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Innovation intermediaries' types and functions: a computational analysis of the literature

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Abstract

Innovation intermediaries have become numerous and diverse. Faced with this growing heterogeneity, there is the need to advance understanding of the organisations that engage in innovation intermediation activities. To do so, we use a combination of text mining and bibliometric techniques, and we identify seven different streams of literature, six of which refer to distinct types of intermediaries that perform specific functions and often involve specific types of organisations. Looking at the evolution of the different streams of literature over time, we find that the early contributions focused on university incubators, science and technology parks, and the role they play within different types of innovation systems. More recently, the focus has shifted to the role of intermediaries in supporting sustainable transitions. Despite the differences between the various types of intermediaries and the literature streams that analyse them, the bibliographic coupling shows that all strands of literature have a common theoretical basis, which includes the open innovation approach and revolves around the role of science parks and incubators.

Key words: Innovation intermediaries, computational literature review, open innovation intermediaries, innovation system intermediaries, transition intermediaries, cluster intermediaries, KIBS, incubators

1. Introduction

As innovation processes become more complex and distributed, involving a multitude of organisations, coordination issues have come to the fore. Most new technologies are systemic in nature, requiring the integration of components and platforms developed by companies with different competences and often in different locations (Coombs et al., 2003; Teece, 2018). Frontier research in such technologies increasingly requires the mobilisation of multidisciplinary teams from academia, public research and industry, who collaborate in the context of publicly-funded projects or public-private partnerships (Kulkarni, 2007; Leydesdorff and Wagner, 2008; Hand, 2010).

The growing need to bring together firms, universities, research institutes and other organisations in the context of complex innovation processes has intensified the debate around organisations that support firm-level and collaborative innovation – often called knowledge, technology or innovation intermediaries (Dalziel, 2010; Bakici et al., 2013; Kivimaa et al., 2019; Rossi et al., 2020, 2022). Research about innovation intermediaries dates back to at least the early 2000s (van Lente et al., 2003; Hoppe and Ozdenoren, 2005; Howells, 2006; Winch and Courtney, 2007; Stewart and Hyysalo, 2008). However, as the literature on intermediaries has expanded, our overall understanding of what innovation intermediaries do and of their characteristics has become hazier. This is so for at least two interrelated reasons.

First, the literature has approached intermediaries from a variety of perspectives, using various terms (e.g., brokers, matchmakers, boundary spanners) and focusing on different types of organisations (including, among others, knowledge-intensive business services providers - KIBS, technology transfer agencies, science parks, incubators, and virtual platforms such as crowdsourcing platforms). This heterogeneity makes it difficult to discern patterns, for example in terms of the key intermediary types and their most important functions.

Second, as intermediaries are increasingly 'in demand', they have become more numerous and more diverse, sometimes specialising in specific activities or sectors, and new types of intermediaries have been created in response to emerging needs. These include intermediaries that deal with new digital technologies, which are systemic and complex in nature, and which require the involvement of actors who are able to co-ordinate and manage these multi-party systems (Hossain, 2012; Rossi et al., 2022). Moreover, the need to invest in sustainability has led to the creation of intermediaries that support sustainable transitions (Polzin et al., 2016; Kivimaa et al., 2019). The expansion of the variety of intermediaries makes it more difficult to identify their common traits and differences.

Faced with this growing heterogeneity, the limitations of subsuming this complex phenomenon under one or a few terms like 'intermediaries' or 'brokers' have become clear, and there are

growing calls for advancing understanding of which organisations engage in innovation intermediation activities, how they differ, and how they relate to each other (Dalziel, 2010; Rossi et al., 2020). The present study aims to fill this knowledge gap by comprehensively mining the literature on innovation intermediaries that has been produced in the last four decades (from 1976 to 2019), in order to identify the key 'types' of intermediaries as they emerge from the literature, and the key organisational characteristics, functions and activities of each type of intermediaries. We also analyse the extent to which the different 'types' are underpinned by separate or overlapping theoretical approaches and sub-fields of literature. To do so, we use a combination of text mining and bibliometric techniques. Starting with a systematic literature search, we analyse the resulting *corpus* (body of texts) to identify its most characteristic features and how these features change over time. We then perform a cluster analysis of articles' title and abstracts, through which we identify different 'types' of intermediaries and, combined with the content analysis of the texts (i.e., the analysis of titles and abstracts and –when necessary –the entire papers), we describe their organisational characteristics, functions and activities. To understand whether and to what extent the various clusters are related in terms of underpinning conceptual frameworks and references to the same literature sub-fields, we also analyse (again by means of content analysis of the texts) the theoretical approaches characterising each cluster, and we deploy a bibliographic coupling analysis.

This paper is original in both scope and methodological approach. While there have been some recent reviews of the literature on innovation intermediaries, they have usually taken specific angles. For example, some studies have adopted the perspective of specific sectors (Klerkx and Leeuwis, 2009; Kilelu et al., 2011; Katzy et al., 2013), or narrowed the definition of intermediaries to specific types (Colombo et al., 2015; Watkins et al, 2015; Albort-Morant and Ribeiro-Soriano, 2016; Hausberg and Korreck, 2020). Others have aimed to understand and improve policies for innovation intermediaries, thus focusing mainly on publicly-funded intermediaries (Dossou-Yovo and Tremblay, 2012; Russo et al., 2018; Rossi et al., 2022), or have reviewed the literature in specific streams such as open innovation (Lopez-Vega and Vanhaverbeke, 2009; Hossain, 2012) or systemic transitions (van Lente et al., 2003; Gliedt et al., 2018; Kivimaa et al., 2019). Several functional taxonomies of intermediaries have been conducted, from the pioneering work by Howells (2006), to more recent efforts by Lopez-Vega and Vanhaverbeke (2009), and Agogué et al. (2017). However, these taxonomies have either been developed empirically in relation to specific sectors or technologies, or, when based on the literature, they have built upon a limited number of articles in a particular research stream.

Our study differs from others insofar as, by adopting a comprehensive approach, we are able to identify patterns that other studies have not uncovered.

We are able to identify six types of innovation intermediaries, with partially different functions and activities: from university incubators, to intermediaries in innovation systems and clusters, KIBS, and, more recently, open innovation intermediaries and transition intermediaries. The content analysis of the abstracts of articles in these clusters shows that these intermediaries have different organisational characteristics and functions. The analysis of the underpinning theoretical approaches and the bibliographic coupling, however, indicate that the literature on open innovation (Chesbrough, 2003; Chesbrough et al., 2006), together with some landmark works on innovation, is used across the board to analyse all these types of intermediaries.

Our findings have implications for research, policy and management practice. Methodologically, we contribute to a small but growing stream of computational literature reviews (Mortenson and Vidgen, 2016; Kunc et al., 2018; Bianchini et al., 2020; Rizzoli et al., 2021) developed since the mid-2000s (Antons et al., 2020) that has potential applicability in many fields, since such reviews allow for fast identification of patterns within a large number of articles. Conceptually, we significantly advance knowledge about innovation intermediaries, providing a comprehensive view of these organisations, and identifying gaps that future research should address. Our findings can be of use to policymakers, since a better understanding of the landscape of innovation intermediaries can help them design effective policies and define their scope more accurately. They can also be useful to managers of innovation intermediaries, who can benefit from greater awareness of the nature and activities of organisations in their sector, in order to improve their positioning and build their competitive advantage within an increasingly crowded field.

The paper is organised as follows. In section 2, we discuss efforts that have been made so far to develop taxonomies of innovation intermediaries and their functions, highlighting how the present work goes beyond prior studies. In section 3 we describe the data and in section 4 our empirical approach. In section 5 we discuss our findings while section 6 concludes with implications for future research.

2. Types of intermediaries and intermediation functions

Innovation intermediaries are organisations that support firms in the context of innovation (Dalziel, 2010). This general definition however masks great variety, both in terms of the types of organisations that can be considered innovation intermediaries (or that perform at least some of the functions of innovation intermediaries), and the functions that they perform. In fact, the literature has acknowledged that there is not a single organisational form that can be considered typical of an innovation intermediary – rather, there are many different types of organisations that perform some kind of innovation intermediation functions (Howells, 2006; Caloffi et al., 2015).

2.1. The functions of innovation intermediaries: an overview

The functions of innovation intermediaries have been investigated extensively since the mid-2000s, with the early work by Howells (2006) representing one of the first efforts to characterise innovation intermediaries as a phenomenon in its own right, and to systematise our understanding of their activities and roles. Over time, the scope and amount of innovation intermediaries' activities have expanded (Dalziel, 2010; Kivimaa et al., 2019), and so has the literature investigating this phenomenon.

