
Knowledge stakeholders in RIS' literature: to be or not to be

Regional innovation system (RIS) research has emerged a popular subject among scholars who analyze how a region transforms and develops into an innovative one. Following a bibliometric approach, this article wants to deep in the role of knowledge stakeholders inside RIS literature and the relationships established between them. Through co-word techniques and science mapping, the thematic networks obtained will present the associations between the main actors taking part inside a RIS, providing a map of the published literature till nowadays.

Los estudios sobre el sistema regional de innovación (RIS) se han convertido en un tema popular entre quienes se dedican a analizar cómo se transforma una región hasta convertirse en innovadora. Con un enfoque bibliométrico el artículo pretende profundizar en el papel de los gestores de conocimientos, dentro de la literatura sobre RIS y las relaciones que se establecen entre ellos. Mediante técnicas de análisis de co-ocurrencia de palabras y establecimiento de correspondencias científicas (science mapping), las redes temáticas obtenidas presentarán asociaciones entre los principales actores que intervienen en un RIS, proporcionando un mapa de la literatura publicada hasta la fecha.

Eskualdeko berrikuntza-sistema (RIS) lantzen duten azterketak gai oso ezaguna bilakatu dira eskualde bat berritzaile bihurtu arte nola aldatzen den aztertzen dutenen artean. Artikulua, ikuspegi bibliometriko batekin, ezagutzen kudeatzaileen eginkizunean sakontzen saiatzen da, RIS-i buruzko literaturan eta beraien artean ezartzen dituzten harremanetan. Hitzen ko-okurrentziaren azterketa bitartez eta korrespondentzia zientifikoa (science mapping) ezarriz, lortutako sare tematikoeak RIS batean parte hartzen duten aktore nagusiekin asoziazioak izango dituzte, gaur egunera arte argitaratutako literaturaren mapa bat eskainiz.

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1. INTRODUCTION

Regional Innovation System (RIS) concept was born in 1992 with a publication made by Phil Cooke, *«Regional innovation systems: competitive regulation in the new Europe»*, in which he delved into interactive learning to boost economic performance across regions. The RIS is a model which comes from the Economic Geography literature underlying the territorial effect and embeddedness to promote relationships among local stakeholders and help to spread knowledge between them. In particular, although different definitions of the concept have been provided in the state of the art, we follow the one given by Doloreux and Parto (2005, pp.134-135): *«A set of interacting private and public interests, formal institutions, and other organisations that function according to organisational and institutional arrangements and relationships conducive to the generation, use, and dissemination of knowledge»*.

The region enables actors to attract, create, and disseminate information by providing the common cultural and social values which facilitate (or impede) social inter-

action among the different stakeholders involved in knowledge dissemination (Cooke *et al.*, 2004). In this sense, the RIS highlights the importance of the region as important base of economic coordination and the systemic dimension of innovation.

The concept of innovation is now seen as a dynamic social process that evolves most successfully in a network of intensive interaction between those producing innovation and those purchasing and using knowledge (Asheim *et al.*, 2016). Thus, innovation is an interactive learning process of a social nature which involves interaction between firms and their environment, particularly between users and producers, but also between businesses and the wider research community. To a large extent, the central idea behind this approach is that innovative performance does not hinge solely on the knowledge banked by firms and public sector organizations, but also depends on the way these different kinds of organizations interact with each other and their environment in regards to production and dissemination of knowledge.

Therefore, the role of the stakeholders involved in knowledge transfer is key for the success of the territory. But who are those possible stakeholders? An example can be found in the explanation made by Hjalager (2002) inside the tourism industry. This researcher identifies among others, university and vocational teaching relationships from a research-enterprise collaboration point of view, cooperation links established between firms along the value chain, or public agencies pushing innovation inside their territories through scientific or innovation policies.

The objective of this article is to deep into the stakeholders appearing at the different stages of the RIS research, through the analysis of the RIS literature published in academic peer-review journals (Doloreux & Porto Gómez, 2017) from 1998 to 2015. We would like to drive readers' attention to the scarce entrance of new stakeholders beyond universities and enterprises. Although, new stakeholders appear in each stage their relevance and impact in the literature is poor. In this sense, for example, is not till the second period that Governments pushing innovation policies appear. Also, we do not identify knowledge stakeholders further than Universities or Research Centers till the third period in which Vocational Training Centers –VTC– appear.

Several studies have focused on the relationships VTCs might have with manufacturing firms in order to execute innovation projects (Albizu *et al.*, 2011; Olazaran *et al.*, 2013; Albizu *et al.*, 2017; Porto-Gómez *et al.*, 2017; Rodríguez-Soler & Brunet Icart, 2018). These works promoted by different Spanish researchers are still young and have not influenced significantly yet the literature. They all share the vision that VTCs can play a role to promote innovation in regionally embedded innovation systems as they are close stakeholders with which mainly SMEs can share a common background (Amin, 1999). An OECD study (2001) also pointed at the positive correlation vocational education could have in the economic performance.

