance among actors, geographic proximity may enable knowledge transfer and consequently the spread of breakthrough innovation (Phene et al. 2006). For Ter Wal (2014), geographical proximity is crucial in an early industrial stage, while in an established industrial stage inventor collaboration is important, both at local and distant levels. However, to gain the advantage from distant collaboration, actors should invest in the potential absorptive capacity, to decrease excessive inter-organizational cognitive distance that otherwise would hinder knowledge absorption (Enkell and Heil 2014).

The “Knowledge cycle” (purple) cluster consists of 14 articles that describe the drivers, determinants, mechanisms, and barriers of knowledge creation, acquisition, transfer, and diffusion. Across both internal (senior managers, satisfaction surveys, etc.) and external (suppliers, competitors, etc.) sources, firms can obtain tacit and explicit knowledge (Weidenfeld et al. 2010), which can be consequently adopted by using organizational resources and capabilities (Florida et al. 2001). Once implemented, knowledge can be transferred to other actors through several mechanisms reinforced by spatial proximity, such as executive mobility and labor mobility (Still and Strang 2009; Weidenfeld et al. 2010); temporary face-to-face interactions (Weidenfeld 2013); close interpersonal relations and inductive learning (Gaba and Meyer 2008); and learning by imitation (Weidenfeld et al. 2010). From an evolutionary perspective, Maskell and Malmberg described the process of ‘social or technical innovation, selection, and retention’ (2007, 613) leading to the establishment of routines
that, on one hand, may ‘economize on fact-finding and information processing’, but on the other hand may generate ‘functional and/or spatial myopia’ (2007, 614). This cycle may lead to barriers to knowledge creation and acquisition, thus bringing inertia and the decline of spatial clusters.

The “University” (sky blue) cluster consists of 14 articles that concern determinants and effects of University-Industry collaboration. Although geographical proximity to a university has been found to enhance firms’ decisions to collaborate, university research quality remains the most crucial collaboration determinant (Laursen et al. 2011) for sustaining regional innovation (Fritsch and Slavtchev 2007). Indeed, distance to the nearest university has no effect on collaboration decisions (Hewitt-Dundas 2013), and firms with higher absorptive capacity were found to collaborate with universities regardless of location (De Fuentes and Dutrénit 2016). Nevertheless, proximity to universities may also affect firm creation (Bonaccorsi et al., 2013), product and process innovation (Maietta 2015), the technological performance of firms (Leten et al. 2014), and it may foster tacit knowledge flow (De Fuentes and Dutrénit 2016). Last, Steinmo and Rasmussen (2016) highlighted that while collaboration among engineering-based firms and universities is nurtured by social and geographic proximity, collaboration among science-based firms and universities relies on cognitive and organizational proximity.

The “Face-to-Face” (orange) cluster consists of 11 articles. The main topic concerns how spatial proximity among users/customers and providers/ producers may affect innovation, and 6 out of 11 articles based their empirical investigation on knowledge intensive business services (KIBS). García-Quevedo and Mas-Verdú (2008) and Fernandes and Ferreira (2013) highlighted how geographic proximity may foster collaboration among actors, especially with KIBS. Bindroo et al. (2012) and Fernandes and Ferreira (2013) concluded that proximity among users and producers may foster both collaboration and innovation. However, other authors have questioned whether spatial proximity can foster innovation, and conclude that neither face-to-face interactions nor knowledge spillovers are keystones of the geography of innovation (Doloreaux and Shearmur 2012). Indeed, the crucial advantage is of the access that a location provides to both local and distant innovation input, and the ease of maintaining the other types of proximity (Shearmur 2011). Weterings and Boshma
came to a similar conclusion: ‘spatial proximity to customers does not strengthen the effect of regular face-to-face interactions on the innovative performance of software firms’ (2009, 753).

The results of BCA are summarized in Table 6.