Initial studies of innovation intermediaries focused mainly on their role of improving the resources, competences and capabilities of client firms, thus leading them to change their innovation behaviours and achieve better performance. In order to boost firms' access to information, intermediaries perform activities such as support for networking, relationship brokering, and information diffusion, for example through targeted introductions and meetings, organisation of various kinds of events, and the provision of interaction spaces (Acworth, 2008; Etzkowitz and Leydesdorff, 1998; Kodama, 2008; Rossi et al., 2010) This support can be particularly valuable to newly created firms and SMEs (Colovic and Lamotte, 2014), which are usually less open than other organisations to external collaborations (Rothwell and Dogdson, 1991). Intermediaries also help firms to boost their innovation capabilities by directly providing training (in the use of specific technologies or in general management) or knowledge-intensive services (such as support for patent search and patent licensing, testing and certification), or by intermediating the provision of services that are able to support their competences (Bessant and Rush, 1995). This activity is particularly important for small and medium-sized enterprises (SMEs), which often lack the ability to acquire useful knowledge, competencies or technologies, or the ability to successfully implement those into products and services. Moreover, firms may be unaware of the knowledge, competencies and technologies they are lacking (Brusco, 1992; Kaufmann and Tödtling, 2002). Through activities such as knowledge and technology mapping, innovation intermediaries can help firms to gain awareness of what they need, in order to find the most appropriate way to acquire it.

Intermediaries can also stimulate collaborative innovation, not only by creating connections between people in different organisations, but also by coordinating collaborative innovation processes themselves; they can do so because they are (supposed to be) able to bridge different knowledge and competencies (Colovic, 2019). One of their main capabilities is to bring together actors from different institutional backgrounds who are too cognitively distant to adequately learn together (Nooteboom, 2000), or who have different norms, values and incentive systems that hinder effective communication (Klerkx and Leuuwis, 2009).

More recently it has been noted that, besides supporting individual economic actors, the activities of intermediaries can strengthen the innovation system as a whole. They can improve information flows in the system (Malerba, 2009), by diffusing information about useful and applicable techniques or technologies for product and service development (Howard Partners, 2007; Rosenkopf and Nerkar, 2001), opportunities for collaborations with other actors (Bougrain and Haudeville, 2002; Colovic and Lamotte, 2014), and by providing shared platforms for communication and exchange. They can also strengthen the formal or informal institutions supporting innovation (Wright et al., 2008), by providing or facilitating access to innovation infrastructures and by facilitating the emergence of social norms that underpin good innovative performance, as when their support for collaborations promotes mutual trust.

2.2. Taxonomies of intermediaries

The literature has proposed several functional taxonomies of intermediaries. The seminal study by Howells (2006) listed ten different, broad functions of intermediaries, and provided examples of organisations performing each function. More recently, a parsimonious taxonomy proposed by Lopez-Vega and Vanhaverbeke (2009) grouped innovation intermediaries in three different function-based categories: intermediaries focused on connecting activities, which include gatekeepers and knowledge brokers; intermediaries that provide collaboration and support services; innovation intermediaries focused on technological services. Agogué et al. (2017) also differentiated between three different classes of intermediaries based on their main functions: intermediaries for problem solving, which support firms that lack special skills or knowledge in the course of a specific problem or for developing an innovation, by connecting firms with external experts or by providing their own knowledge; brokers for technology transfer, which commercialise technological developments; and innovation intermediaries that act inside an innovation system and support networking, build objectives and recruit new organisations for the system. Some functional taxonomies of intermediaries have been developed in relation to specific sectors or technologies, such as agriculture (Klerkx and Leeuwis, 2009; Kilelu et al., 2011), space technology (Vidmar, 2021) or new product development services (Colombo et al., 2015).

A limitation that is common to all of these taxonomies is that they are based either on empirical analyses focused on a specific sector or technology, or on reviews of the literature that examine specific streams such as open innovation, and that build on a relatively small number of articles. So far, no attempt has been made to develop a classification of types and functions of intermediaries based on a systematic review of the literature, supported by automated text analysis methodologies. Our computational review of the literature, covering over four decades of research, uses text mining

and bibliometric analysis in order to characterise the phenomenon of innovation intermediaries comprehensively, and detect patterns over time and across different topics.

3. Data

Data collection for the review followed the four phases of the PRISMA statement and guidelines: identification; screening; eligibility; and inclusion (Moher et al., 2009). Our data come from scientific journal articles. To identify relevant articles, we performed a search on the Elsevier-Scopus database (www.scopus.com) using several criteria. We considered journal articles written in English and published in the fields of economics, business/management and social sciences (all years). Drawing on the existing general taxonomies of innovation intermediaries (Howells, 2006; Lopez-Vega and Vanhaverbeke, 2009; Rossi et al., 2022), we chose a combination of several keywords, some of which are related to the many labels that can be found in the literature in relation to intermediaries (e.g.: science park, KIBS), and others that are related to different intermediary functions (e.g.: matchmaker, boundary spanner, advisor). We made this choice because a wider range of agents than the one identified with the "intermediary" label can perform intermediation functions.

In particular, we used the following keywords: innovation AND intermediar*, innovation AND broker, innovation AND matchmaker, innovation AND boundary spanner, innovation AND advisory service, innovation AND KIBS, innovation AND service centre/center, innovation AND science park, innovation AND incubator).[1] The keyword search was performed in all areas (title, abstract, keywords). Table 1 shows the results of our search. Once we eliminated any duplicates[2], we obtained a sample of 1,404 papers that have been published in 558 scientific journals from 1976 to 2019.

The scientific debate on intermediaries is hosted by a large number of journals (Table 1, third column), which, on average, have published 2.5 articles on intermediaries over the entire period. However, the average figures hide a long-tail distribution in which few journals host a significant share of contributions, and many others (235, or about 42% of the journals) host only one article.

[1] We excluded from our database search results for articles using some of the terms mentioned by Howells (2006) as possible labels used to indicate innovation intermediaries, because they lacked clarity and consistency. The keyword combinations excluded were innovation AND gatekeeper, innovation AND third parties, innovation AND bricoleur, because they provided very heterogeneous results. A word like gatekeeper combined with innovation can be found in papers referring to very different topics, not necessarily to innovation intermediaries, which are the focus of our analysis. At the same time, there may be papers that do in fact talk about intermediaries but are not included in this literature review. For example, a paper that talks about incubator X without ever using the term incubator or intermediary or any of the above terms is not included in our review. We will elaborate on this point in section 5.3.

[2] The number of duplicates is very high, which reinforces our belief that different labels and functions converge into a unique, although varied, field of research.

Table 1. Number of journal articles and journals by keyword search

Keyword search	N. journal articles	N. journals in which articles are published	Average n. of articles by journal
Innovation + intermediar*	154	93	1.7
Innovation + broker*	382	256	1.5
Innovation + matchmaker*	4	4	1.0
Innovation + boundary spanner*	54	46	1.2
Innovation + advisory service*	73	44	1.7
Innovation + KIBS	197	88	2.2
Innovation + service centre/center*	40	38	1.1
Innovation + science park*	199	89	2.2
Innovation + incubator*	391	194	2.0
Total (duplicates excluded)	**1404**	**558**	**2.5**

Table 2 displays the top 10 academic journals by number of articles on intermediaries. *Technovation* and *Research Policy* are on the top of the list that includes many innovation management journals, as well as field journals on rural innovation (*The Journal of Agricultural Education and Extension*) or local development (*European Planning Studies*). The full list of journals, which is not shown here, features many journals from different subject areas, from political science to sociology, marketing, finance, information systems, and education.

Table 2. Top 10 journals by number of articles

Top 10 journals
Technovation (41)
Research Policy (36)
International Journal of Entrepreneurship and Innovation Management (33)
Journal of Technology Transfer (30)
International Journal of Innovation Management (27)
Technology Analysis and Strategic Management (27)
International Journal of Technology Management (26)
Technological Forecasting and Social Change (26)
Journal of Agricultural Education and Extension (24)
European Planning Studies (21)

Note: In brackets, we indicate the number of articles published on the topic of our interest.

As shown in Figure 1, the research field has grown steadily, especially since 2010, from few articles per year between the 1970s and the early 2000s to 166 articles in 2019. The incidence of the literature on innovation intermediaries on the total number of articles published on Scopus has grown significantly over time, as can be seen from Figure 2, which shows the share of articles published in Scopus that refer to innovation intermediaries. The variety of journals has also

gradually expanded: until 2009 articles on intermediaries were published in 192 journals, while from 2010 onwards the number of journals has increased to 447.

