Exploring the knowledge base of innovation research: Towards an emerging innovation model

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Abstract

This study provides a systematic review of the literature on innovation research (IR) over the past two decades. We used data-driven approaches integrating network and natural language processing techniques on 41 innovation core and ancillary journals to characterize the IR landscape. Contrary to previous efforts, we explored knowledge in the whole IR field from general and specific patterns of growth and interaction using cluster-and term-based data and macro-and micro-level perspectives, respectively. Our results helped us uncover the changing features of the IR landscape in recent years: (i) a strong move into social-and sustainability-driven innovation; (ii) the merging of products and services into business model innovation; (iii) the more influential role of stakeholders such as the government and the general public; (iv) the use of global analytical perspectives while considering local contexts; (v) the importance of greater visions "pulling" innovation; (vi) the greater role of "soft" issues such as behaviors; and (vi) a shift into sectoral, geographical, and methodological diversification. Building on these aspects, we developed an emerging model for future innovation research and a series of IR propositions. Our findings help generate opportunities to build future innovation capabilities in research, practice, and education.

Keywords: Innovation research; innovation model; knowledge base; networks; bibliometrics

1. Introduction

The concept of "innovation" is continuously evolving to meet the ever-more complex managerial and organizational challenges faced by researchers and practitioners in science, technology, and innovation-driven change (Fagerberg et al., 2013a, Fagerberg and Srholec, 2008). The incessant desire to cope with novel ways of creating and capturing value from innovation has led to the constant development of new and often recombined innovation knowledge (Camillus, 2008, Fagerberg and Srholec, 2008). The field of innovation encompasses a highly vibrant and diverse research community, including economics, sociology, entrepreneurship studies, business management, scientometrics, knowledge management, science and technology studies, and creativity studies (Fagerberg et al., 2013b, Fagerberg and Verspagen, 2009, Martin, 2012, Clausen et al., 2012). From the many terms used to describe the study of innovation, this paper refers to this field as "innovation research" (IR), which we define as the study of all the processes, explanatory factors, and economic and social consequences of innovation (Martin, 2012, Fagerberg et al., 2012), regardless of the disciplines and perspectives involved.

Extant literature has extensively examined the evolution, growth, and transformation of the IR field as a whole, including the formation of intellectual interdependencies (Martin, 2012, Rossetto et al., 2018), the building of scholarly communities (Fagerberg and Verspagen, 2009, Fagerberg et al., 2012), the evolution of core innovation topics (Lee and Kang, 2018, Meyer-Brötz et al., 2018, Shafique, 2013), and the identification of relevant stakeholders (Yang and Tao, 2012, Cancino et al., 2017). Studies analyzing the whole IR field have often relied on aggregated perspectives—article or cited reference levels—that tend to obscure the particularities of the growth of specific innovation concepts and constructs. The latter often results in incomplete or even misleading assessments, especially for continuously growing, highly interconnected, and diverse fields such as IR. In contrast, fine-grained analyses provide more accurate depictions of IR growth and interaction and richer insights into the features of future innovation models. Thus, the existing literature is scant in answering the following questions:

(1) How has IR knowledge evolved in terms of general and specific patterns of growth and interaction?
(2) How can these findings be used to formulate a conceptual model for future IR knowledge?

To this end, we used scholarly publications extracted from 41 IR-relevant journals indexed in Clarivate's Web of Science and Elsevier's Scopus bibliographic databases from 2002 to 2021, resulting in 31,233 scholarly articles and conference proceedings. We explored the general and specific patterns of IR knowledge growth by constructing scatter plots depicting the growth rates in the number of publications and citations derived from IR cluster- and term-based data, respectively. Subsequently, we assessed the patterns of interaction between relevant IR terms by analyzing their relevant co-occurrence relationships through co-word or term mapping approaches.

Our findings contribute to the existing body of evidence from several perspectives. First, we provide researchers with an up-to-date understanding of relevant research trends in the IR field while considering the diverse innovation communities (Fagerberg et al., 2013b, Fagerberg et al., 2012, Martin, 2012). Second, our approach enhances previous quantitative-driven research efforts by focusing on relevant innovation concepts and constructs, and their cognitive interconnections. Third, we extend the work of Martin (2016) and Fagerberg et al. (2013a) by inferring from our findings the features of a conceptual model, followed by a series of propositions for guiding future IR. Finally, our results help generate opportunities for building future innovation capabilities in research, practice, and education.

The remainder of this paper is structured as follows: Section 2 provides an overview of the relevant literature. Section 3 presents the research methods and data. Section 4 describes the results in terms of the growth patterns at cluster and term levels. Finally, Section 5 highlights the discussions and implications drawn from this study, which mainly focus on the impact of these changes on the definition of an incipient innovation model and the formulation of a series of propositions involved in such models.

2. Theoretical Background

2.1. Defining the field of Innovation Research

Since the earliest attempts by Schumpeter (1934) in the 1930s and the 1940s, innovation has been widely considered an essential driver of the sustainable economic and social development of companies, industries, and countries (Fagerberg and Srholec, 2008). It encompasses different levels of analysis and dimensions involved in innovation processes (Crossan and Apaydin, 2010). Over the years, as research on innovation has advanced the field into a "normal science" (Steinmueller, 2013), its body of knowledge has grown significantly through the contribution of communities of scholars and practitioners from multiple backgrounds, such as economics, engineering, geography, history, humanities, management, policy, psychology, sociology, and S&T studies (Fagerberg and Verspagen, 2009, Quintana-Martínez and Ramos-Rodríguez, 2014).

Different “invisible colleges” have formed around the study and practice of innovation (Martin, 2012, Steinmueller, 2013), driven by specialized research centers, conferences, journals, and professional associations (Martin, 2012, Fagerberg and Verspagen, 2009, Clausen et al., 2012). Multiple labels depict the body of knowledge accumulated by different communities, including innovation studies, technology and innovation management, science of science, S&T studies, research evaluation, science and technology policy studies, science policy, innovation studies, and economics of technical change (Martin, 2012). This paper uses the more broad-encompassing concept of “innovation research,” which we define, following Martin (2012), as the study of all the processes, explanatory factors, and economic and social consequences of innovation, regardless of the disciplines or perspectives involved.

2.2. Data-driven studies on the evolution of innovation research

Previous studies have focused on the origin, structure, and dynamics of innovation research. Different units, levels of analysis and research methods have been proposed over the years. Godin (2012) examined the origins of innovation studies from a sociological perspective. Martin (2012) identifies the most influential intellectual developments and their evolution by focusing on highly cited references in science policy and innovation studies. Martin (2016) characterized the 20 challenges facing innovation studies and science policy research. Lee and Kang (2018) identified 50 core topics using latent Dirichlet allocation, a topic modeling approach, and explored their evolution in terms of “hot” and “cold” topics. Similarly, Meyer-Brötz et al. (2018) mapped technology and innovation management literature using hybrid bibliometric networks. They describe the six latest research fronts and their evolution: sociotechnical transition, future studies, leadership, knowledge flows in project management, IT and smart factories, and top-management teams and competencies.

Meanwhile, Rossetto et al. (2018) and Akbari et al. (2020) used co-citation methods to analyze the evolution of the intellectual structures supporting IR. Powell et al. (2016) used bibliometric techniques to map intellectual bases, interactions, and evolution of knowledge and innovation research. Cancino et al. (2020) analyzed the dynamics of entrepreneurship and innovation research in Ibero-American countries. From a more general perspective, Lee et al. (2020) described the past, present, and future of innovation research. Additional studies have focused on defining the body of knowledge that encompasses the field of innovation (Yanez et al., 2010, Thongpapanl, 2012, Innovationsledarna, 2020).

Other research efforts have approached the study of IR through the lens of its emerging research organizational structures. For instance, Thieme (2007) and Yang and Tao (2012) investigated the most influential scholars of innovation management. Focusing on organizations, Cancino et al. (2017) described the most relevant and productive universities in the IR field. Other studies investigated the development of IR within and between countries (Merigó et al., 2016, Seol and Park, 2008, Tello Gamarra et al., 2018). Merigó et al. (2016) and Ramos Rodríguez and Ruíz Navarro (2004) used co-authorship networks to identify "invisible colleges" involved in innovation management. Building on the role of "weak ties" in researcher networks, Fagerberg and Verspagen (2009) analyzed the different clusters of innovation scholars observed through survey data. Soete (2019) examined the impact of the Science Policy Research Unit (SPRU) on the field of science policy and innovation studies.

Some studies have investigated miscellaneous topics in the IR field. Building on the concept of "sleeping beauties," Teixeira et al. (2017) identified long unnoticed innovation studies that have recently accumulated significant citations. Other studies have analyzed the interconnection of IR with other fields of research, such as entrepreneurship, technology management, and science and technology studies (Landström et al., 2015, Bhupatiraju et al., 2012, Sarin et al., 2018, Quintana-Martinez and Ramos-Rodriguez, 2016). Focusing on intellectual structures, Shafique (2013) also described the interconnections between IR and other disciplines (e.g., finance, general management, and economics).

Additional research has examined intellectual structures and research developments of relevant IR journals (Antons et al., 2016, Durisin et al., 2010, Ramos Rodríguez and Ruíz Navarro, 2004). Others have focused on specific innovation topics, including design thinking (Micheli et al., 2019), open innovation (Lopes and de Carvalho, 2018, Chaudhary et al., 2022), innovation systems (Rakas and Hain, 2019, Cirillo et al., 2019), organizational innovation (Crossan and Apaydin, 2010), innovation ecosystems (de Vasconcelos Gomes et al., 2018), servitization (Khanra et al., 2021), and social innovation (van der Have and Rubalcaba, 2016).

3. Data and Research Methods

This study adopted a research approach based on bibliometric and network-driven methods. Figure 1 illustrates a schematic of the research data and methods used in this study, focusing on the patterns of dynamics and interconnection at the cluster (macro analysis) and term (micro analysis) levels.