Table 6. Main topics analyzed by BCA clusters

<table>
<thead>
<tr>
<th>Cluster Name</th>
<th>Short Description</th>
<th>Years</th>
<th>Journals (n of documents)</th>
<th>Average Citations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beyond</td>
<td>Looking for determinants of knowledge networks beyond</td>
<td>2005-2017</td>
<td>Regional Studies (14) Economic Geography (4) Franklin (4)</td>
<td>59</td>
</tr>
<tr>
<td>Geographical Proximity</td>
<td>co-location</td>
<td></td>
<td>Journal of Business Research (4)</td>
<td></td>
</tr>
<tr>
<td>Scouts</td>
<td>Seeking to conceptualize the Proximity and Innovation relationship</td>
<td>1994-2014</td>
<td>Regional Studies (9) Research Policy (6) Technovation (6)</td>
<td>156</td>
</tr>
<tr>
<td>Knowledge Spillovers</td>
<td>Trying to capture the effect of proximities on knowledge spillovers</td>
<td>2000-2017</td>
<td>Research Policy (7) Journal of Economic Geography (4) Franklin (4)</td>
<td>43</td>
</tr>
<tr>
<td>Proximity vs Distance</td>
<td>Investigating the trade-off between proximity and distance, not only spatial</td>
<td>2003-2017</td>
<td>Research Policy (5) Industry and Innovation (3) Strategic Management Journal (2)</td>
<td>59</td>
</tr>
<tr>
<td>Knowledge cycle</td>
<td>Describing factors enabling or not knowledge creation, acquisition, transfer and diffusion</td>
<td>2001-2016</td>
<td>Journal of Industrial Ecology (2) Journal of Tourism Research (2)</td>
<td>48</td>
</tr>
</tbody>
</table>
Describing determinants and effects of University-Industry collaboration 2006-2017

Investigating how spatial proximity among users/customers and providers/producers affect innovation 1999-2015

3.3 CCA – The Intellectual Sub-Structure

This section displays the results of both CCA and BCA-CCA matrix. Figure 3 shows the intellectual sub-structure evolution from 1990 to 2017:

Figure 3a. 1990-2001 (lower-bound 2 citations)

Figure 3b. 1990-2006 (lower-bound 2 citations)
The time analysis shows how CCA clusters were formed and the evolution of the intellectual substructure. In line with Appio et al. (2017), we chose four time periods: 1990-2001, 1990-2006, 1990-
2011, and 1990-2017. Each area has a color that identifies the density of contributions, ranging from blue (low-) to red (high-density), the font size concerns inter-database article citations, and the proximity of articles reveals their similarity. Figure 3 shows that the study of Saxenian (1994) emerges as a crucial contribution in all four phases. Other central contributions are those of Jaffe (1989), Jaffe et al. (1993) and Audretsch and Feldman (1996), which increased their impact over the four phases. Notably, Boschma’s (2005) work has the higher citation increase between 2011 and 2017. By comparing 1990-2001 to 1990-2017, it is clear that the relevance of several works have diminished in terms of the definition of the intellectual sub-structure. Thus, to obtain a reliable and effective understanding of this sub-structure, we decided to rely only on the core density area of 1990-2017, thus leaving out the most peripheral contributions. Hence, by setting the lower-bound of CCA to 3 citations we obtained 7 clusters, as shown in Figure 4.

Figure 4. 1990-2017, co-citation analysis (7 clusters, lower-bound 3 citations)

The “Locus of Innovation” (red) cluster. A firm alone cannot achieve the knowledge needed to innovate, thus innovation should be sought across networks of learning (Powell et al. 1996). However, a firm can learn from, assimilate, and apply new knowledge only if it has enough innovation...
capability (absorptive capacity), which depends on its knowledge base (Cohen and Levinthal 1990): the development of absorptive capacity is not only history- but also path-dependent. The flow of information is also influenced by geographical propinquity, organizational form, embeddedness, and weak ties (Granovetter 1973; Owen-Smith and Powell 2004; Uzzi 1997).