Figure 1 - Number of academic articles per years

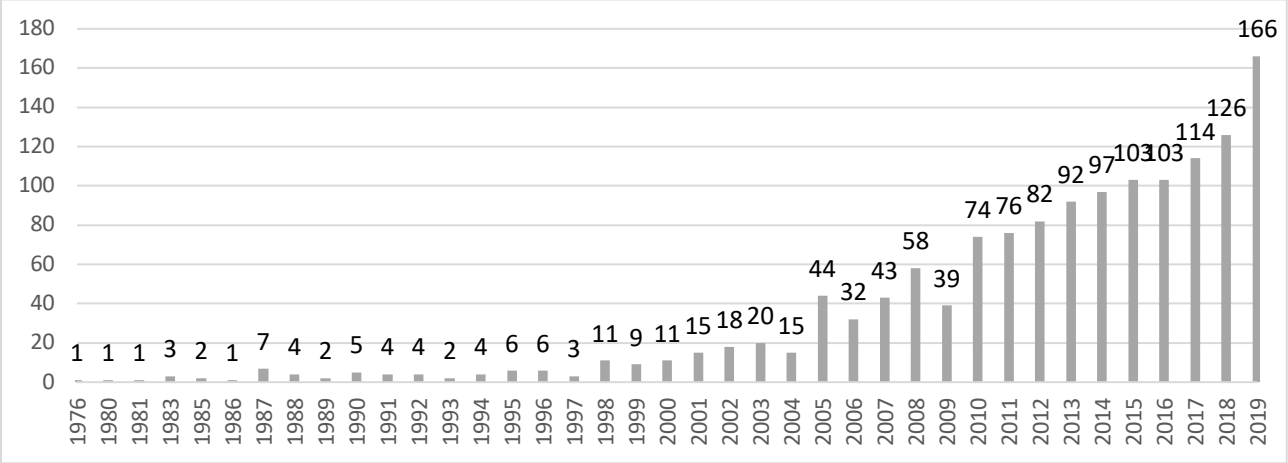
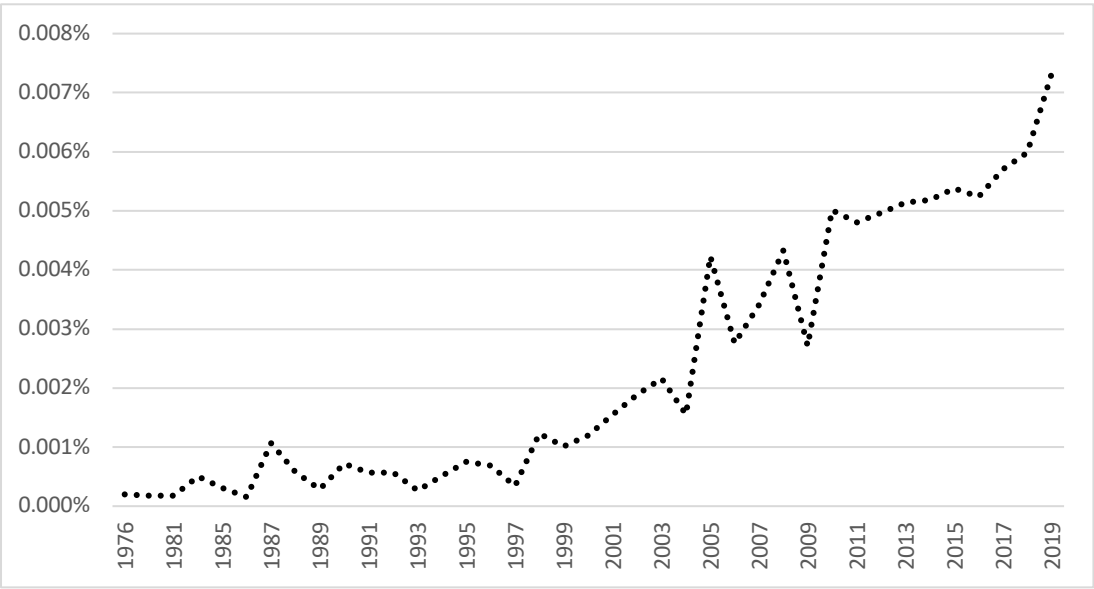


Figure 2. Percentage of innovation intermediaries-themed articles in the total number of articles published in Scopus



Note: the total number of articles included in the Scopus database is taken from Thelwall and Sud (2022)

To create our dataset for text mining, we collected the titles and abstracts of the 1,404 articles included in our sample. They constitute the textual *corpus* under analysis, which comprises 271,712

occurrences (word-tokens) and 13,548 distinct forms. The lexicometric measures showed that the corpus has a good redundancy[3] (Lebart et al. 1998; Tuzzi 2003; Bolasco 2013), which is fundamental as we are using an approach based on words count. In fact, the type/token ratio (number of distinct forms, i.e., words as they appear in the dictionary, divided by the total number of occurrences) is < 20% and *hapax legomena* (forms that appear only once) stand for < 50% (see Table 3).

Table 3 – Lexicometric measures of the corpus

N – Word-tokens	271,712
V – Word-types	13,548
(V/N)*100 – Type/Token ratio	4.99
(V_1/V)*100 – Hapax percentage	42.85

The textual corpus was homogenised with minimal intervention. We performed the analysis with words "as they occur", without replacing them with lemmas or stems. Uppercases have been replaced with lowercase letters by means of the TaLTaC2 software package (version, 2.10.2, Bolasco et al., 2000). Multiword expressions (or, simply, multiwords), i.e., meaningful sequences of words, with frequencies ≥ 10 were identified following a two-step procedure. First, we implemented an automatic search for the repeated sequences of words in the *corpus* (e.g., a noun followed by another noun, as in "science park"; Pavone, 2018). Then, such sequences were manually checked by three different co-authors, and discussed to agree upon their relevance. Such procedure allowed us to identify 308 multiwords.

4. Empirical approach

In order to identify groups of articles that refer to similar 'types' of intermediaries and describe their features (organisational characteristics, functions) we analysed the text using three different content analysis techniques (Tuzzi, 2003), combining quantitative techniques such as lexical correspondence analysis and cluster analysis, with a classical (qualitative) content analysis. To identify the underpinning theoretical approaches and the degree of similarity between the literatures, we combined qualitative content analysis and a bibliographic coupling exercise.

[3] Redundancy is understood as repetition of words sufficiently to be able to count, i.e. to carry out quantitative analyses of texts with a bag-of-words approach (that is based on words count).

First, in order to identify groups of articles that refer to similar 'types' of intermediaries, we performed a cluster analysis on the title and abstract of the articles in our dataset. This allowed us to identify groups of articles that used the same meaningful "lexical words" (cf. Reinert, 1993), i.e., groups of words referring to a class of meaning. To perform this analysis, we used the Reinert (1986) method, implemented in the IRaMuTeQ software package (version 0.7; Ratinaud, 2009). Following this method, the words that form a cluster are identified on the basis of their co-occurrence (i.e., the number of times they appear together) in the elementary units of context (ECU), which, in our case, are the combination of title and abstract. The attribution of each article to a single cluster is made on the basis of a chi square association test (Sbalchiero, 2018). The result of the cluster analysis, obtained through a hierarchical descending classification, is a dendrogram that groups together words or multiwords into classes that were created on the basis of similar lexical contexts. The maximum number of clusters to search for was set at 25. Then, the best number of clusters resulting from the analysis was determined by two parameters: maximum homogeneity into a class (i.e., the ECU in the same cluster must have the closest possible lexical content) and maximum difference between classes (i.e., the ECU that falls in different clusters must have as few words in common as possible).

Second, to analyse the content of the clusters, we carried out a qualitative, classical content analysis of the papers. This analysis was aimed at identifying the distinctive features of the intermediaries analysed in each cluster. A careful reading of the texts (i.e., titles and abstracts and, when necessary, the entire paper) allowed us to identify the following features: the type of intermediary investigated in the cluster (e.g., innovation centres, KIBS, incubators); the nature of such organisations (public or private); their main goals; the main activities they perform; and the most common theoretical approaches used to analyse them. We then observed the distribution of articles within and across each cluster over time.

Third, in order to highlight latent temporal patterns in the *corpus* we used lexical correspondence analysis (CA). This allowed to observe how the language relating to intermediaries varies over time. CA is a statistical method that allows to visualise the associations between words, variables and words and variables (Greenacre, 1984; Murtagh, 2005). We used it to analyse the temporal pattern in words, starting from a contingency table that relates years (the modalities of the considered variable), words and years and words. This analysis was performed using SPAD software, version 5.6 (Decisia, 2003).