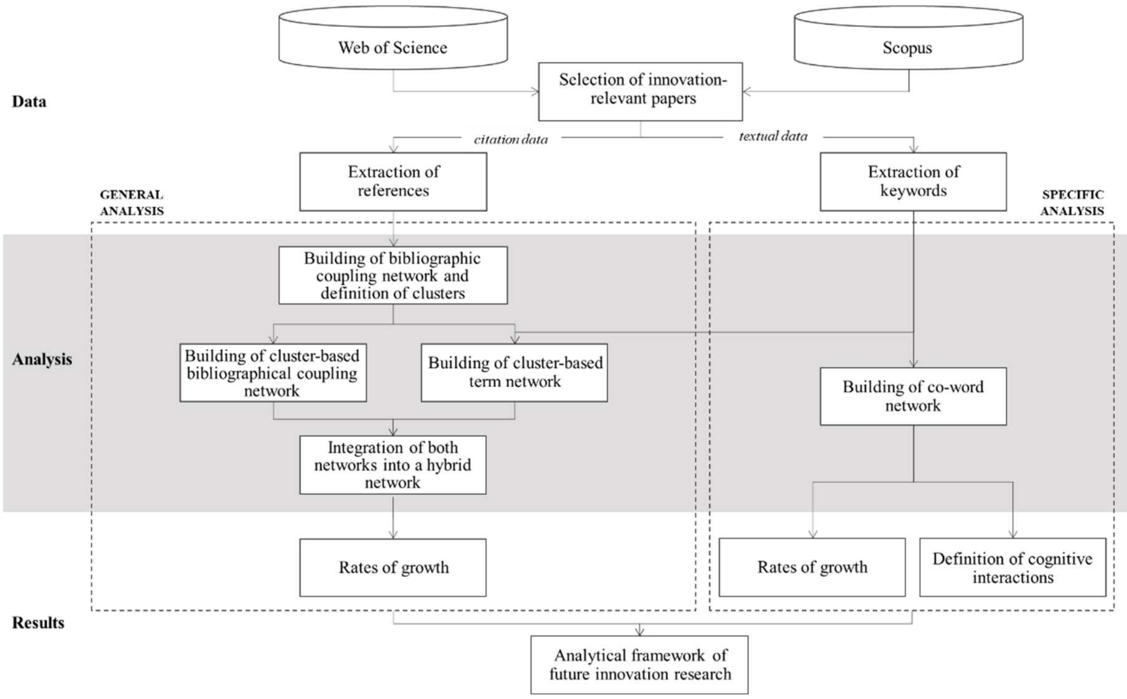

Figure 1 Flow diagram of the data and research methods of this study.

3.1 Research data

The unit of analysis in this study is publications—articles, conference proceedings, and book chapters—from innovation-relevant journals indexed in the Web of Science (Clarivate) and Scopus (Elsevier) bibliographic databases from 2000 to 2021. We used scholarly publications as they represent not only the highest impact in the field (Crossan and Apaydin, 2010) but they also entail the latest research directions (Börner et al., 2003). Delineating multidisciplinary domains such as innovation is challenging (Lee, 2015, Rakas and Hain, 2019). To this end, we used an enhanced set of journals, including 23 core innovation (CI) journals and 18 non-core innovation (NCI) journals, that is, journals with scopes in general business/management fields but of high relevance for innovation research (e.g., Strategic Management Journal, Academy of Management Journal, and Academy of Management Review). While the identification of CI journals relied on academic journal guides (CABS, 2018) and innovation journal rankings (Thongpapanl, 2012), the selection of NCI journals relied on journal citation relationships between CI and NCI journals extracted from the Journal Citation Reports (Clarivate, Inc.). *Supplementary Information 1* describes the 41 journals used in the analysis.

For the case of CI journals, we collected the totality of existing documents. For the case of NCI journals, we selected a subset of documents citing CI journals, high-impact innovation references, or those cited by CI journals. We reviewed these papers to exclude irrelevant documents. Finally, 31,233 publications were collected. We also extracted terms from titles, abstracts, and author keywords using a natural language processing approach. After a series of cleaning procedures and setting thresholds, we obtained 5,404 relevant keywords with two or more records. We defined four periods: period 1 (2002-2006), period 2 (2007-2011), period 3 (2012-2016), and period 4 (2017-2021).

3.2 Research methods

3.2.1 General patterns of growth

We used a hybrid network that integrates citation and textual data to approximate an IR knowledge base (Thijs et al., 2013, Meyer-Brötz et al., 2018). To this end, a citation-based bibliographic coupling network was built that relates papers based on the number of times they shared similar cited references (Kessler, 1963). We also constructed a textual-based network that connects publications based on the number of similar keywords that they share. Subsequently, both citation- and textual-based networks were combined into a single hybrid network using the similarity measure proposed by Thijs et al. (2013). We extracted the largest component from this network and obtained its clusters (i.e., highly interrelated nodes) using the VOSviewer software (Van Eck and Waltman, 2011). After several iterations, we converged into 28 clusters that approximated the knowledge structure underlying the IR field and examined these clusters in scatter plots relating the growth rates in the number of publications to those in the number of accumulated citations in five-year comparisons over the last two decades: 2002-2006 vs. 2007-2011 and 2012-2016 vs. 2017-2021.

3.2.2 Specific patterns of growth and interaction

We extracted terms from the titles and abstracts of all the collected documents using a natural language processing and added author keywords to the above list of terms. The collected terms underwent several cleaning and pre-processing loops. We then applied a threshold of terms equal to or more than 20 records to reach 1,583 IR-relevant terms, which formed the basis of this study. We estimated the rates of growth and the interaction of IR-relevant terms. For the former, similar to Section 3.2.1, we constructed scatter plots relating the rates of growth experienced by IR keywords in terms of their number of publications and accumulated citations by five-year comparisons over the last two decades: 2002-2006 vs. 2007-2011 and 2012-2016 vs. 2017-2021. To estimate the extent of cognitive interaction between IR terms, we compared the normalized co-occurrence values using the cosine similarity measure (Salton and McGill, 1983) of IR terms for the period 2017-2021 using an overlay mapping approach. We focused on the interactions with the largest predominance in the last five years based on their number of interconnections.

4. Results

This section explores the general and specific patterns of growth and cognitive interactions of IR knowledge obtained from cluster-and term-based data.

4.1. Macro-level analysis: General patterns of growth

4.1.1. IR knowledge structure

We approximated the knowledge structure underlying IR through a hybrid citation-textual network. We extracted 28 clusters that provided coherent IR classification. Table 1 describes the IR clusters based on their size, content, key references, and relevant journals. Relevant articles were selected based on the number of accumulated citations, normalized by the year of publication. In general, the results of Table 1 indicate the diversity of topics in the IR field. As expected, terms, cited references and journals appear to associate more strongly to certain clusters. *Supplementary Information 2* provides a more detailed description of the IR clusters.

Table 1 Description of IR clusters extracted from bibliographic coupling network in terms of their size, relevant terms, and key references and journals.

Innovation Themes	Size	Relevant terms	Key references	Key journals
1. Product & Service Innovation				
1.1. New Product/Service Development	1425	Product/service innovation, organizational aspects, performance, team-related issues, marketing, and market-orientation.	Brusoni et al., 2001; Bitner et al., 2008; Morgan et al., 2009	Journal of Product Innovation Mgt, Management Journal, Technological Forecasting & Social Change
1.2. Innovation Diffusion and Adoption	1137	Diffusion & models, adoption & models, innovator network, emerging technology, new product development, ICT, market	Gawer & Cusumano, 2014	Technological Forecasting & Social Change, Management Science, IEEE Transactions on Engineering Mgt
1.3. Project Management and Portfolio	715	Project management, new product development, uncertainty, real options, projects, team issues, risk	Engwall, 2003; Hoegl & Gemuenden, 2001; Shenhar, 2001	IEEE Transactions on Engineering Management, Journal of Product Innov Mgt, R&D Management
1.4. Customer-centric Innovation	685	Service sector, user innovation, design, user activities, strategy, knowledge, lead user, service innovation, co-creation	Poetz & Schreier, 2012; Baldwin & Von Hippel, 2011; Hipp & Grupp, 2005	Journal of Product Innovation Mgt, Technological Forecasting & Social Change, Creativity & Innov Mgt
2. Entrepreneurship				
2.1. Entrepreneurial activities	2216	Entrepreneurship, start-up, institutional, opportunities, industry, entrepreneurial behavior, SMEs, strategy	Shane, 2000; Lumpkin & Dess, 2001; Pache & Santos, 2010; Zahra et al., 2009	Small Business Economics; Journal of Business Venturing; Organization Science
2.2. Finance and Top Management	1305	Start-up, entrepreneurship, venture capital, top management, firm growth, survival, finance, founder, risk	Antoncic & Hisrich, 2001; Maxwell et al., 2011; Hillman & Dalziel, 2003	Small Business Economics; Journal of Business Venturing; Strategic Management Journal
3. Innovation and Geography, R&D Policy, and Knowledge Flows				
3.1. R&D Policy and Management	1094	R&D, SME, R&D subsidy, R&D fund, productivity, industry, R&D management, policy approaches, firm-level, family businesses	Artz et al., 2010; Becker & Dietz, 2004; Gonzalez & Pazo, 2008; Schulze et al., 2001	Research Policy, Economics of Innovation and New Technology, Small Business Economics
3.2. Geography and Agglomeration	824	Regional context, regional development, industry, regional innovation system, employment, policy approaches, geographic issues	Porter, 2003; Coe et al., 2008; Ellison et al., 2010; Menzel & Fornahl, 2010	Regional Studies, Research Policy, Journal of Economic Geography
3.3. Knowledge Flows and Innovation	802	R&D, knowledge spillover, regional contexts, knowledge, patents, foreign direct investment	Cassiman & Veugelers, 2006; Acs et al., 2002	Regional Studies, Research Policy, Journal of Economic Geography
3.4. Globalization of Innovation	634	Regional development, cluster development, geographic issues, agglomeration, globalization, local innovation, multinational enterprise	Meyer et al., 2009; Khanna & Palepu, 2000	Regional Studies, Journal of Economic Geography, Research Policy
4. Future Thinking & Intellectual Capital				
4.1. Inventions and Patents	1733	Patents, inventive activity, scientometrics, intellectual property rights, citation-based issues, R&D, knowledge	Kaplan & Vakili, 2015; Singh & Fleming, 2010; Dushnitsky & Klueter, 2017	Scientometrics, Research Policy, Technological Forecasting & Social Change
4.2. Future Thinking	682	Scenario planning, foresight, Delphi model, technology roadmapping, technology forecasting	Kwakkel & Pruyt, 2013; Postma & Liebl, 2015; Daim et al, 2016	Technological Forecasting & Social Change, Foresight, Technology Analysis & Strategic Management
5. Science of Science				
5.1. Science of Science	1988	Scientometrics, citation-based issues, science, journal, academic research, evaluation/assessment, scientific productivity, interdisciplinarity	Boyack et al, 2005; Zahedi et al, 2014; Abramo & D'Angelo, 2014	Scientometrics, Research Evaluation, Journal of Informetrics
5.2. Collaboration in Science	586	Collaboration, innovation network, international collaboration, co-authorship, university	Wagner & Leydesdorff, 2005; Hoekman et al., 2010; Wang et al., 2014	Scientometrics, Journal of Informetrics, Research Policy