In order to perform the analysis, we employ a bibliometric approach based on science mapping analysis (Cobo *et al.*, 2011a) to analyze the articles included in the

Scopus database. In the field of innovation system, there are few studies that have turned into bibliometric techniques to analyze the evolution of the research field. Sun & Grimes (2015) employed bibliometric performance analysis to understand the evolution of National Innovation Studies, from articles derived from the ISI Web of Science, based on references citation. Another example might be the analysis of the science parks in the UK in order to measure their influence in the R&D (Minguillo *et al.*, 2014). These authors also recurred to performance analysis of the articles dealing with UK scientific parks published in Scopus during the period 1975-2010. Abramo and D'Angelo (2015) employed bibliometric methods to identify what are the research areas in the different provinces of Italy, attending to the academic publications of Italian researchers. On the one hand, Lee and Su (2010) provide a bibliometric analysis applied to Regional Innovation System literature. These authors offer a static view of the published articles till 2008, focusing on the relationships between the researchers publishing those articles, their schools and countries they belong to. On the other hand, Toivanen and Ponomariov (2011) focus on the regional innovation systems located in Africa and provide a bibliometric research in order to clarify the research collaborative networks in that continent. Several other approaches appear in the literature to provide a framework around RIS (Navarro, 2009; Asheim *et al.*, 2011; Doloreux & Porto-Gomez, 2017).

However, the available studies do not provide a direct insight into the available stakeholders or relationships established between them inside RIS theory and its evolution. Therefore, the main goal of the present article is to provide the reader an evolutionary map of the players involved in knowledge generation and spread in the literature over time, focusing on their territorial area of influence.

The paper is organized as follows. Next section provides a general overview of possible stakeholders involved in innovation. Section 3 –Research method– describes the bibliometric analysis to be performed and introduces the rationale of the data set used in the study. Section 4 –Study findings– describes the results for the key terms associated with the research question (query) and the main themes (and their areas) addressed in RIS papers published and the relationships between these themes, along with other directly linked concepts (thematic networks). Finally, conclusions are drawn and some contributions are discussed.

2. STAKEHOLDERS IN THE INNOVATION ARCHITECTURE

Turning back to the question made in the first section, «*who are those possible stakeholders?*», we will deep into the RIS literature so as to find identified the players taking part in the regional development and innovation projects. Therefore, we would be able to detect subthemes so as to deep into their relationships and evolution through a bibliometric analysis.

In this sense, we find Phil Cooke's (1996) publication «*The New Wave of Regional Innovation Networks: Analysis, Characteristics and Strategy*». In this article, Prof. Cooke describes possible stakeholders that might boost innovation inside a network, trying to bring them together. This article cites, among others, large firms and SMEs, Universities and Training Organizations, Development Agencies, Governments and Chambers of Commerce, as possible members of that regional network.

These members are organized around 3 different subsystems which interconnected, conform the RIS model: *Knowledge Exploration Subsystem*, in which Universities, Research Centers or Vocational Training Centers might be included, *Knowledge exploitation Subsystem*, –formed by business which use and produce the created knowledge, transforming it into value added products or services– (Autio, 1998; Cooke, 2004) and an *Institutional Infrastructure Subsystem*, which combines the formal and informal institutions inside the region that support the innovation activities within the production structure (Asheim & Gertler, 2005).

Focusing on the knowledge exploration subsystem, different types of knowledge bases are identified around RIS (Asheim, 2007), being each player more prone to one type or another. In this sense, Universities or Research Centers for example would be more involved in *analytical* knowledge spread, based on the technological inventions and research discoveries made. On the contrary side, we find polytechnic schools or vocational training centers, in which a more practical and problem-oriented knowledge –*synthetic*– is promoted.

However, even though the presence of regionally rooted stakeholders is important, intangible issues more linked to interpersonal relationships promotes the efficiency in the knowledge diffusion, for example between large multinational firms and SMEs around their value chain (Camagni & Capello, 2013).

Even Public Administration and Governments –part of the institutional subsystem– are key players to promote innovation inside a region, adapting the regulatory system, establishing policies, promoting subsidies, etc. However, each actor should take care about the role played by each of the players inside the network, so that jointly, they are able to follow the beat (Etzkowitz & Klofsten, 2005).

3. RESEARCH METHOD

3.1. A few words on bibliometric approach and analysis

Bibliometrics is an interesting technique to assess and compare the academic works conducted throughout time, in different research teams, published in different journals and languages. It provides a review of the science field studied (Martinez *et al.*, 2014), identifying the most important scientific publications, underlying the main scholars or research teams, or for example, highlighting the principal sub-themes around the research area.