Fourth, to understand whether and to what extent the clusters are related in terms of references to the same literature sub-fields, we performed a bibliographic coupling exercise (Kessler, 1963). This is a very simple, but for our purpose, useful measure of similarity between journal articles (in our

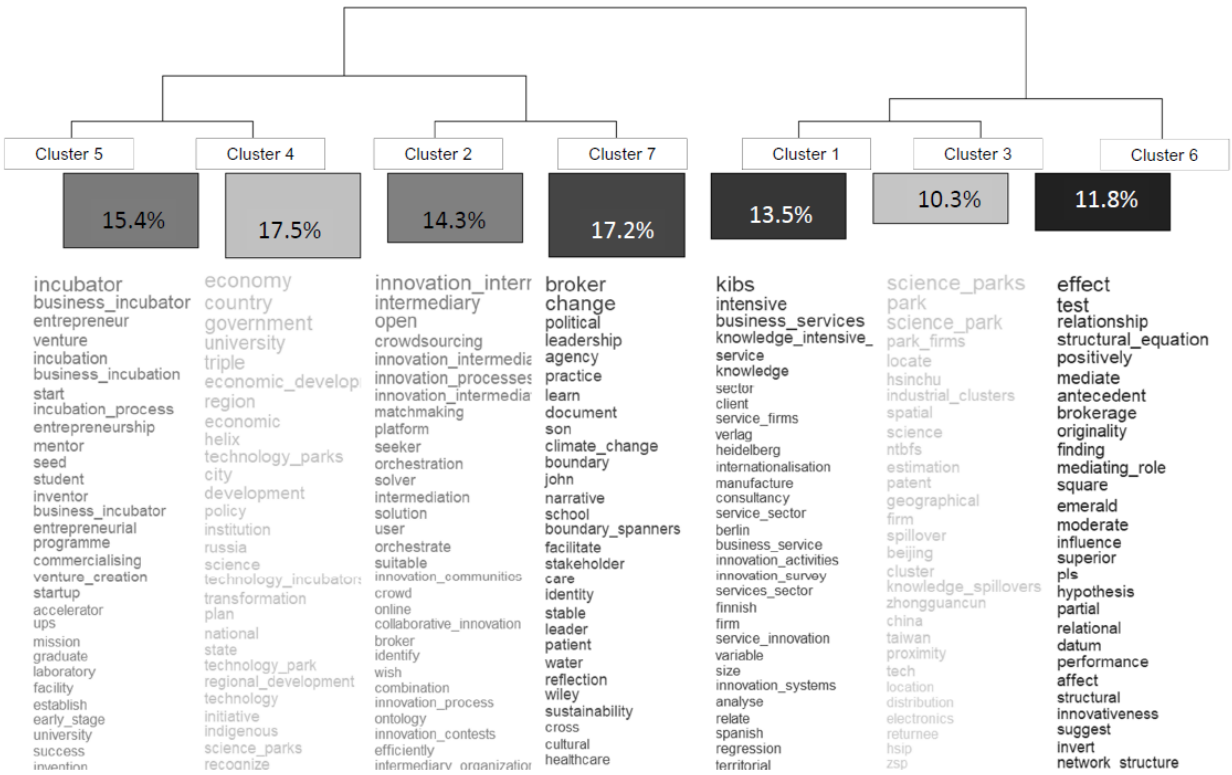
case, articles grouped in clusters). Such measure refers to the number of articles that are cited simultaneously by two or more journal articles (in our case, in two or more clusters). The higher the number of articles included in both the bibliography of cluster A and cluster B, the more closely A and B are linked. The underlying assumption is obviously that two clusters that have very similar bibliographies will also have very similar contents. Bibliographic coupling is only one of the many ways to measure similarity between articles or research fields. As shown by Boyack and Klavans (2010), no method is superior to the others, and all of them have high performance, i.e., they are able to capture with high accuracy the different aspects of similarity between scientific articles or lines of research. In this final part of the analysis, we chose bibliographic coupling because we are interested in uncovering the theoretical basis upon which the clusters – or, more specifically, the different streams of literature that are included in them – have developed.

5. Findings

5.1. Intermediary types and functions

To identify topics as discussed within different strands of intermediaries' literature, highlighting different types and functions of intermediaries, we performed a cluster analysis. The dendrogram, obtained by means of the Iramuteq software (Ratinaud, 2014), groups together words and multiwords into classes that have a similar lexical content (Figure 3). The closer two classes are in the dendrogram, the closer their lexical content. The larger the size of the font, the stronger their association with the cluster. Looking at the dendrogram, two distinct groups of clusters can easily be identified - one grouping clusters 5, 4, 2, 7 and the other grouping clusters 1, 3 and 6. This division into two large classes is important, as it corresponds to an important distinction between the literature that adopts a systemic approach, and the one that instead focuses more on a single organisation. Contributions in the former group generally adopt the point of view of a system and try to understand the role that intermediaries play in it, and how the system changes or could change as a result of the activities carried out by intermediaries. In the latter group, intermediaries can be understood as agents that operate within a system, but the focus of the literature is not that much on the system as on the intermediary.

Figure 3 –Cluster dendrogram. Words ordered by decreasing values of association (χ^2)



However, this distinction provides an oversimplified image of the relevant literature. Therefore, we analysed the content of the clusters in greater depth, through qualitative content analysis.

To systematically explore these clusters, we read the abstract and (if needed) the introduction and the theoretical section of the articles included in them and identified the following characteristics:

i) the type of intermediaries to which the analysis referred (e.g. incubators, science parks, KIBS, innovation centres)

ii) the nature of the intermediaries (public, private or mixed)

iii) the functions performed by the intermediaries and the type of activities they carry out

iv) the theoretical approaches used to analyse their activity

The results of our qualitative content analysis relating to points (i), (ii) and (iii) are presented in Table 4. The categories in our taxonomy (type, nature, functions, activities) are similar to those used in other attempts to classify intermediaries functionally (e.g. Lopez-Vega and Vanhaverbeke, 2009; Agogué et al., 2017).

Table 4. A taxonomy of intermediaries based on Reinert clustering technique

Cluster	Type	Nature	Functions	Activities
5 - University incubators	Mainly incubators	All	Incubate new firms; Support innovation in firms	Incubate new firms / support entrepreneurship in new industries / promote technological entrepreneurship
				Organise events to stimulate creativity and networking

				Provide entrepreneurship classes
				Create networks between businesses and venture capitalists
4 –Innovation system intermediaries	Science parks, technology parks, providers of advisory services	Mainly public or mixed public-private	Support innovation and technology transfer	Support university-industry R&D projects
				Support other types of R&D collaborations
				Incubate new firms/ support entrepreneurship in new industries / promote technological entrepreneurship
				Perform knowledge and technology check-ups to firms (SMEs in particular)
				Promote business education
				Develop technological leadership, also aimed at attracting innovative companies
				Support foresight exercises
				Manage knowledge across boundaries
				Organise and animate communities of practice
				Support firms, SMEs in particular, with other knowledge-intensive services
2 - Open innovation intermediaries	Mainly innovation centres	All	Support open innovation processes	Support interfirm networks
				Scout ideas and connect people/organisations who can collaborate in their development
				Create and manage interfaces between different sectors of the same organisation
				Create and manage open IT platforms or other tools that allow and motivate open participation
				Spread information on the value of openness
7 - Transition intermediaries	All (also internet platforms)	All	Promote transitions towards environmental sustainability; Promote institutional change in society; Promote organisational change in firms, public administration and other organisations	Diffuse information and promote networks to facilitate political change
				Promote interdisciplinarity in research projects
				Promote the transition to new governance systems
				Include various components of a constituency in an open debate
				Promote changes in the system of norms and standards towards sustainability
				Translate theoretical research into applied projects
				Support team collaboration
				Support foresight exercises
				Organise and animate communities of practice
				Manage knowledge across boundaries
				Give voice to transition leadership
1 - KIBS	Mainly KIBS	Private	Support innovation in firms	Perform knowledge and technology check-ups
				Perform technology and sector forecast analysis
				Monitor possible sources of funding
				Help companies to identify possible business partners
				Provide firms with other knowledge-intensive services
3 – Cluster intermediaries	Mainly science parks and incubators	All	Support innovation and competitiveness in firms	Create networks among local (regional/cluster) agents
				Bring external knowledge and technologies into the cluster
				Promote R&D collaboration projects
				Incubate new firms/ support entrepreneurship in new industries / promote technological entrepreneurship
				Provide other knowledge-intensive services to local firms (SMEs in particular)
6 – Intermediaries performance	Mainly innovation centres	All	Support innovation in firms	Support the formation of inter-firm networks
				Facilitate the integration of firms in existing networks
				Identify and connect technology experts
				Support patent licensing
				Identify and diffuse best practices in product, process and marketing innovation
				Diffuse knowledge about dominant designs
				Support firms in the identification of distribution channels