6. Knowledge Management & Innovative Behavior				
6.1. Knowledge and Learning	1358	Knowledge, knowledge management, learning, organizational learning, knowledge transfer, routine, knowledge sharing, knowledge creation	Zollo & Winter, 2002; Tsai, 2001; Gupta & Govindarajan, 2000; Nonaka & Von Krogh, 2009	Journal of Knowledge Management, Organization Science, Management Science
6.2. Innovative Behavior and Knowledge	1195	Knowledge management, employee, creativity, knowledge sharing, leadership, cultural issue, innovative behavior, trust	Yuan & Woodman, 2010; De Jong & Den Hartog, 2010; Gong et al., 2009; Tierney & Farmer, 2002	Journal of Knowledge Management, Creativity & Innovation Mgt, International J of Technology Mgt
7. Organizational Innovation				
7.1. Tech Change, Strategy, and Capabilities	1175	Strategy, capabilities, emerging technology, incumbent firms, competitive advantage, disruptive innovation, technology diversification	Daneels, 2004; Hockerts & Wuestenhagen, 2010; Breschi et al., 2003	Strategic Management Journal, Technological Forecasting & Social Change; Int J of Technology Mgt
7.2. Business Model Innovation	678	Business model, strategy, platforms, dynamic capability, opportunities, ecosystem approaches, value creation, emerging technologies	Todorova & Durisin, 2007; Helfat & Peteraf, 2015; Zott et al, 2011; Hannah & Eisenhardt, 2018	Technological Forecasting & Social Change, International Journal of Technology Mgt, California Mgt Rev
7.3. Organizational Culture and Change	720	Organizational strategy, strategy, knowledge, competitive advantage, behaviors, capabilities, strategic planning	Iyer & Miller, 2008; Chattopadhyay et al, 2001; Detert et al., 2000, Gioia et al., 2000	Strategic Management Journal, Technological Forecasting & Social Change, Organization Science
8. Organizational Innovation				
8.1. Innovation Networks	1159	Innovator network, network, knowledge, social network, collaboration, social capital	Adler & Kwon, 2002; Ahuja, 2000; Davidsson & Honig, 2003	Organization Science, Technological Forecasting & Social Change, Research Policy
8.2. Interorganizational Relationships	783	Alliances, transaction cost, collaboration, governance, strategic alliance, trust, contract, cooperation	Dirks & Ferrin, 2001; Argyres & Mayer, 2007; Baum et al., 2000	Strategic Management Journal, Organization Science, Industrial & Corporate Change
8.3. M&A and Collaborations	735	M&A, competition, acquisition activity, alliances, innovation network, collaboration, learning, inventive activity	Katila & Ahuja, 2002; Zollo & Singh, 2004; Gnyawali & Park, 2011	Strategic Management Journal, Research Policy, Technological Forecasting & Social Change
9. Technology Transfer & STI Policy				
9.1. Technology Transfer	1432	University, academic research, technology transfer, academic entrepreneurship, industry-university relations, commercialization, start-up	Cohen et al., 2002; D'Este & Patel, 2007; Siegel et al., 2003; Di Gregorio & Shane, 2003	Journal of Technology Transfer, Research Policy, Scientometrics
9.2. Science, Technology and Innovation Policy	1121	STI policy, policy approaches, science, industry, knowledge, collaboration, government, policy maker, politics	Tether, 2005; Escribano et al., 2009; Edler & Georghiou, 2008; Gault, 2018	Science & Public Policy, Research Policy, Technological Forecasting & Social Change
10. Innovation Policy & Sustainability				
10.1. Innovation Policy and Capability Building	910	Policy approaches, China, industry, innovation systems, government, developing country, STI policy, institutions, capabilities, policy maker	Kivimaa & Kern, 2016; Hekkert et al., 2007; Meyer et al., 2009; Weber & Rohracher, 2012	Research Policy, Technology Forecasting & Social Change, Technology Strategy & Strategic Mgt
10.2. Sustainability and Innovation	794	Sustainability, transitions theory, energy industry, policy approaches, eco-innovation, renewable industry, crisis, resilience	Geels & Schot, 2007; De Marchi, 2012; Kesiduo & Demirel, 2012	Technological Forecasting & Social Change, Research Policy, Technology Analysis & Strategic Management
11. Organization & Learning				
11.1. Organization and Learning	951	Absorptive capacity, knowledge, exploration, exploitation, ambidexterity, innovation performance	Gupta et al., 2006; He & Wong, 2004; Jansen et al., 2005; Spithoven et al., 2010	Journal of Knowledge Management, Technology & Strategic Management, R&D Management
11.2. Open and User Innovation	751	Open innovation, open science, collaboration, knowledge, open source, innovation network, crowdsourcing, intermediary organization	Dahlander & Gann, 2010; Lee et al., 2010; Franzoni & Sauermann, 2014; Bayus, 2013	R&D Management, Research Policy, Creativity & Innovation Management

4.1.2. Rates and directions of growth at the cluster level

Figure 2 presents scatter plots for the periods 2002-2011, top, and 2012-2021, bottom, which relate IR clusters based on their rate of growth of publications [RG PUB], x-axis, and the rate of growth of normalized citations by the years of publication [nRG CIT], y-axis. The size of the bubbles represents the total number of publications in each IR cluster. The colors depict the innovation themes used to facilitate the description of IR clusters. The red dotted lines and colored areas refer to median and quartile 1 (Q1) and quartile 3 (Q3) values of both axes.

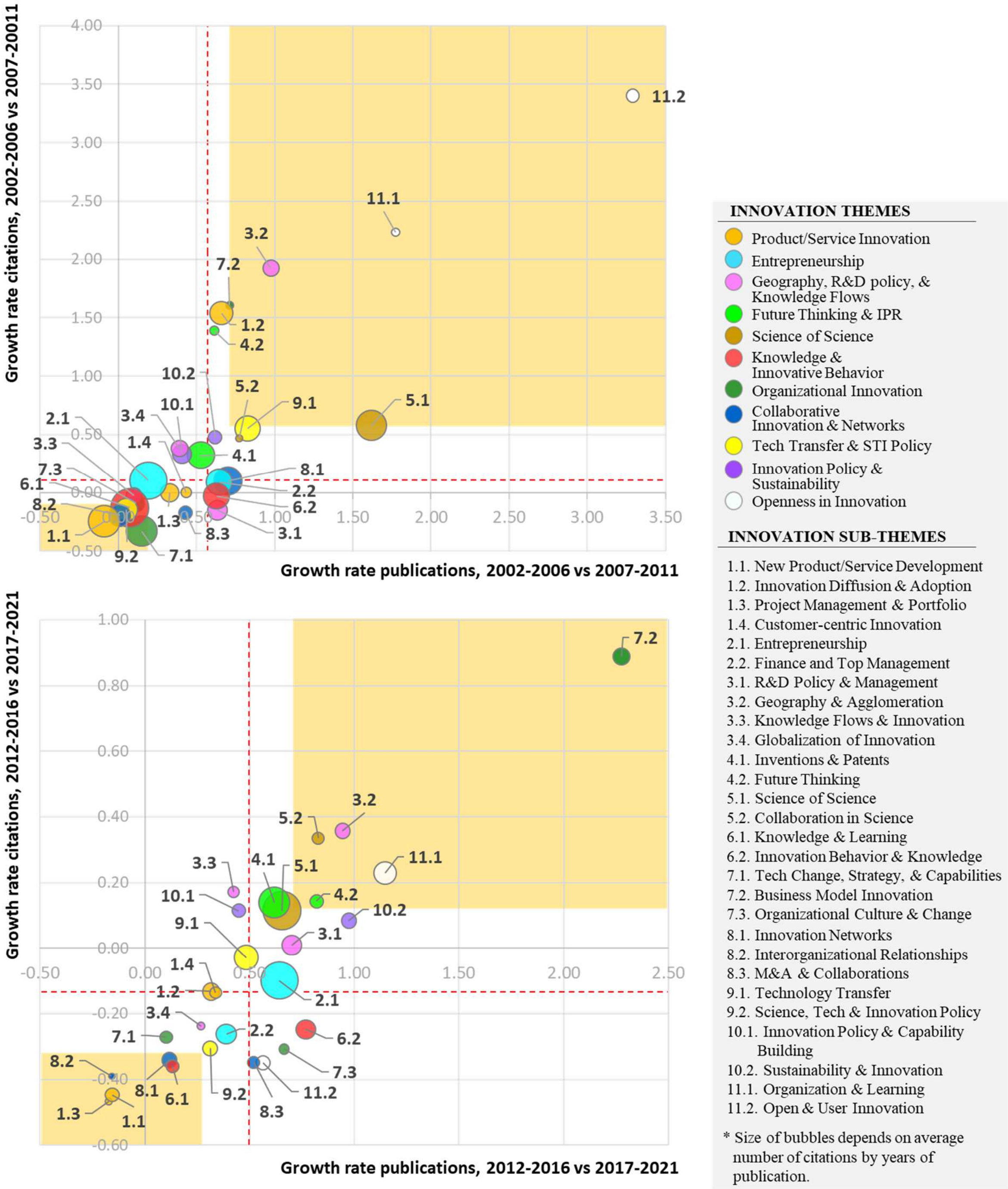

Figure 2 Scatter plot locating IR clusters across rates of growth in publications (x) and normalized citations by years of publication (y) for the first and second decades, top and bottom figures, respectively. The sizes of the bubbles represent the number of publications related to each cluster. Colors depict the innovation themes described in Table 1. The red dotted line refers to the median of the x and y axes. The highlighted areas depict the quartiles Q3 (left, bottom) and Q1 (right, top) of both axes *(Notes: Color figure available online. Authors' own elaboration).*