Bibliometrics is supported by two basic methods to explore the science field of study: performance analysis (van Raan, 2005) –*which aims to compare the citation references and importance of each one for the area analyzed, providing a statistical description of the available data*– and science mapping (Noyons, 2001) –*which proposes a conceptual plot where the evolution of subthemes and main areas are included*–.

Being the objective of this work to provide a conceptual analysis of the players involved in knowledge generation and dissemination in the RIS literature, we will specifically rely on Science Mapping (Morris & Van der Veer Martens, 2008; Cobo *et al.*, 2011a). This technique helps to study the conceptual structure of a particular research field, illustrating how disciplines are related to one another.

The workflow to perform a science mapping analysis starts with the article database selection (Cobo *et al.*, 2011b). There are different databases from which data can be obtained. The most frequent ones are the Web of Science and Scopus. After the paper selection, the relationships between the keywords, authors or references of the articles, attending to the objective of the paper, are shown through a network. The complete process performed is explained by Murgado-Armenteros *et al.* (2015).

Focusing on the science mapping, different techniques can be performed, such as co-occurrence, coupling or direct linkage (Boyack & Klavans, 2010). Co-occurrence helps us to identify the relationships between two units of analysis –*authors, words or references*– that appear in several articles. The method of word co-occurrence analysis is called co-word (Leydesdorff, 1998; Lee & Su, 2010), and provides the researcher a relational exploration of the documents which conform the database, attending to the keywords specified by authors and the evolution of the research field based on the transition from one item into another.

Based on Cobo *et al.* (2011a), the approach adopted four stages to analyze the RIS research, as performed in previous scientometric studies (Muñoz-Leiva *et al.*, 2013; Martínez-Rojas *et al.*, 2015).

- Performance analysis description: This first stage proposes a quantitative and qualitative description of the research works included in the study, considering the number of published documents per author, citations of each work and of each author, most cited articles, etc.¹
- Research themes detection: The research themes for each stage under study are detected, through co-word analysis, based on the co-existence of same keywords appearing in the dataset.

¹ Even though a complete bibliometric analysis should undergo these points, the Performance Analysis description would provide a photograph of the RIS literature with descriptive statistics already published in a previous work (Doloreux and Porto Gomez, 2017).

- Strategic diagrams and thematic networks building: Based on centrality and density² indicators, the research themes are characterized in order to identify whether they are actually relevant research areas –see Figure 1– under study (Motor Themes), peripheral themes with low importance at the present since they have been highly or scarcely studied in the literature till the moment (Highly developed and isolated themes), weakly developed concepts which are at the point of disappear or emerge (Emerging or Declining themes) or general concepts relevant for the field but not strategic ones (Basic and Transversal themes).
- Thematic areas discovery: In order to detect the progress of the field, an evolutionary map shows the relationships between the subthemes along the years of study.

Figure 1. **STRATEGIC DIAGRAM**

		Density	
	Highly developed and isolated themes	Motor Themes	Centrality
	Emerging or declining themes	Basic and Transversal Themes	

Source: Own elaboration.

3.2. Data sets

The dataset employed to perform the science mapping analysis comes from a previous work performed by Doloreux and Porto Gomez (2017), which covers the period 1998-2015 of articles published in peer-review journals indexed in SCOPUS. The science mapping analysis is performed using the software tool SciMAT.

Considering that one article requires normally a minimum of 6 years to be renowned (Glänzel & Schoepflin, 1995; Nederhof & Noyons, 1992; Nederhof & Van Raan, 1993), 1998 might be considered the minimum year so that Cooke's presentation of the RIS concept (Cooke, 1992) gained enough relevance so as to generate a new research trend. That's the reason for the selection of 1998 as the year in which Cooke's initial work would have developed a new research trend in the Geography and Innovation literature.

² Centrality and density are key indicators in a bibliometric analysis. Centrality measures the intensity of the links between the keywords themselves and between the keywords with other clusters. The stronger the links are the higher importance of the themes for the scientific community. On the other hand, Density represents the research theme capacity to maintain itself or to evolve over the years.

Three criterias were defined so as to judge a study eligible for inclusion: (a) that deals with regional innovation systems as the core analytical concept under which the empirical investigation is carried out. Therefore, empirical studies dedicated to other territorial innovation models (regional clusters, industrial districts, innovative milieu, learning regional, local production system, and so on) were not retained; (b) that it has to be an article published between 1998 and 2015 inclusively in a peer review journal. Other publications forms (conference proceedings, book, chapters, working papers, etc.) were not considered; and (c) that includes empirical and conceptual studies.