The ‘university incubators’ cluster gathers articles (15.4% of the total) mainly related to incubators, and to university incubators in particular. Incubators support the birth of new businesses and entrepreneurs – some of them focusing on high tech sectors or emerging industries (Cooke et al., 2006; McAdam et al., 2006; Jamil et al., 2015). To this end, they perform the usual functions of incubation, organise events to stimulate entrepreneurial ideas, promote entrepreneurship education, induce networking between venture capitalists and nascent entrepreneurs or between established entrepreneurs and new entrepreneurs (Lamperti et al., 2017). The ‘innovation system intermediaries’ cluster is the largest, comprising 17.5% of the articles. The literature included in it mainly refers to public (or public-private) science parks, technology parks, providers of advisory services. These intermediaries have, at least partly, a public mandate: policymakers might task them to address specific system failures (Intarakumnerd and Chaoroenporn, 2013; Russo et al., 2018), to facilitate the exchange of knowledge across boundaries, to avoid that certain territorial contexts become prey to knowledge lock-ins or other obstacles to innovation, or to provide support for what can be perceived as the most fragile components of the system (Smedlund, 2006; Polzin et al., 2016). For example, science parks can be required to support nascent entrepreneurs, while advisory service providers are often required to help small firms (Etzkowitz, 2002; Vedovello and Godinho, 2003). More generally, intermediaries included in this cluster operate to strengthen relations among organisations within a territorial, sectoral or technological context, which could generate innovation (Klerkx and Leeuwis, 2009; Klerkx et al., 2015; Kanda et al., 2019). These include supporting the development of relations between universities and businesses enterprises or, more generally, among organisations that possess different pools of knowledge and skills (Doloreux and Dionne, 2008).

‘Open innovation intermediaries’ can be formal or informal organisations, operating in different fields, whose goal is to facilitate open innovation processes among firms or other organisations (e.g., universities) or individuals (e.g., seekers and solvers; communities of practice). These intermediaries are often innovation centres that facilitate collaboration among firms in open networks (Ferrary, 2008, 2011). However, an intermediary’s role can also be played by innovation project managers, teams of employees, or crowdsourcing platforms (Lopez-Vega and Vanhaverbeke, 2009; Hossain, 2012; Garcia-Martinez and Walton, 2016; Aquilani et al., 2017). They scout new ideas, connect people and organisations that can collaborate to develop them (Hossain, 2012; Randhawa et al., 2017). They can stimulate and orchestrate networks that pursue different goals. To do so, they can use various tools, including virtual platforms.

The ‘transition intermediaries’ cluster is the second largest, with 17.2% of contributions. The group is composed of a rather heterogeneous set of organisations of different nature (public, private,

mixed) (van Lente et al, 2003; Hyysalo et al., 2018; Sovacool et al., 2020). What these organisations have in common is the fact that they play a role of breaking and mending rules and practices of an existing system, to promote change in firms, public administration or other organisations, and in the society as a whole (Bakici et al., 2013; Watkins et al., 2015; Gandara et al., 2017). Some of them work to facilitate transitions to sustainability (Matschoss and Heiskanen, 2018; Gliedt et al., 2018; Kivimaa et al., 2019). To play these roles, intermediaries organise coalitions against the status quo and give voice to leaders and communities of practice that promote change. They operate in different contexts combining different ways of seeing and thinking to facilitate the emergence of change, disseminate information and promote foresight exercises that can drive change (Rossi et al., 2020).

KIBS are organisations – mostly of private nature – which aim to support innovation in enterprises (Strambach, 2001; Wong and He, 2005). They pursue their objective by offering a wide range of knowledge-intensive services, which range from the provision of knowledge and technology check-ups, to market analysis, or support for partner search or funding sources (Shearmur, 2012; Amara et al., 2016; Rodriguez et al., 2017). KIBS also support regional innovation and regional economic development (Muller and Zenker, 2001; Simmie and Strambach, 2006; Smedlund and Toivonen, 2007).

'Cluster intermediaries' operate within geographical or technological clusters. Most are science parks around which a cluster has emerged or could emerge. Although these agents operate within a system, the system is often left in the background to focus more on the characteristics of the intermediary. The latter is here analysed in its ability to support the performance of clustered firms, where performance is measured in terms of networking abilities, competitiveness and innovation (Lindelöf and Löfsten, 2006; Huang et al., 2012). The contributions that have a higher degree of relevance to the content of this cluster analyse whether and to what extent intermediaries such as science and technology parks are able to help firms to build relationships with external organisations and ultimately to innovate (Felsenstein, 1994; Chan et al., 2010; Lai et al., 2009; Díez-Vial and Montoro-Sánchez, 2017). This ability of intermediaries may also be important for facilitating the development of clusters (Hu et al., 2005; Malairaja and Zawdie, 2008).

Finally, the articles in the last cluster focus on the analysis of intermediaries' performance (considering mostly innovation centres and science parks). This literature addresses the question of whether the ability to support firms depends on internal or external resources and competences of intermediaries, and in particular which knowledge, competences and practices (e.g., knowledge management practices) are the most useful in fulfilling the intermediation role (Bettiol et al., 2012; Carmona-Lavado et al., 2013; Knockaert et al., 2014). A small number of contributions study how

intermediaries manage to generate internal value for themselves while producing value for the firms they support (Martín-de Castro, 2015; De Silva et al., 2018). Often, intermediaries are judged on the basis of their ability to recombine pieces of different knowledge and skills, to transfer useful knowledge to firms, and to support product or process innovation (Keszey, 2018; Zhang et al., 2019; Janssen et al., 2020).

5.2. The analysis of content (topics and language) over time

The analysis of the temporal distribution of the articles within each cluster (Table 5a) shows that the clusters overlap, although they have initiated in different periods. The most established cluster is the 'university incubators' cluster, with more than 10% of the articles published before 1999; still, 63.4% of the articles in this cluster have been published after 2010. The 'innovation system intermediaries', 'KIBS' and 'cluster intermediaries' clusters have largely developed in the 2000s, but they remain significant after 2010. Finally, interest in 'open innovation intermediaries' and in the performance of innovation intermediaries has developed in more recent times, more than 80% of the contributions included in these clusters were published after 2010. Although all of the clusters remain significant after 2010, it nevertheless appears that interest in innovation system intermediaries and university incubators (and to a lesser extent KIBS and cluster intermediaries) has decreased.

Table 5. Distribution of articles within each cluster over time

#Cluster	% of articles published			
	Until 1999	From 2000 to 2009	From 2010 to 2019	Total
5 - **University incubators**	11.0	25.6	63.4	100.0
4 - **Innovation system intermediaries**	9.7	37.2	53.1	100.0
2 - **Open innovation intermediaries**	1.3	17.5	81.3	100.0
7 - **Transition intermediaries**	6.7	17.6	75.6	100.0
1 - **KIBS**	2.0	25.2	72.8	100.0
3 - **Cluster intermediaries**	4.3	22.6	73.0	100.0
6 - **Intermediaries performance**	2.3	9.1	88.6	100.0

These patterns are also evident when looking at the distribution of articles across clusters over time (Table 6). Before 1999, out of a total of 64 articles, the majority of the articles concerned university incubators (about one third of all articles) and innovation system intermediaries (about one third of all articles). As the number of articles on intermediaries increased, the distribution across clusters has become more balanced. In the first decade of the 2000s, out of a total of 255 articles, innovation system intermediaries remained very prevalent (almost one third of all articles), and the period saw strong increases in the shares of articles on open innovation intermediaries and KIBS, while the

share of articles on university incubators decreased. In the decade after 2010, the distribution appeared very balanced with each cluster accounting for between 10% and 18% of all articles. The shares of articles on open innovation intermediaries and transition intermediaries increased, while the shares of the other clusters either decreased or remained constant. The distribution of the articles across clusters is significantly different in the three periods (Pearson chi2(14) = 96.0598, Pr = 0.000).