As shown in Figure 2 (top), the image of IR in the period 2002-2011 is spearheaded by three IR clusters: 11.2 Open and user innovation, 11.1 Organization and Learning, and 3.2 Geography and agglomeration. These are followed by several IR clusters located on the fringes of the Q3 area of Figure 2 (top), including 7.2 Business model innovation, 1.2 Innovation diffusion and adoption, 4.2 Futures thinking, 5.1 Science of science, 5.2 Collaboration in science, and 9.1 Technology transfer. Trailing these aspects are several IR clusters with growth rates above the median and below the upper quartile Q3, including, listed in order of their number of publications, 2.2 Finance and top management, 6.2 Innovative behavior and knowledge, 3.1 R&D policy and management, and interestingly 10.2 Sustainability and innovation, which is still not relevant.

In contrast, we observe low dynamism in traditional IR clusters, such as 1.1 New product and service development, which is the only sub-theme with negative growth rates; knowledge management topics such as 3.3 Knowledge flows and innovation and 6.1 Knowledge and learning; organizational-related IR clusters such as 7.3 Organizational culture and strategy and 8.2 Interorganizational relationships; 7.1 Technology change, strategy, and capabilities; 9.2 Science, technology and innovation policy; and 2.1 Entrepreneurship.

The second decade, 2012-2021, shows a different growth profile (Figure 2, bottom). The greatest growth is displayed by the IR clusters 7.2 Business model innovation, including organizational characteristics oriented towards breakthrough innovations, innovation ecosystem approaches, and technology-driven business model innovation, 3.2 Geography and agglomeration, 11.1 Organization and learning, 10.2 Sustainability and innovation, 4.2 Futures thinking, 5.2 Collaboration in science, 4.1 Inventions and patents, 5.1 Science of science, and 6.2 Innovative behavior and knowledge. The third group of IR clusters is characterized by growth rates between median and Q3 values: 2.1 Entrepreneurship, 9.1 Technology transfer, 11.2 Openness in innovation, and 8.3 M&A and collaborations, in order of their number of publications. In contrast, IR clusters with the lowest growth rates are 6.1 knowledge and learning, 8.1 Innovation networks, and with negative growth rates in publications we have 1.1 New product and service innovation, 1.3 Project management and portfolio, and 8.2 Interorganizational relationships.

The aggregated view provided by IR clusters overlooks the smaller intricacies that can be discerned from the specific growth patterns described below.

4.2. Micro-level analysis: Specific patterns of growth

This section describes the specific growth patterns obtained from relevant IR terms extracted from the collected publications. In this section, we present two analyses: (a) rates and directions of growth through scatter plots and (b) cognitive interactions through co-occurrence relationships of IR terms.

4.2.1. Rates and directions of growth at the term level

Similar to Section 4.1, the understanding of the dynamics of the growth of IR knowledge at the micro-level relied on the growth rates in the number of publications and citations—[RG PUB] and [RG CIT], respectively—for IR-relevant terms in the decades 2002-2011 and 2012-2021 (Figures 3 and 4). After excluding general or obvious terms (i.e., innovation, knowledge, effects, and technology), we set a threshold for IR terms with records equal to or greater than 30, prioritizing those terms accumulating publications in recent years. In some cases, we used a threshold of 20 records for those IR terms with this number of records in the last two years.

4.2.1.1. Emerging and outlier IR terms

Table 2 presents a list of emerging terms (i.e., those terms that have appeared in the last five years of each decade) and outliers (i.e., those terms that deviate markedly in their rates of growth of publications [RG PUB] or citations [RG CIT]). As shown in Table 2, the decade 2002-2011 shows no emerging IR terms but several outliers. Among these, open innovation is the only term with significantly high RG PUB values, as it was introduced at the beginning of the first decade (Chesbrough, 2003). The rest of the IR terms show outlying RG CIT values emphasizing organizational innovation approaches such as creative industries and cities, communities of practice, ambidexterity, network brokerage, and sustainability-related topics, including eco-innovation and transitions theory. Interestingly, the macro analysis of the previous section was unable to detect the relevancy of sustainability-related topics.

Table 2 Description of emerging terms and outliers extracted from IR publications for both decades, including average publication year (AVPUB YEAR), number of publications (SIZE), rates of growth in the number of publications (RG PUB), and rates of growth in the number of citations (RG CIT). Terms are arranged according to the value of RG PUB.

Emerging terms		Outlier terms			
TERMS	**SIZE**	**TERMS**	**SIZE**	**RG PUB**	**RG CIT**
		2002-2006 vs 2007-2011			
-	-	Creative industries/cities	39	2.9	227.0
-	-	Open innovation	202	6.4	48.6
-	-	Dyad/brokerage	44	4.0	33.0
-	-	Communities of practice	41	3.1	26.4
-	-	Transitions theory	42	3.3	21.3
-	-	Ambidexterity	42	3.3	20.5
-	-	Eco-innovation	32	1.2	20.5
		2012-2016 vs 2017-2021			
COVID-19	117	Industry 4.0	92	90	40
Blockchain	114	Digital platform	58	55	0.2
Cryptocurrency	44	DIY (do-it-yourself) labs	27	25	3
Circular economy	37	Sharing economy	50	23	24.7
Fintech	20	Internet of Things	95	21.5	12.6
-	-	Neural networks	56	17	1.1
-	-	Sustainable entrepreneurship	20	13	1.07
-	-	B2C (business-to-customer)	22	12	4.1
-	-	SDG (sustainable devel. goals)	27	11.5	153.2
-	-	Accelerators	45	11.3	27.3
-	-	Artificial intelligence	136	10.6	1.4
-	-	Automation	55	10	1.7
-	-	Crowdfunding	105	9.7	56.5
-	-	Lean startup	20	8	6.2
-	-	Deep learning	99	6.7	3.5
-	-	Big data	204	6.5	14.0
-	-	Frugal innovation	35	6.3	3.5

In contrast, the decade 2012-2021 displays diverse emerging terms and outliers. Regarding emerging terms, the COVID-19 pandemic brought about a significant production of IR-related publications, about 117 documents, between 2020 and 2021 (Belhadi et al., 2021). Similarly, emerging and growing are new finance-driven technologies, such as blockchain, cryptocurrency, and fintech (Pazaitis et al., 2017). We can also observe the nascent growth in research on the circular economy as a relevant sustainability-driven emerging topic (Despeisse et al., 2017).

Outliers in the second decade indicated wider topical diversity. We can observe the dominance of digitally driven technologies, including Industry 4.0, digital platforms, and the Internet of Things enabling organizational innovations such as do-it-yourself (DIY) labs, business-to-consumer (B2C) business models, the sharing economy, and digital transformation (Santoro et al., 2018, Teece, 2018, Frank et al., 2019). Closely related to these technologies are several information-related technologies, such as neural networks, artificial intelligence, deep learning, and big data (Hengstler et al., 2016). These technologies have become the focus of IR studies and are becoming a part of the toolkit of research tools for the IR community. Another set of outliers includes entrepreneurship-related terms such as crowdfunding, accelerators, lean startup, and sustainable entrepreneurship (Winterhalter et al., 2017, Cohen et al., 2019, Pauwels et al., 2016). It also includes terms such as the United Nations' SDGs and frugal innovation (Centobelli et al., 2020, Dost et al., 2019).

4.2.1.2. Growing IR terms

Figures 3 and 4 present scatter plots relating the rates of growth in the number of publications (x-axis) and citations (y-axis) for relevant IR terms comparing the periods 2002-2006 vs 2007-2011 and 2012-2016 vs 2017-2021, respectively. Both figures focus on quadrants I (high rates of growth of publications and citations) and III (low rates of growth of publications and citations) to gain insights into growing and declining IR terms. Growth rates are relevant, but considerations were also made on their development patterns over time.