The “Seminal” (green) cluster includes fundamental contributions regarding innovation and competitive advantage (Cohen and Levinthal 1989; Nelson and Winter 1982; Porter 1990; Von Hippel 1988). Among these, several works investigate the relationships concerning innovation and the spatial dimension of innovation (Camagni 1991; Lundvall 1992; Saxenian 1994), and in particular this cluster is characterized by research highlighting positive correlations among the spatial agglomeration of firms (at local, regional, and national levels) and their innovation capacity (Audretsch 1998; Baptista and Swann 1998; Cooke et al. 1997).

The “Not only Local” (blue) cluster. Geographical proximity cannot be considered as the sole dimension fostering learning and innovation (Boshma 2005). Indeed, tacit and codified knowledge may be exchanged at both local and global levels (Bathelth et al. 2004). Therefore, this cluster explored not only the new proximity dimensions that can affect inter-organizational learning (Boshma 2005; Knoben and Oerlemans 2006; Malberg and Maskell 2002; Ponds et al. 2007; Torre and Gilly 2000) but also firm-specific characteristics (Giuliani 2007).

The “Public Research & Knowledge Spillovers” (yellow) cluster. Here, innovation spills over from universities to influence business actors and the creation of commercial innovation (Anselin and Varga 1997; Jaffe 1989; Zucker et al. 1998). Geographic proximity can foster university-industry collaboration (Audretsch and Stephan, 1996), so universities and businesses located in the same place may share tacit knowledge, thus enhancing local economic development (Zucker et al. 1998). Additionally, university research can nurture both new R&D projects and also the completion of existing ones (Cohen at al. 2002).

The “Patent & Knowledge Spillovers” (purple) cluster. The main focus of this cluster is on patents (Acs et al. 2002; Glaeser et al. 1992; Griliches, 1990; Jaffe, 1986; Jaffe et al. 1993) and R&D (Audrestch and Feldman, 1996; Griliches, 1979). Knowledge externalities are fundamental in
industries where knowledge plays a crucial role, thus increasing spatial clustering (Audrestch and Feldman, 1996). Indeed, knowledge spillovers are localized (Jaffe et al. 1993), but co-location alone is not sufficient: to benefit from other firms’ R&D, actors should themselves invest in R&D (Jaffe, 1986).

The “Interactions and Knowledge” (sky blue) cluster. Face-to-face interactions, proximity, and mobility are crucial factors in enabling knowledge flow (Torre and Rallet 2005). Indeed, (i) face-to-face contact provides efficient communication, solves incentive problems, enhances socialization, and provides psychological motivation (Storper and Venables 2004), and (ii) as the need for geographical proximity is not permanent, mobility can enhance the share of information necessary for cooperation (Torre and Rallet 2005). Interactions should not only be within an industrial cluster, but also between clusters, fostering both related and unrelated knowledge flow and thus specialization and diversification (Feldman and Audretsch 1999; Frenken et al. 2007; Maskell 2001). Hence, the acquired synthetic and/or analytic knowledge base of firms influences the type of innovation achievable, either incremental or radical (Asheim and Coenen 2005).

The “Structure, Actors and Innovation” (orange) cluster. The Triple Helix model underlines the importance of university-industry-government relationships to foster the evolution of innovation systems (Etzkowitz and Leydesdorff 2000). However, this should not be considered as a static model, as the replacement of old resources or obsolete structures and the renewal of institutions are necessary to achieve sustainable competitiveness (Maskell and Malmberg 1999). At a regional level, Morgan (1997) highlighted the interdependence between public and private power, which can nurture or hinder innovativeness. At a cluster level, Giuliani and Bell (2005) show that firms may play different roles in cluster knowledge networks (gatekeepers, isolated, etc.), interacting differently with institutions and public research actors, and influencing the cluster innovativeness and competitiveness as a whole. Co-location with other innovative firms can enhance a firm’s likelihood for innovation (Beaudry and Breschi 2003). At the sector level, the technological trajectories are dominated by three different firms’ categories: suppliers, production intensive or science based (Pavit 1984).
As shown in Figure 5, the BCA-CCA matrix displays the relationship among BCA and CCA clusters. In Figure 5 (up), the sky-blue arrows show the most cited CCA cluster (purple square) from the BCA cluster (green circle), thus highlighting the intellectual sub-structure of each “proximity” and “innovation” intellectual core cluster. For example, the “seminal” cluster represents the theoretical foundation of the “scout” cluster. In Figure 4 (down), while the majority of BCA and CCA clusters tend to fall in pairs, “Behind Geographical Proximity”, “Proximity vs. Distance”, “Knowledge Cycle” (BCA), “Not only Local” and “Locus of Innovation” (CCA) are clustered together (red), thus highlighting their complementarity in the debate regarding the space of innovation.