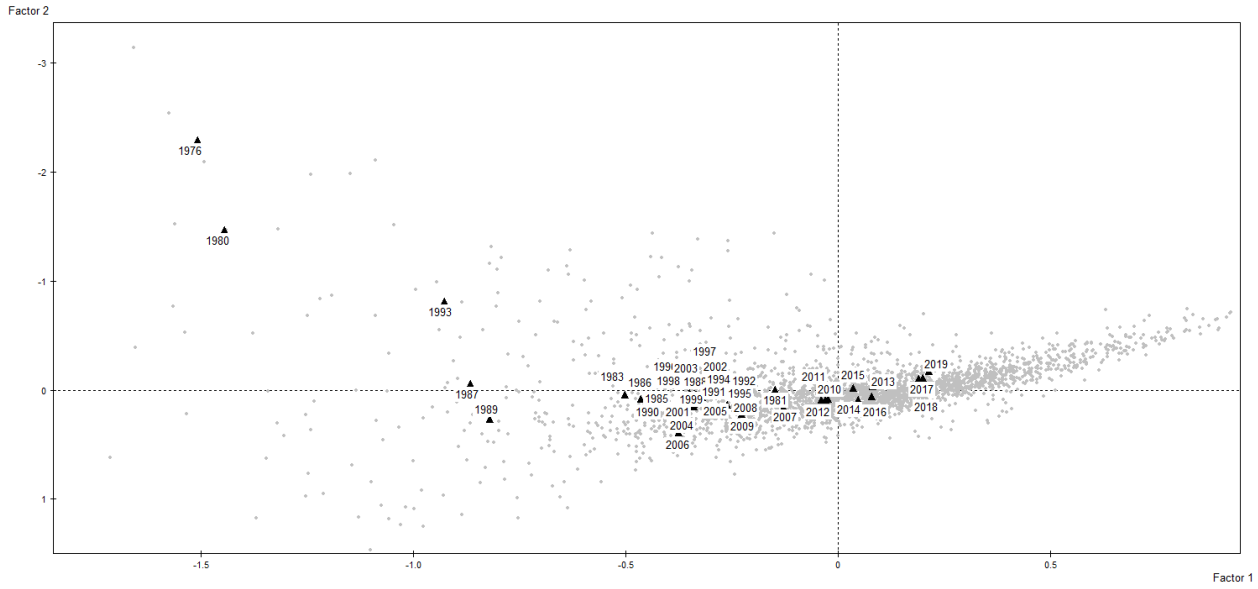
Table 6. Distribution of articles across clusters over time

#Cluster	% of articles published		
	Until 1999	From 2000 to 2009	From 2010 to 2019
5 - **University incubators**	29.7	17.3	13.6
4 - **Innovation system intermediaries**	29.7	28.6	12.9
2 - **Open innovation intermediaries**	3.1	11.0	16.3
7 - **Transition intermediaries**	20.3	13.3	18.3
1 - **KIBS**	4.7	14.9	13.8
3 - **Cluster intermediaries**	7.8	10.2	10.5
6 - **Intermediaries performance**	4.7	4.7	14.6
Total	100.0	100.0	100.0

To visualise the changes in language employed by authors to study intermediaries over time, we used a lexical correspondence analysis on the whole corpus, whose results are displayed in Figures 4 and 5. Figure 4 shows the relationship between words (and multiwords) and time. It displays the first two factors of the correspondence analysis (called Factor 1 and Factor 2) on the Cartesian plane. Together, these factors collect 10.7% of the information (explained inertia). The years are highlighted with a black triangle and a label, while the grey dots are the words and multiwords of our *corpus*. Two words are similar (and close in the graph) if they have been used with similar frequency in the same year; two years are similar (and close in the graph) if papers published in those years used the same words with similar frequency (Tuzzi, 2018).

The distribution observed in Figure 4 seems to be fairly consistent over time. Indeed, the years are placed in the plane from left to right, with 1976 to the far left and 2019 to the far right. The shape of the distribution suggests that, over time, the language becomes more homogeneous. Indeed, the dispersion of words - which is initially high - progressively decreases, and from 2010 on words thicken into very dense clouds. The emergence of a common vocabulary is a typical phase in the development of a strand of literature. It can be due to the formation of a core of articles that define the foundations of the topic (as well as the vocabulary to be used), which are increasingly cited by many authors (Sedita et al., 2020).

Figure 4 - First factorial plane of correspondence analysis. Projection of years



Note to Figure 3: The year 2000 has been set as a supplementary variable

Figure 5 puts the words in the foreground, while the years (always highlighted with black triangles) remain in the background. This analysis is broadly aligned with the time trends in the literature we discussed in section 2.1, however it is able to highlight more detail and to identify additional trends. In the early years, the literature on intermediaries focused on their role in <technological innovation> processes. These intermediaries are tools to support the <collaboration> between companies, but they are also means to provide education to entrepreneurs or aspiring entrepreneurs (<entrepreneurship education>), access to dedicated infrastructure such as laboratories and financial support (<laboratory>, <finance>). The activity of these organisations is often targeted at supporting <small firms>.

In the 1990s, a literature that analyses the territorial context within which intermediaries operate also emerges. In this regard, terms related to cities (<metropolitan area/s>) emerge, in which innovation intermediaries such as incubators or science parks are often located. As pointed out above, until 1999, much of the innovation intermediaries' research was concentrated in clusters 5 (university incubators) and 4 (innovation system intermediaries), which explains the prevalence of the terms relative to entrepreneurship and fostering collaboration between the actors of the innovation system. The territorial dimension also seems important, as innovation systems were considered as being embedded in a geographically bounded area.

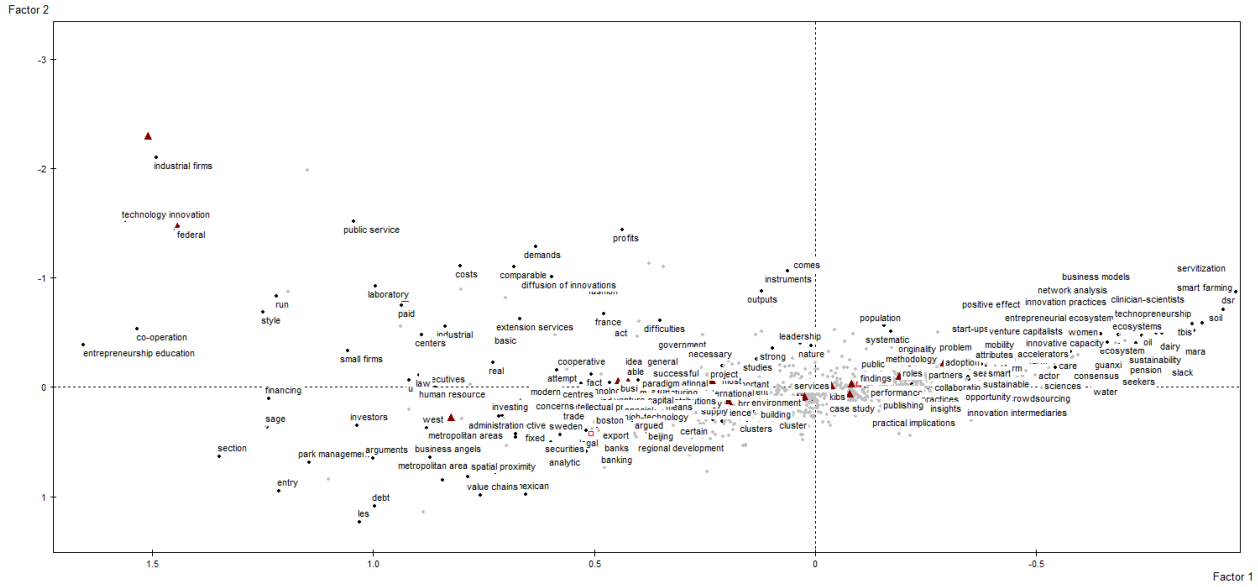
Around the year 2000 the terms related to the role of intermediaries in processes of <technological transfer> and in the management of relations between companies and universities within these relations (e.g., the management of <intellectual property rights>) gain importance. Intermediaries

are seen as organisations that can play a role in bringing start-ups and spin-offs (especially <high tech>) closer to <venture capitalists>. Between 2000 and 2009, research on university incubators (cluster 5) and innovation system intermediaries (cluster 4) has developed further, with the interest shifting from entrepreneurship to developing links between universities and to technology transfer and spin-offs.

Since 2010, studies on the role of intermediaries within <clusters> or <regional development processes> have gained prominence. Words such as <leadership> also emerge, which underline the type of role that intermediaries can play in these development processes. Leadership is also discussed in relation to the role that intermediaries can play in sustainable transitions processes. Words like <environment> or <nature> that we find since the mid-1990s are linked to this literature.