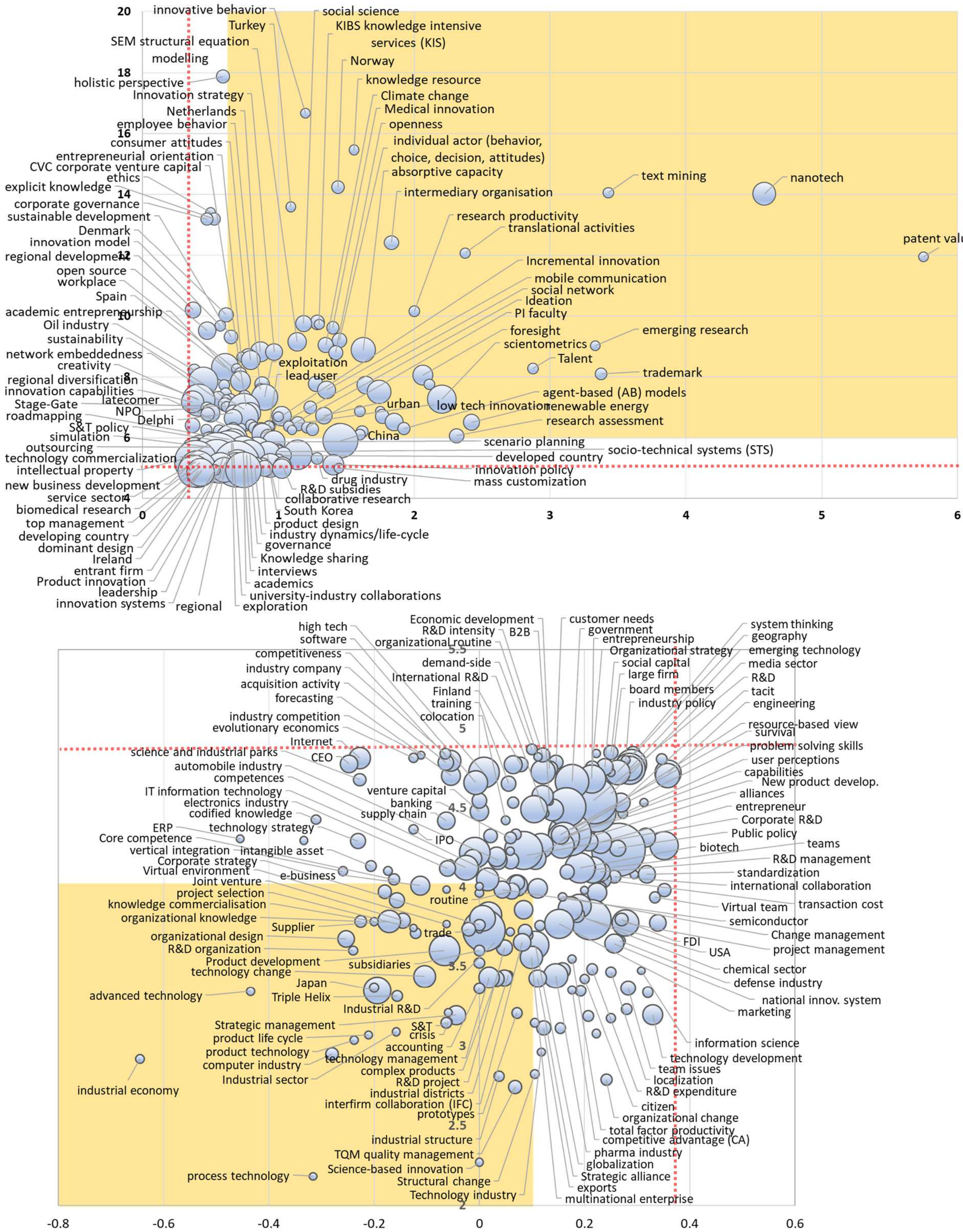

Figure 3 Scatter plots of quadrants I (top) and III (bottom) for the second decade. IR-relevant terms are positioned in this graph according to their rates of growth in publications (x axis) and citations (y axis) in the years 2002-2006 vs 2007-2011. Highlighted areas describe the regions denoted by the 3rd and 1st quartiles for both axes of quadrants I and III, respectively. The dotted red line corresponds to the median values of the axes *Source: Authors' elaboration (color online).*

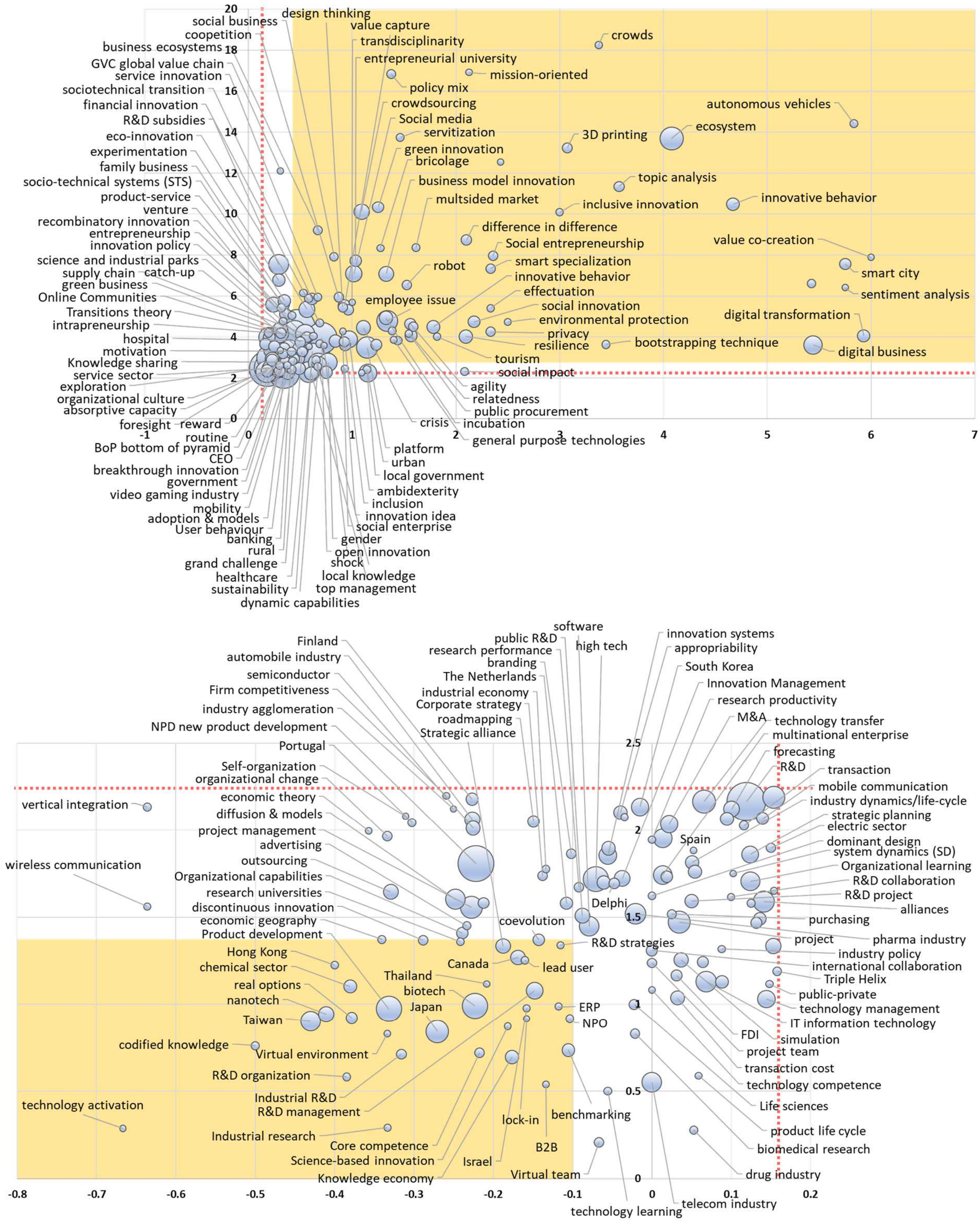

Figure 4 Scatter plots of quadrants I (top) and III (bottom) for the second decade. IR-relevant terms are positioned in this graph according to their rates of growth in publications (x axis) and citations (y axis) in the years 2012-2016 vs 2017-2021. Highlighted areas describe the regions denoted by the 3rd and 1st quartiles for both axes of quadrants I and III, respectively. The dotted red line corresponds to the median values of the axes *Source: Authors' elaboration (color online).*

The scatter plots indicate a definite trend in the second decade of innovation initiatives aimed at creating and transforming social value, including terms such as social innovation, social entrepreneurship, inclusive innovation, bottom-of-the-pyramid, frugal innovation, hybrid organizations, and social impact (Avelino et al., 2019, Asongu and Le Roux, 2017). Similarly, a series of social-related topics take relevant positions, such as research on gender, inequality, and migration (Mohammadi and Shafi, 2018). We also observed a significant move towards transformative innovation and change driven by grand or societal challenges (e.g., the United Nation's Sustainable Development Goals (SDGs)) and mission-oriented approaches (Kuhlmann and Rip, 2018). Broader perspectives, such as socio-technical transitions and the circular economy, play a significant role in the second decade (Jabbour et al., 2019). Sustainability-related issues are closely connected to innovation's social impact. The position of sustainability research has solidified over the decades. Concepts such as responsible innovation, resilience, crisis, smart cities, transformative innovation, socio-technical transitions, and circular economy (Bresciani et al., 2018) complemented traditional sustainability terms such as sustainability, green innovation, eco-innovation, and renewable energy in the second decade.

We can also observe a change in the role of government in the innovation ecosystem, moving from its traditional position as an intermediary stakeholder (e.g., policy mixes, public policy, policy intervention, bricolage, smart specialization, and R&D subsidies) to an active practitioner of innovation (e.g., public procurement, e-government, open government, public innovation, and state-owned enterprises) (Arundel et al., 2019, Jia et al., 2019).

Although no longer at the forefront of IR as in the first decade, open innovation still shows solid growth rates, fueled in recent years by research on collaboration and partnerships, small and medium enterprises (SME), digital business models, and particularly co-creation mechanisms and the use of crowds (Osei-Frimpong et al., 2018, Browder et al., 2019). Additionally, the participation of citizens as active stakeholders in innovation processes has accelerated in recent years. Traditional collaboration mechanisms, including joint ventures, transaction costs, strategic alliances, outsourcing, and buyer-supplier integration, display declining dynamics in the second decade. While the first decade is characterized by the importance of leading users and communities of practice, the second decade highlights ideation methods such as design thinking (Dell'Era et al., 2020).