Figure 5. BCA/CCA network representation
3.4 Further Research – The Future

The future research questions collected were categorized into four groups.

First Group refers to questions concerning essential aspects of proximity and innovation. The multidisciplinary literature has expanded the boundaries of proximity research, thus diminishing both clarity and unanimity regarding the nature of the numerous proximity dimensions (Capone and Lazzeretti 2018). Therefore, future research should investigate the conceptual development of proximity, thus enhancing the definitions that can capture the true meaning of each dimension (Lazzeretti and Capone 2016; Steinmo and Rasmussen 2016). Furthermore, as personal bonds can influence strategic, research and business collaborations, the concept of personal proximity must now be considered in the proximity framework (Ooms et al. 2018). In addition, the synergic effect between different types of proximity is still controversial (Marek et al. 2017), thus requiring further investigation into the interactions among proximities (Fitjar et al. 2016; Presutti et al. 2017; Steinmo and Rasmussen 2016). From the innovation perspective, many authors have underlined the necessity to differentiate both the sources and types of innovation, to achieve a better understanding (Li et al. 2018; Geldes et al. 2017; Presutti et al. 2017; Pucci et al. 2017). In terms of the relationship between
proximity and innovation, the impact of actors’ technological distance on collaboration and innovation should be assessed (Kudic et al. 2016; Pucci et al. 2017; Rodríguez et al. 2018). Moreover, the ‘perspective that argues that contemporary information and communication technologies (ICTs) provide a way to leapfrog the dominant role of proximity in innovation processes, creating a complimentary rather than a substitution effect for more remote and peripheral places’, merits further investigation’ (Baycan et al. 2017, 962). Similarly, future research should investigate the ability of digital technology to foster knowledge flows (Forman and van Zeebroek 2018). Last, ‘more research is needed to understand how innovation processes and collaborative dynamics unfold at the intersection between virtual and physical spaces’ (Aslesen et al. 2018, 10).

Second Group refers to those questions concerning actors and relationships. In terms of actors, recent interest has increased for multinational enterprises and their commitment to local innovation dynamics (le Duc and Lindeque 2018). Similarly, researchers are questioning the role that anchor firms may play in local level innovation productivity (Hamidi and Zandiatashbar 2018). For what concerns actors’ characteristics, diversity on knowledge base and on contingency factors (such as absorptive capacity) and their relationship with proximity and innovation should be further investigated (Presutti et al. 2017; Rodríguez et al. 2018). Moreover, both organizational structures and firms’ boundaries should be considered as factors influencing innovative collaboration and knowledge diffusion (Crescenzi et al. 2016). On terms of relationships, there is a necessity to reveal, deepen and identify knowledge-sharing instruments (Rodríguez et al. 2018), formal mechanism for gathering knowledge spillovers from market stakeholders (Li et al. 2018), and patterns of knowledge exchange between public and private research (Rizzo et al. 2018). The differential effect of intentional and serendipitous knowledge flow relying on vertical and horizontal cognitive ties, has been recently identified, thus calling for further research (Teixeira and Oliveira 2017). Additionally, both formal and informal relationships should be investigated and compared to understand the relational dynamics of networks (Capone and Lazzeretti 2018). Last, further research on the role of trust and of other social capital dimensions in local environments is required (Nestle et al., 2018; Nugroho, 2018).
Third Group refers to various challenging and promising questions. Further research should (i) include the nature, scope and scale of collaborative agreements (Drejer and Østergaard 2017), (ii) understand the reason why actors cooperate (Crescenzi et al. 2016), and (iii) analyze partner selection decisions (Gattringer et al. 2017). For researchers to take multifaceted and dynamic perspectives, they should examine the influence power constellations have on the impact of proximity dimensions on collaborations and innovation (Hansen and Mattes 2017). Additionally, investigations into spatial ambidexterity, which is the technological exploration and exploitation pursued by firms in local environments, should be further extended to include non-technological activities (Geerts et al. 2018). From a managerial perspective, the combination of management of proximities and knowledge bases may generate a new organizational capability, which is particularly valuable in a multi-locational company (Davids and Frenken 2018).