Among the latest trends, we still find the theme of <sustainability> and the themes of <collaborations> and <networks>, although this time analysed in the context of innovation <ecosystems>, in which intermediaries can play a role as system integrators. Also, the theme of support to entrepreneurship is found in recent years, but in a <technoentrepreneurship> key. In recent times, the literature also documents the role of intermediaries in facilitating the integration between manufacture and services (<servitisation>), characteristic of new technologies (e.g., IoT), as well as the application of the latter to traditional fields such as agriculture (<smart farming>). From Table 6, we can observe that, since 2010, interest has shifted towards transition intermediaries (cluster 7), which corresponds to the increased focus on sustainability and the environment. In parallel, an increase in interest in open innovation intermediaries (cluster 2) can be observed, triggered by the development of new technologies, that require a speedier innovation process, and the resulting opening of boundaries to facilitate the inflow and outflow of technology and innovation.

Figure 5. First factorial plane of correspondence analysis. Projection of the 15% of words with the highest contributions



5.3. The proximity between the various strands of literature

In order to analyse, whether the clusters differ in terms of their underpinning sub-fields of literature, we consider both bibliometric information and the qualitative content analysis of the articles.

Table 7 shows, for each cluster, some bibliometric information as well as the main underpinning theoretical approaches as they emerge from the qualitative content analysis.

Table 7. Some bibliometric information on the clusters

	Average number of authors per article	Average number of citations per article	Interdiscipl. Index (%)	Average number of articles per journal	Top three journals by number of published articles	Papers' nature	Main theoretical approaches
#Cluster							
5 - **University incubators**	2.3	21.7	20.5	1.7	J. Tech. Transf.; Int. J. Entrep. Innov. Manag.; Technovation	Mostly empirical – qualitative research	Innovative entrepreneurship
4 - **Innovation system intermediaries**	2.1	15.1	25.6	1.6	Int. J. of Entrep. Innov. Manag.; Ind. High. Educ.; Technovation	Mostly empirical – qualitative research	Triple Helix, learning region, national innovation system, regional innovation system
2 - **Open innovation intermediaries**	2.0	24.0	20.0	1.6	Int. J. Innov. Manag.; Technol Forecast Soc. Change; Technol. Anal. Strateg. Manag	Mostly empirical – qualitative & quantitative research	Open innovation
7 - **Transition intermediaries**	2.5	22.6	32.4	1.2	Res. Policy; J. Clean. Prod.; Energy Res. Soc. Sci.	Conceptual & empirical (qualitative research)	Sustainable transitions, many others
1 - **KIBS**	2.4	22.2	15.4	1.9	Serv. Ind. J.; Int. J. Serv. Technol. Manag.; Serv. Bus.	Mostly empirical – qualitative & quantitative	Many

						research	
3 - **Cluster intermediaries**	2.5	29.7	13.4	1.8	J. Technol. Transf.; Technovation; Int. J. Innov. Manag.	Mostly empirical – qualitative research	Innovation cluster, regional innovation system
6 - **Intermediaries performance**	2.6	24.3	18.5	1.6	J. Knowl. Manag.; J. Prod. Innov. Manag.; Res. Policy	Empirical – qualitative & quantitative research	Many
F-statistic	3.69	0.69					
p-value	0.0006	0.6782					

Note: The interdisciplinarity index is calculated as the percentage of Scopus categories to which, on average, the articles in the cluster are attributed, out of the total number of Scopus categories involved in our analysis. Journals' names are spelled according to the Standard Abbreviation (ISO4) of Scopus-ranked Journals.

In terms of underpinning theories, the contributions included in the 'university incubators' cluster are often inspired by the various strands of literature on innovative entrepreneurship and university spin-offs; the top journals in terms of the number of publications of the cluster are in the area of entrepreneurship, innovation and technology transfer: *The Journal of Technology Transfer*, *Technovation*, *International Journal of Entrepreneurship and Innovation Management*. Most of the articles included in this cluster take a qualitative approach and focus on case studies related to specific territorial or technological systems (e.g., Sofouli and Vonortas, 2007; Battistoni and Barbero, 2019). Others have a more theoretical focus, and are aimed at constructing taxonomies or conceptual frameworks that are useful for understanding the variety of incubators, their roles and performance (e.g., Mian, 1994; Bergek and Norman, 2008). Among the most cited contributions we find seminal contributions on academic incubators such as Mian (1994, 1996).

The articles in the 'innovation system intermediaries' cluster build on a fairly wide range of theoretical approaches, including the Triple Helix models of innovation, the learning region, the national and the regional innovation system, and have been published in a wide range of journals. Also in this cluster, as in the previous one, most of the articles are empirical contributions that take a qualitative approach based on case studies. Among them, we also find the most cited contributions in the cluster, such as Klerkx and Leeuwis (2008, 2009).

The articles in the 'open innovation intermediaries' cluster build mainly on the open innovation literature, and have been published in several innovation management journals, such as *International Journal of Innovation Management*, *Technological Forecasting and Social Change* and *Technology Analysis and Strategic Management*. Among the most cited papers we find some of Henry Chesbrough's work (e.g., Chesbrough and Brunswicker, 2014), along with quantitative empirical studies such as Lee et al. (2010) or qualitative case-study research such as Antikainen et al. (2010), Sieg et a.l (2010) or Alexander and Martin (2013).

The theoretical approaches used to study 'transition intermediaries' are the most diverse. Indeed, the interdisciplinarity index is very high - the highest among the observed clusters. At the same time, the number of articles per journal is the lowest, as research in this field has been published in a relatively wide variety of journals. Among the most cited papers we find the conceptual contributions by Van Lente et al. (2003) and Kivimaa et al. (2019).

By contrast, the interdisciplinarity index of the 'KIBS' cluster is relatively low. Articles on KIBS are often published in a relatively narrow range of journals, including field journals, specialised in the analysis of the service sector (*Service Industries Journal*, *International Journal of Services*, *Technology and Management Service Business*). However, the theoretical approaches used are varied. Most of the papers in this cluster are qualitative empirical analyses based on case study analysis. Among the most frequently cited articles, we find the seminal contribution by Muller and Zenker (2001).

Contributions included in the 'cluster intermediaries' cluster build on the theoretical approaches of innovation clusters and regional innovation systems. These articles receive, on average, a relatively large number of citations (the largest among the observed clusters). The interdisciplinarity is the lowest, because the contributions tend to be concentrated in the field of innovation management, and in a relatively small number of journals, among which the *Journal of Technology Transfer*, *Technovation*, and *International Journal of Innovation Management*. Among the most frequently cited articles are some of Phil Cooke's works (e.g.: Cooke, 2002), as well as Zhang and Li (2009) and Kodama (2008).

Finally, the articles in the 'intermediaries' performance' cluster focus on the innovation management category (top three journals are: *Journal of Knowledge Management*, *Journal of Product Innovation Management*, *Research Policy*). The performance of the intermediary is analyzed along various dimensions, and consequently the papers adopt various types of empirical approaches. However, unlike other areas of the innovation literature, such as, the evaluation of R&D subsidies, where the use of counterfactual methods is widespread (e.g., Lerner, 2000; Wallsten, 2000; Bronzini and Iachini, 2014; Howell, 2017), here the studies that take a counterfactual approach are relatively few (Cumming and Fischer, 2012).[4] Indeed, the evaluations are carried out primarily using qualitative case studies (e.g., Colombo et al 2014).