The COVID-19 pandemic has driven the publication of several studies in only a couple of years, as previously described. Interestingly, terms such as virtuality and virtual environment were not relevant during the pandemic. Thus, only telemedicine has experienced regrowth in recent years. Instead, publications appear to focus on the impact of COVID-19 in regions, sectors, industries, companies, and individuals, their responses to the pandemic, and the role of certain technologies and management approaches in counteracting the crisis (Abdel-Basset et al., 2021, Škare et al., 2021, Brem et al., 2021).

Compared with the first decade, recent years have witnessed the importance of several terms related to employees, including personality, transdisciplinarity, innovative behavior, employee innovation, and organizational slack (Afsar and Umrani, 2019). In this regard, topics that deal with the top management's role in the innovation process are also relevant (Boone et al., 2019). Despite the low number of publications, terms such as transformational leadership and transformative innovation are becoming more common.

Several entrepreneurship-related terms occupy relevant positions in the scatter plots. These terms include incubation and acceleration approaches, intrapreneurship, entrepreneurial universities, angel finance, lean startup, and crowdfunding (Ghezzi, 2019). Also relevant are a handful of more subjective entrepreneurship-related aspects, such as entrepreneurial intention and orientation, and effectuation (Meoli et al., 2020, Ferreira et al., 2020). Related terms such as venture capital do not appear to follow the high dynamics of entrepreneurship-related topics.

Interestingly, we observed a series of traditional terms providing theoretical lenses that have remained relevant over the last two decades, such as absorptive capacity, dynamic capabilities, and ambidexterity (Koryak et al., 2018). In addition, spatial dimensions, such as agglomeration and clusters, have perdured in the interest of the innovation community, particularly driven by aspects such as relatedness and smart specialization (Balland et al., 2019, Miguelez and Moreno, 2018).

4.2.1.3. *Decreasing IR terms*

We observed a significant trend away from product-related terms, such as product design and new product development. Furthermore, methodologies and concepts closely related to product development have been characterized by declining dynamics in recent years, including new product development, front-end, real options, portfolio methods, project management, conjoint analysis, and vertical integration/disintegration. Similarly, future thinking approaches (e.g., foresight, scenarios, and Delphi techniques) and scientometric/bibliometric techniques display dwindling growth in the second decade.

A series of long-established terms related to organizational issues also appear to have lost their predominance in recent years, including core competence, capabilities, organizational design, and topics related to knowledge management. Traditional technology strategy terms, such as high-tech, standardization, R&D management, dominant design, evolutionary theory, technology dynamics, and intellectual property rights, appear to be declining in interest among the IR community. For both decades, we observed significantly decreasing dynamics in several traditional business management topics, including change management, benchmarking, enterprise resource planning, balanced scorecard, and strategic planning. Operations management-related topics, such as concurrent engineering, just-in-time, ISO-9000, mass customization, lean manufacturing, quality function deployment, and quality management, also display declining dynamics over the decades.

4.2.1.4. *Technologies and sectors under study*

Moving from the predominant role of nanotechnology in the first decade, a new set of emerging technologies such as 3D printing, artificial intelligence, big data, machine learning, Internet of Things, robotics, cloud technologies, clean technologies, autonomous vehicles, blockchain, and cryptocurrency dominate the IR landscape in the second decade (Su et al., 2020). These technologies have led to the reappearance of broad-encompassing terms such as general-purpose technologies (Conti et al., 2019). Relevant topics include the impact of these emerging technologies on ecosystems, platforms, and business models across sectors such as services, healthcare, manufacturing, and digital businesses, and their adoption and acceptance among potential users owing to the incipient technical and market uncertainties of these technologies. Over the years, several innovation initiatives have been enabled by these technologies, including crowdsourcing, crowdfunding, makers movements, digital transformation, multisided markets, co-creation schemes, advanced manufacturing, telemedicine, smart cities, sharing economy, DIY labs, and B2C and C2C business models (Caputo et al., 2019, Rietveld et al., 2019, Papa et al., 2020).

As IR transitions into the technologies mentioned above, several mature sectors appear to have lost interest in the innovation community in the last decade. These sectors include semiconductors, automobiles, pharmaceuticals, mobile/wireless communications, electronics/optoelectronics, biotechnology, and chemicals. By contrast, service-oriented sectors display positive growth dynamics, including banking and finance, digital businesses, healthcare, mobile apps, video games, tourism and hospitality industries, and, to a lesser degree, the film industry (Yoo et al., 2017). We can also observe a trend across sectors to integrate products and services as inferred from the growth experienced by terms such as servitization and product-service (Kohtamäki et al., 2020).

4.2.1.5. Countries under study

Figure 5 (left) compares the countries under study in IR publications in terms of their rates of publication growth and the number of publications for the second decade.

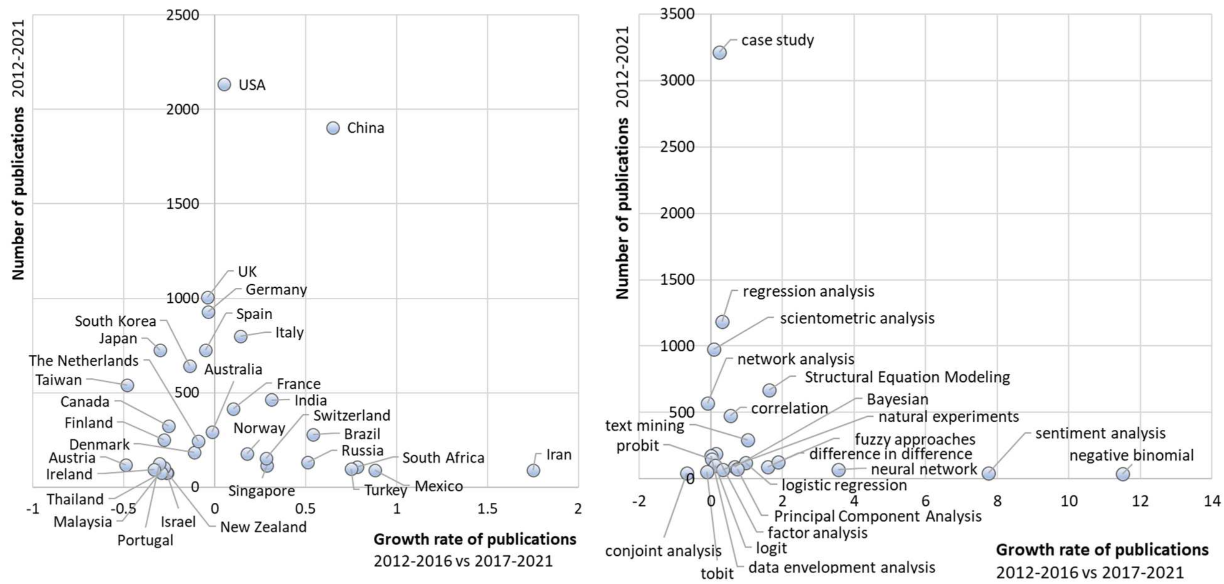

Figure 5 Scatter plots comparing the rates of growth of publications and number of publications for countries (left) and research methods (right) under study in the decade 2012-2021. We set a threshold for countries with equal to or more than 70 records. *Source: Authors' elaboration (color online).*

Figure 5 (left) indicates the strong emphasis on IR publications in the United States (US); however, its growth rate is almost negligible. Unsurprisingly, China still dominates the interest of the IR community, as it shows a number of publications similar to the US but growing seven times larger. A series of European countries traditionally strong on IR trail behind with no or slightly positive growth, including the UK, Germany, Spain, and France. In the last decade, other countries have gradually lost their appeal to the IR community. Included here are IR-relevant Asian countries such as Japan, South Korea, and Taiwan, and several additional countries such as Canada, Finland, Austria, Ireland, Malaysia, Portugal, Israel, and New Zealand. Despite their low number of publications, several countries appear to be forging ahead with their higher growth rates, particularly developing countries such as Brazil, Russia, South Africa, Turkey, Mexico, and Iran. The latter appears to be driven by the diversification of IR across non-traditional geographies.

4.2.1.6. Research methodologies used by IR studies

Figure 5 (right) analyzes the research methodologies mentioned in the abstract and the authors' keywords. This figure indicates the dominant role of case studies in IR publications, also reinforced by the significant influence of Yin (2003)'s book on case study research design and methods. Regression analyses, scientometric/bibliometric studies, network analyses, and correlation approaches have trailed behind case studies. In particular, the structural equation modeling approach displays solid growth rates, which infers the interest of IR community towards discerning latent relationships. At a much lower number of IR publications, we observe research methods such as data envelopment analysis, factor analysis, principal component analysis, Bayesian approaches, difference-in-difference methods, natural experiments, fuzzy approaches, and a series of regression approaches, such as logit, probit, and tobit. The most significant growth rates are observed in research methods such as neural networks, sentiment analysis, and negative binomial regressions. Although we cannot infer conclusive results from Figure 5 (right) in the total number of publications using specific research methods, they point to the diverse toolkits available for solving IR problems.

4.2.2. Cognitive interactions among IR terms

Figure 6 shows a term network that interconnects IR terms as a function of co-occurrence levels for the last period. The thickness of the network lines relates to the strength of the co-occurrence relationships between IR terms. The size of the nodes depicts their number of interconnections in the network.