Fourth Group concerns technical or methodological issues examined in the literature. Many authors have questioned the suitability of using patents to measure technological capabilities or innovation (Aharonson and Schilling 2016; Liang and Liu 2018). Furthermore, both network and longitudinal analysis are required to understand the evolution of relationships (Leszczyńska and Khachlouf 2018; Romero 2018). Qualitative research can also address the challenge of understanding the reasons behind knowledge exchange and inter-firm collaborations (Jespersen et al. 2017; Teirlink 2018).

4. Conclusion and Limitations
This research demonstrates an increase in the proximity literature over the last decade, both in terms of numbers of contributions and issues covered. The contribution of Boschma (2005) was found to be fundamental to analytically summarizing previous research intuitions and findings, thus providing the literature with a structured framework comprising the pros and cons of each highlighted proximity dimension. The literature then entered a second phase of exploration towards new dimensional conceptualizations. However, as previous research has found (e.g.: Capone and Lazzeretti 2018; Lazzeretti and Capone 2016), this development increases the ambiguity and divergence in the
definitions of the nature of proximities, and the empirical results are often conflicting. As the 17 dimensions described in Table 5 show, the path of the concept of proximity has become dispersed. Additionally, as previously noted by Knoben and Oerlemans (2006), several proximity definitions overlap (e.g.: cognitive-technological, institutional-cultural, institutional-organizational, vision-organizational, etc.). This ambiguity and the fragmentation of proximity dimensions may become detrimental. Indeed, if we break up the concept of proximity into many subdimensions, we risk considering proximity as a discontinuous phenomenon, thus losing the aggregate dimension. We are thus in danger of creating an ineffective concept of proximity. Thus, as future research suggests, it is necessary to reach an agreed conceptualization of proximity. This work represents a first contribution towards this goal, thus offering the following inputs to those readers looking for the red thread linking proximity to innovation:

1. The description of the intellectual core clusters allows to detect not only themes, but those prominent journals to monitor, thus decreasing the complexity faced by old and new researchers dealing with proximity and innovation.

2. The explanation of the sub-structure and the BCA-CCA matrix enables us to place each intellectual core cluster in a broader literature picture, thus suggesting from where, how and why these themes have been originated.

3. The detection of recent literature progress offers an up to date list of modern challenges guided by the strengthening of globalization forces, new technological paradigms, new sources of competitive advantage, and new ways in which actors interact.

This work presents some limitations. As in any bibliometric analysis, our results are influenced by the online abstract and citation database selected, the key words searched, the subject areas selected, and the journal rankings used for the detection of the most influential journals. The description of the bibliometric findings is also the result of the subjective understanding of authors, and thus liable to bounded rationality. Additionally, future research indications are collected from articles and conference proceedings published in the last three years. Nevertheless, we recognize that some major
future research findings may have emerged in previous years, and thus we hope future research will accomplish a more inclusive investigation in this direction. Furthermore, we have not included contributions from journals that mainly deal with geography, so we hope that this gap will be filled by further contributions in this area (e.g.: Yu and Jun 2018).

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