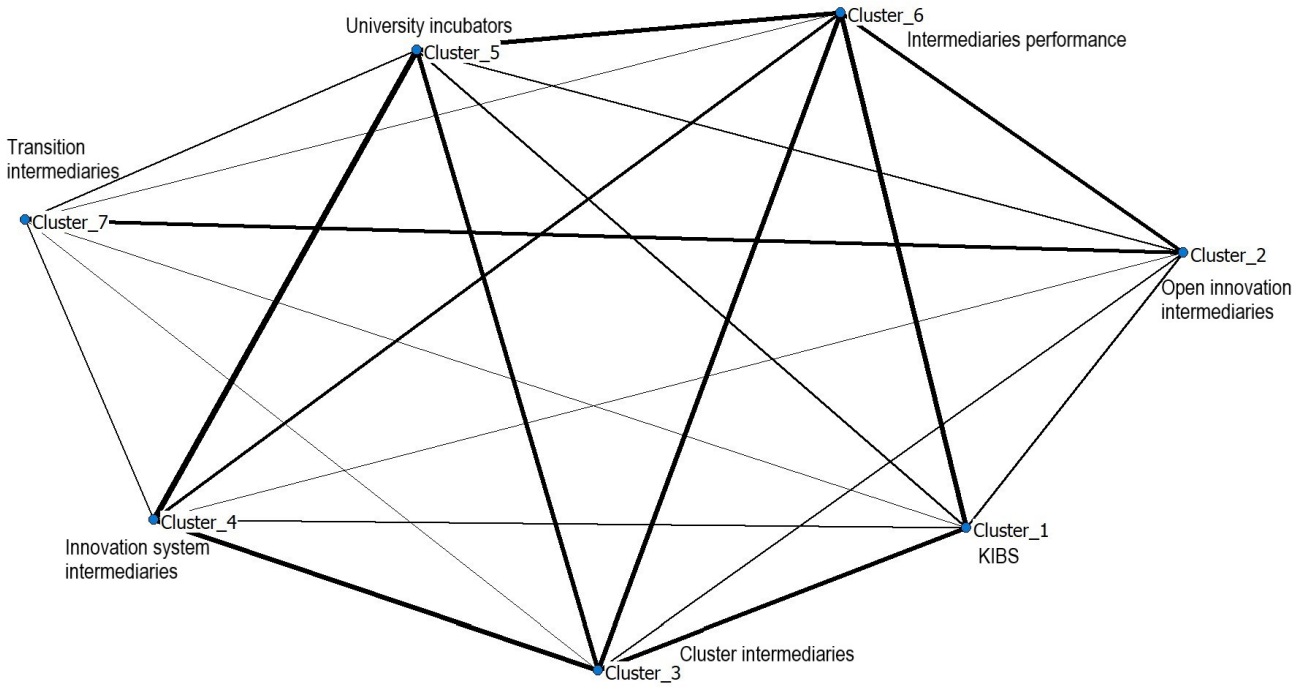
Summing up, the qualitative analysis of the clusters' main theoretical frameworks shows remarkable heterogeneity: some clusters build on a variety of theoretical approaches (innovation

[4] However, we are aware that - even if they do not explicitly use the term innovation intermediary - there are counterfactual evaluations of agencies or consortia that do in fact play this kind of role (see, for instance: Branstetter and Sakakibara, 2002; Toole, 2012; Autio and Rannikko, 2016). Nonetheless, these articles are not included in our review because they do not explicitly use the term innovation intermediary (and their variants described in the methodology) and do not refer to the literature on innovation intermediaries.

system intermediaries, transition intermediaries, KIBS, intermediaries' performance), while others build on fewer theoretical approaches, which differ across clusters (university incubators, open innovation intermediaries, cluster intermediaries). To identify the extent to which the articles in each cluster are underpinned by references to the same or different literature sub-fields, we use a similarity measure based on bibliographic coupling, i.e., on the literature cited by the various articles.

The following Figure 6, obtained using simple social network analysis techniques, shows the coupling strength between the clusters we observe. The nodes of the network are the 7 clusters identified before, and the links among them are based on the number of references they have in common. The thicker the connecting line between clusters, the more references these clusters have in common. The larger the symbol representing the cluster, the greater the number of articles included in it.

Figure 6. Network of clusters



As can be seen in Figure 6, we obtain a network in which there are no isolated nodes: each of the clusters has relations – more or less intense – with all the others. Cluster 4 (innovation systems intermediaries) and cluster 5 (university incubators) are the most closely related (the articles included in these two clusters share 231 articles in the bibliography), but also cluster 6 (intermediaries' performance) is very closely related to clusters 1 (KIBS) and 3 (cluster intermediaries), with 212 and 216 articles in common, respectively). Cluster 3 (cluster intermediaries) also has intense relations with cluster 4 (innovation systems intermediaries) (216 articles in common). The cluster that overall has fewer links to the others is cluster 7 (transition intermediaries), which relies on a relatively heterogeneous set of literatures dealing with the topic of transition.

We find, therefore, a literature base that all clusters have in common. Additionally, we also find a literature base that is common to almost all articles included in our database. Analysing the reference lists of all the articles, we found a set of more than twenty articles which are cited by about 80% of the papers analysed. This common base includes classical references on innovation, starting from the books by Schumpeter (1911, 1942), Rosenberg (1982), Nelson and Winter (1982), Rogers (1995), to works on innovation systems (be they technological or territorial) by Lundvall (1992) and Edquist (1997), or by Porter (1990, 1998) and Saxenian (1994). The list also includes contributions on open innovation by Chesbrough (2003) and Chesbrough et al. (2006), evidently cited by most articles besides those included in the 'open innovation intermediaries' cluster. Widely cited articles are also those by Yin (1989) on case study research – evidently a widely adopted methodology in studies on intermediaries –, as well as a few field articles on intermediaries, such as Hargadon and Sutton (1997) on technology brokering, and Löfsten and Lindelöf (2002) and Phan et al. (2005) on science parks.

Taking into account these common roots, and the other similarities mentioned above, it seems reasonable to consider the field of literature on innovation intermediaries as a single field, underpinned by common references to seminal papers on innovation theory, innovation systems and open innovation; however, within this field, there are some distinct strands of literature, referring to different types of innovation intermediaries characterised by different functions, some of which use specific theoretical approaches within the broader innovation studies field (such as innovative entrepreneurship, national or regional innovation systems, learning regions, innovation clusters, Triple Helix). These strands of literature have gathered momentum in different periods (e.g. 'university incubators' emerged in the 1990s; 'innovation system intermediaries', 'KIBS' and 'cluster intermediaries' developed in the 2000s; open innovation intermediaries and intermediaries' performance emerged after 2010). While they are all continuing to the present day, interest in some

of these has slowed down. At the same time, the language underpinning the whole *corpus* is becoming more homogeneous, suggesting that some of the clusters may disappear and others may merge in the future.

6. Conclusion

Through a computational literature review complemented by qualitative content analysis, we identified and characterised seven different clusters representing different streams of innovation intermediaries' literature. Six of these refer to distinct types of intermediaries, performing specific functions and often involving specific types of organisations. While university incubators, innovation system intermediaries, cluster intermediaries and KIBS are more established categories, open innovation intermediaries and transition intermediaries have come to the fore later, in the last decade. They qualify therefore as emerging types which are being scrutinised more intensively by the more recent literature.

The analysis allows us to identify research gaps, which can provide some suggestions for further research.

First, the clustering exercise has shown how research streams cluster into two main groups before splitting into seven clusters: literature in clusters 5, 4, 2, 7 adopts a systemic perspective, trying to understand how intermediaries affect the systems they operate in, while literature in clusters 1, 3 and 6 tends to take the perspective of the organisations, analysing how they operate. Therefore, there seems to be some potential for greater focus on individual organisations in clusters 5 (university incubators), 4 (innovation system intermediaries), 2 (open innovation intermediaries) and 7 (transition intermediaries), with more research needed on how these intermediaries operate, and on their challenges and success factors. In parallel, for organisations in clusters 1 (KIBS), 3 (cluster intermediaries) and 6 (intermediaries' performance), there is scope for a greater attention to the effect of these intermediaries' activities on the contexts in which they operate.

Second, time trend analysis shows that, while the number of articles in all clusters has increased over time, some clusters exhibit a slowdown in their growth – in particular, interest in innovation system intermediaries and university incubators (and to a lesser extent KIBS and cluster intermediaries) appears to have decreased. Here there might be scope for further analyses aimed at understanding how these intermediaries are evolving and whether they are still meaningful.

Finally, so far limited attention has been dedicated to the effects of digitalisation on intermediaries' activities, including the possibility of automation of some of these activities and their effects on intermediaries' prospects and viability – as well as on the emergence of new types of intermediaries

in this area. More research on intermediaries and digitalisation would therefore be needed to shed light on these and other issues.

In this research, we have deployed a combination of qualitative and quantitative techniques to analyse a large and important literature on innovation intermediaries, whose role in facilitating and fostering innovation at different levels has been widely recognised both by scholars and practitioners. While prior research has provided insights on specific streams within this large body of literature, with its comprehensive approach our study provides a holistic picture of the literature, identifying seven inter-related clusters that comprise it, and uncovering its theoretical foundations. Our findings are of potential interest to scholars, policymakers and practitioners. Scholars seeking to further investigate the field can benefit from our study in order to identify research gaps that could be filled, and to better identify the streams of literature they wish to build on and contribute to. Our findings could also be of use to policymakers who need to have a better understanding of the field, for example in order to better formulate their policies for innovation intermediaries. Finally, managers of innovation intermediaries might also benefit from greater conceptual understanding of their organisations' positioning within the field.

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