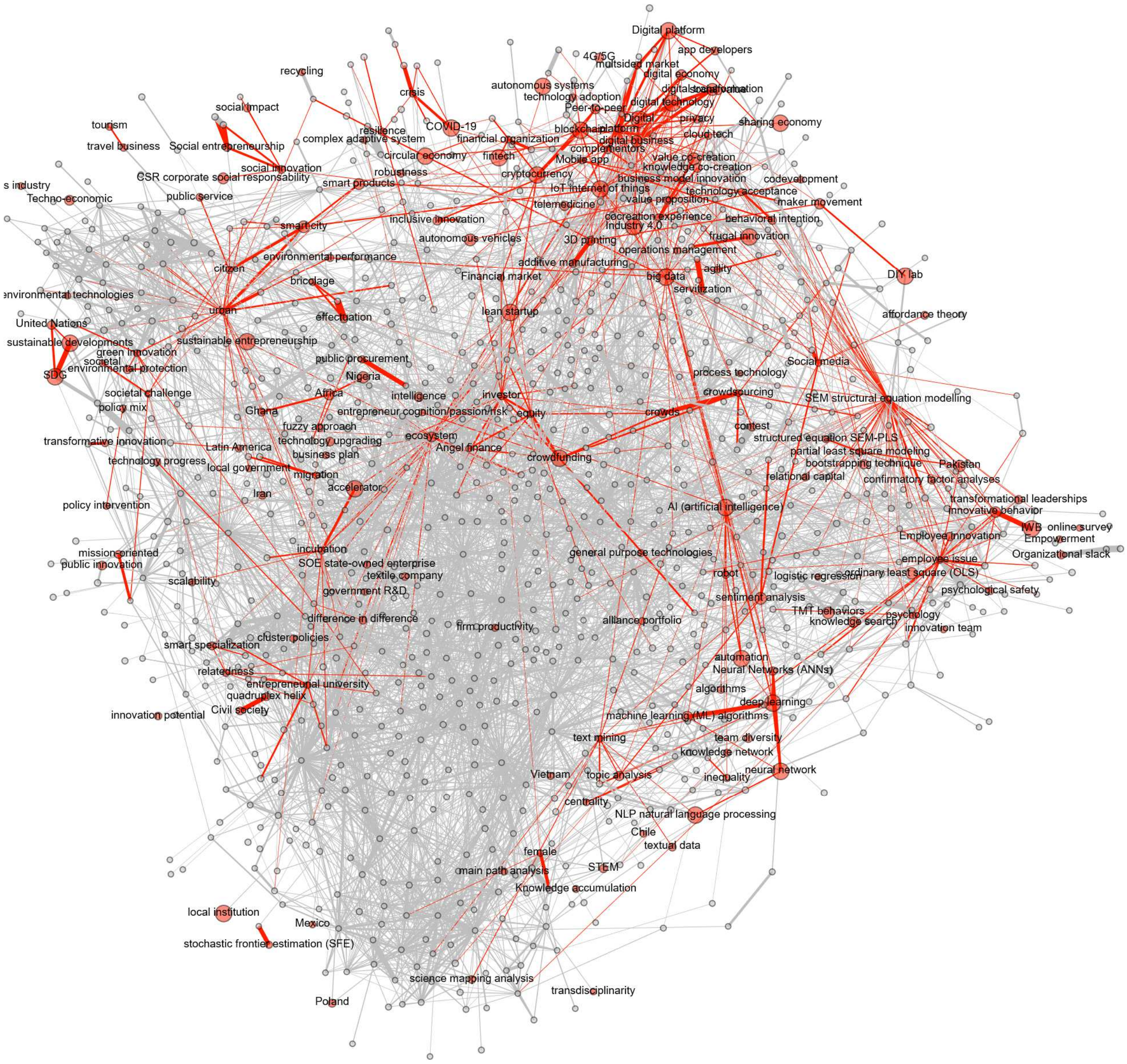

Figure 6 Overlay of term map analyzing the co-occurrence between IR terms in the last years. Red edges relate to link outgoing nodes with the highest number of relations.

Driven by the emergence of several new technologies, we observe strong interconnections between emerging technologies and their adoption by consumers, as well as ensuing behaviors, attitudes, and perceptions towards these new fields, particularly digital business (Baudier et al., 2020, Magistretti and Dell'Era, 2019). Several emerging technologies often appear together (Yu et al., 2020, Zhou et al., 2021). Relevant interactions are observed between emerging technologies and the impact, opportunities, and processes of value creation and capture (Chang et al., 2020, Agostini and Filippini, 2019).

The concept of ecosystems shows a significant affinity to several entrepreneurship-related terms (e.g., startup, incubation, and accelerators), collaboration and network issues, platforms, value creation and capture, and business models (Urbinati et al., 2019, Rietveld et al., 2019, Schmeiss et al., 2019). The latter, in turn, is particularly interconnected to digital transformation and digital technologies (Li, 2020, Frank et al., 2019). Social innovation remains highly interconnected with social-related terms, such as social business and social impact. However, we also observed initial insights into the diversification of this field into aspects such as entrepreneurship, platforms, business models, institutions, and openness (Carayannis et al., 2019, Rayna and Striukova, 2019). In particular, connections to sustainability are built through research focusing on societal challenges and society in general (Soni et al., 2021).

Sustainability mainly interacts with a diversity of closely positioned topics, such as analytical perspectives (transitions, multilevel analysis, and sociotechnical systems), related labels (green innovation, green business, eco-innovation, and sustainable development), technologies (biomass, smart city, electric vehicles, and solar energy), and policy (policy mix and government). In addition, there are several terms, farther positioned, now interacting with sustainability, examples are business models, frugal innovation, supply chain, citizen, circular economy, and emerging technologies and disruptive innovation (Klein et al., 2021, Fritz et al., 2021, Sauermann et al., 2020). The latter depicts the rapid diffusion of sustainability-related issues in IR.

Despite the declining growth dynamics in the last decade, issues related to product development are relevant in the recent years. Figure 6 shows that product development frameworks have expanded into several relevant domains described above, including social innovation, ecosystems, platforms, business models, and services (Wang et al., 2020, Zhu et al., 2019, Hagiu and Wright, 2020). The open innovation field has also evolved. While its focus still lies on collaboration, their interactions are now broadening to include the study of SMEs, the role of crowds and networks, and innovation contests (Lyu et al., 2019). Through terms such as value creation and capture, open innovation is now building strong bridges to business models and, therefore, to other terms, such as sustainability, social, service, and product innovation.

Finally, regional innovation is concentrated on the periphery of the network in Figure 6, focusing on interactions with several topics related to the contexts of regions in innovation. In particular, we observe strong interactions with phenomena and policy issues associated with location, including spatial agglomeration, relatedness, and smart specialization (Balland et al., 2019, Miguelez and Moreno, 2018). The influence of interactions of regional innovation goes further to embrace aspects such as sustainability, entrepreneurship, and ecosystem (Yu, 2020, Pierrakis and Saridakis, 2019, Veldhuizen, 2020).

5. Discussion and Implications

This study provides a systematic review of the literature on innovation research (IR) over two decades. Using different data-driven approaches, we evaluated the rates and directions of IR growth and cognitive interaction. We approached IR from the general and specific levels of analysis. For the former, we relied on clusters extracted from a hybrid network; for the latter, we used relevant IR terms obtained from the publications. In both cases, we focused our analyses on the growth rates of publications, accumulated citations, and levels of cognitive interaction.
Our findings show a trend from product development issues to higher degrees of change epitomized by the business model, value creation/capture, and ecosystem transformation (de Vasconcelos Gomes et al., 2018). Rather than pointing to the demise of product innovation, our study illustrates the diversification of this IR topic into platform technologies (e.g., sharing economy and multisided platforms), product-service hybrids (e.g., servitization and productization), and business models. Similarly, in line with the results of Lee and Kang (2018), we noticed a shift away from business management—change management, TIM, benchmarking, and a balanced scorecard. Human-based issues in innovation show strong dynamics (e.g., innovative and entrepreneurial behaviors and attitudes) or emerging characteristics (e.g., creativity, culture, leadership, transdisciplinarity, and learning).

Our results also reflect the significant drive of sustainability-related issues, which strongly resonates with Schot and Steinmueller (2018)'s call for policymakers and researchers to focus more on the transformative change associated with contemporary social and environmental challenges. Broad-encompassing theoretical perspectives such as sociotechnical systems, transitions theory, transformative innovation, and circular economy have gained considerable attention. Despite this, locality appears to be a relevant issue. A significant transition into social-related issues exists (e.g., responsible innovation, social innovation, social entrepreneurs, reverse innovation, frugal innovation, and bottom-of-the-pyramid).

As with any scientific field, the field of IR shows a proclivity to “academic fads” or “bandwagon effects” (Fenn and Raskino, 2008). This is portrayed not only in the large rates of growth experienced in the implementation of some innovation approaches (Chesbrough and Brunswicker, 2014, Gaglio, 2017) but also in the types of sectors being focused on by the research community. This study observed a move from previously attractive sectors, such as biotech and nanotechnology, into the currently “hot” areas of artificial intelligence, machine learning, blockchain, fintech, autonomous vehicles, and the Internet of Things. Our results also demonstrate imminent sectoral diversification into service-oriented sectors such as banking and finance, the digital economy, health care, and even tourism and hospitality, which are highly service-oriented sectors. Of interest is the move of the government as an active practitioner of innovation beyond its traditional role as an intermediary or gatekeeper.

Although the transition of research from manufacturing to services is widely known in IR, as mentioned above, we can discern deep interactions between both sectors, as inferred from concepts such as product servitization and service productization (Candi, 2016). Despite the maturity of research on SMEs and large, incumbent organizations, recent focus has shifted to start-ups and particularly family businesses, partly driven by the different, rapidly growing entrepreneurship-related research trajectories observed in this study. However, understanding how large firms can become more innovative remains a challenging IR topic. In particular, our results also resonate with Martin (2016)’s concept of “dark innovation,” which is an analogy of the invisibility of “dark matter” in the universe, using existing instrumentation. Up to now, the key “invisible” innovation topics are responsible innovation, inclusive innovation, frugal innovation, socially-driven innovation, and gender issues in innovation.

Interestingly, despite the significant presence of open innovation approaches, traditional collaboration-related concepts rooted in technology management, such as strategic alliances, joint ventures, outsourcing, university–industry collaborations, and communities of practice, have shown declining and even negative growth rates. A similar situation is observed in user innovation-related topics (e.g., market orientation, open-source, and open science), which are now driven by additional concepts, such as crowdsourcing, accelerators, and knowledge co-creation. In relation to this, innovation systems approaches—national, technological, and regional innovation systems—are considered maturing and, in some cases, declining. However, terms related to the impact of relatedness and agglomeration (e.g., creative industries/cities, science and industrial parks, and innovation ecosystems) are emerging. Despite the declining nature of traditional innovation terms, such as competencies, capabilities, and knowledge management, except for dynamic capabilities, other traditional terms originating in the 1980s (e.g., catch-up, absorptive capacity, and ambidexterity) are characterized by a high persistence in the IR community. We also observed declining dynamics in terms, such as high-tech and technology dynamics, emerging technologies, exploration innovation, and breakthrough innovation, which have typically enjoyed high levels of visibility in the IR community.

5.1. Features of an emerging innovation model

Building on this study's results, the remainder of this section proposes some initial insights into the development of an innovation model for the future (Figure 7).

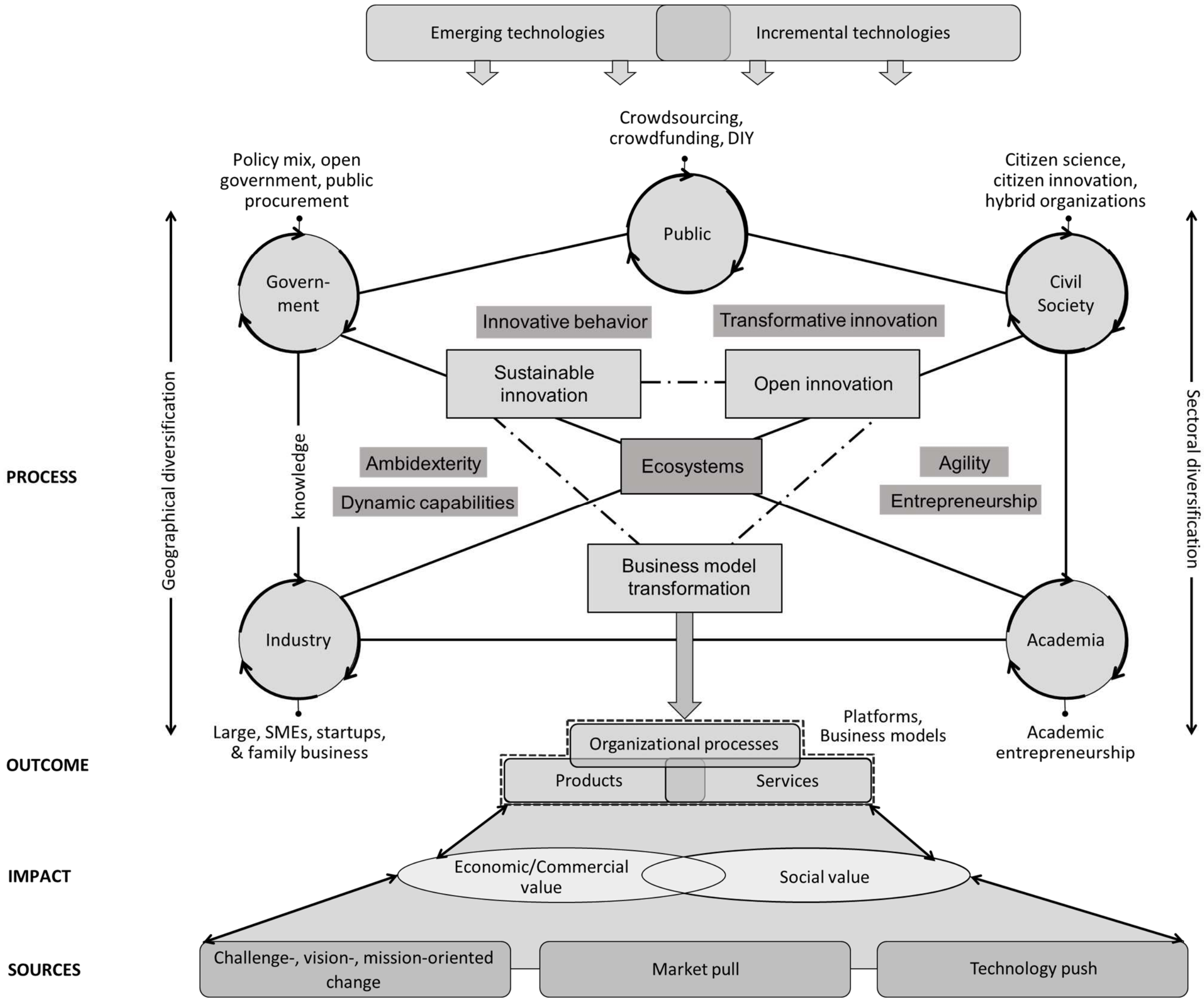

Figure 7 Features of an emerging innovation model

The traditional actors of innovation models (e.g., government, industry, academia, and civil society) (Leydesdorff and Etzkowitz, 1996, Carayannis and Campbell, 2012) are now enhanced with the greater role of the general public as a source of innovation, as inferred from approach such as crowdsourcing, crowdfunding, knowledge co-creation, citizen science, DIY labs, challenges and contests, and innovation marketplaces. This multi-agent context calls for broadly encompassing concepts, such as ecosystem approaches. We defined three main pillars of an incipient innovation model: sustainability-driven innovation, open innovation, and business model transformation. These three aspects can act together or individually to generate future innovation opportunities. To face new innovation contexts, firms need to radically transform their business models; here, the use of challenge-or vision-oriented approaches (e.g., grand challenges or societal problems) is becoming a more common innovation driver. New and enabling technologies increase the possibilities of innovation through the transformation of new business models or firms' processes. Digital transformation, emerging technologies, and ecosystem approaches have driven the development and management of platform-based technologies, and harbingers of several business models proliferating in today's economic system, such as multisided platforms, the sharing economy, B2C business models, makers movement, innovation marketplaces, advanced manufacturing and services, crowd-based sourcing and funding, product-services, servitization, and smart innovations.

The role of government similarly increases, involving a more significant commitment to the creation and diffusion of innovation. Public procurement, policy mixes, open government, and mission-oriented interventions are poised as recurrent innovation topics. As people are the conductors of innovative change, it becomes more important to understand how they are adaptable to innovation. In particular, firms' ability to master explorative and exploitative innovation-driven change, embraced by the concept of ambidexterity, is still prominent. Moreover, the latter might need the capability to absorb and exploit knowledge from these diverse sources of innovation to be concentrated at both global and local levels. Other relevant aspects include entrepreneurial intentions, innovative behavior, agility, and management leadership. As observed in this study, these processes occur under high sectoral and geographical diversification levels, thereby widening accumulated innovation knowledge.

Building on the discussions above, the rest of this section proposes insights into a series of propositions that shape future innovation research.

- *Product-service*: The border between products and services is no longer clear-cut. This division is now giving way to a more suitable construct of the "business model" for understanding value creation and capture in innovation. Product-as-a-service or servitization, technology platforms and innovation ecosystems, are other related concepts.
- *Local-systemic*: The borders of companies and innovations are pushed farther beyond, now involving business and innovation ecosystems in value creation and capture processes. Here,

concepts such as the circular economy and global innovation systems visualize the entire cycle of innovations. Despite this, locality and regionality are highly relevant for understanding innovation.

- *Social-for-profit*: For-social and for-profit are no longer mutually exclusive but complementary aims for organizations. Examples of financially successful hybrid companies with socially driven business models are becoming more recurrent in the theory and practice.
- *Sustainability-for-profit*: The financial success of an organization cannot be detached from its sustainability aims, which goes beyond corporate social responsibility to the development of sustainability-driven, responsible, and conscious enterprises and the impact of technology and innovation on sustainability.
- *Internal-external*: The role of external agents in innovation will continue; however, its nature is changing, moving away from passive to more active and deeper participation. Examples are co-creation communities, crowdsourcing, and C2B business models in which user and customer participation will not only lead but also profoundly shape innovation processes.
- *Public sector innovation*: The government's role as an intermediary organization is complemented by its more active role as an innovator. Examples include open government and public procurement.
- *Greater push-Greater pull*: The role of deep science, that is, those fields of research heavily scientific in nature, and grand challenges, such as SDGs, will have a deeper impact on innovation from greater push and pull perspectives, respectively.
- *Human-technical*: "Soft" topics in innovation and entrepreneurship, such as intentions, opportunities, motivations, aspirations, behavior, and culture, have remained relevant throughout the years; hence, research will have to address human and technical issues and their interactions when dealing with innovation.
- *Ambidexterity-Multidexterity*: Despite decades since its establishment (March, 1991), the concept of ambidexterity is still relevant in the IR field. Organizations should now deal with multiple dimensions across the different stages of the innovation process: emerging and low-tech, social and economic value, transdisciplinarity, internal and external opportunities, human and technical issues, and short-and long-term goals.
- *Experiments-traditional methods*: Newer technologies and ensuing business models enable the study of innovation using different research methods. Conducting of experiments in real

settings has become common in innovation and entrepreneurship (e.g., living labs or simulation approaches). As data and computing power become widely available at a more affordable cost, AI, machine learning, deep learning, and neural networks are often used to understand the different facets of innovation.

5.2. Limitations and Future Research

Despite the contributions of this study, it had some limitations. In contrast to scientific and engineering fields, social sciences tend to diffuse their academic achievements through means other than scholarly articles, such as books, reports, and academic meetings, which we did not consider in our analysis. Rather than depicting zero-sum transitions, the dynamic patterns observed in this study complement, and cooperate with, each other to constitute the increasingly expanding and diversifying field of IR. While bibliometric studies provide reliable tools to evaluate fields of research globally, their level of detail is limited. Therefore, future research efforts should be directed toward a deeper understanding of the interconnections between IR terms. Moreover, further studies should elaborate on the contributions of the different stakeholders involved in the IR community and the role that labels play in the evolution of fields such as IR.

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