The articles were identified adapting a three-step process as described below:

1. First, keyword searches using terms such as «regional innovation system», and «regional systems of innovation» in the title, keywords or abstract were used to identify the potential universe of articles on RIS relevant to this review. Like in other studies, we chose Scopus (Gorraiz & Schloeggel, 2008; Archambault *et al.*, 2009) for this research.
2. Second, the search returned 531 articles published in scholarly journal and containing the respective term: regional innovation systems articles (496 articles) and regional systems of innovation (35 articles).
3. Then, each of the two authors of the present work performed an initial selection of potentially relevant articles addressing the focal topic. We defined the articles with an explicit focus on RIS as the cores articles for the review. We excluded subsequent articles that were not dealing explicitly with RIS. This list was pooled yielding a list of 341 potential relevant articles, and the articles in the pooled list were rated by each of the authors independently in terms of core or not-related. These manuscripts contain a total of 1,871 keywords.

The search query was extracted from Scopus using 31 December 2015 as the last date of publication:

Query: TS = ('regional innovation system') or TS = ('regional systems of innovation'), where the field TS is a topic-based query ('topic' = 'title' + 'keyword' + 'abstract').

Prior to the analysis, a normalization process was carried out in which singular and plural forms were combined and acronyms were converted into their respective keywords. Also, the words dealing with the same concepts were grouped so as to establish relationships between the trends.

In order to analyze the evolution of the concepts and the subthemes around Regional Innovation System, we establish 3 periods which cover the time lapse as done in Doloreux and Porto Gomez (2017). Accordingly, the data is divided in consecutive periods of time: 1998-2005, 2006-2010, 2011-2015. The results of how the docu-

ments are being published are presented in Table 1. It's clear that the theme is gaining relevance, since for each article published in the first period, we find three in the third one.

Table 1. **REGIONAL INNOVATION SYSTEMS PUBLISHED IN SCOPUS DURING 1998-2015**

	1998-2004	2005-2010	2011-2015	Total
Regional Innovation System	50	112	162	324
Regional System of Innovation	5	6	6	17
	55	118	168	341

Source: Own elaboration.

4. STUDY FINDINGS

This section is structured as follows. The first section displays the strategic diagrams based on the most frequent concepts identified in the RIS literature. The third section identifies the trends in each of the periods, so the impact and tendency of those concepts can be measured. Finally, the thematic network of the RIS is provided.

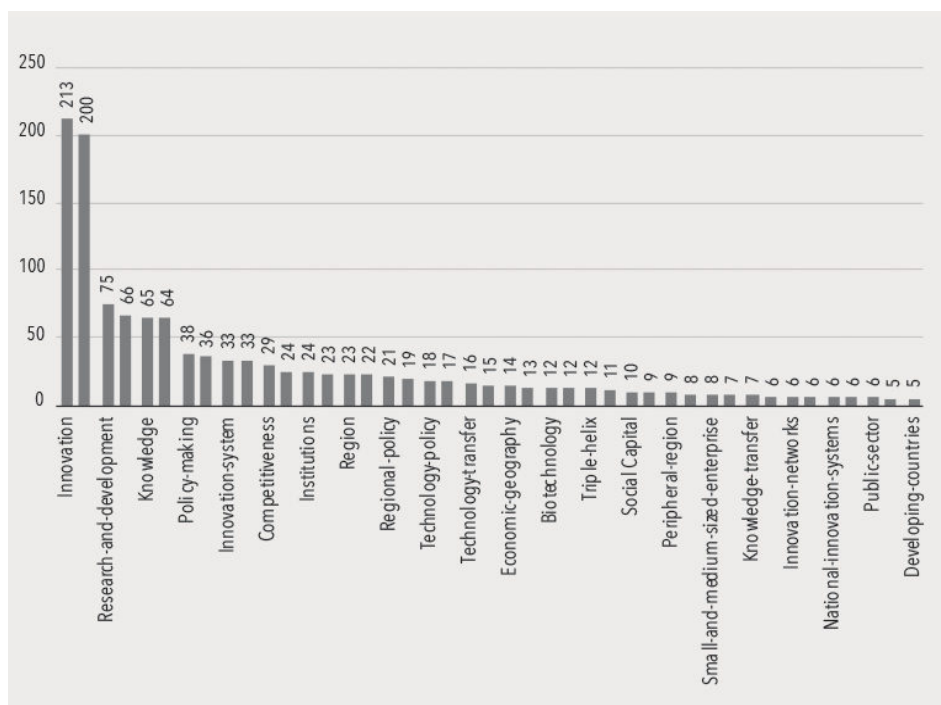
4.1. Research Theme detection

At this section, we detect by co-word analysis the most significant research themes around RIS literature. This technique is based on the employment of keywords so as to describe and characterize the type of article. The co-occurrence of same keywords in different articles can be employed to identify and model co-words networks showing the most significant themes (Callon *et al.*, 1991).

Then, as a first step we deep into the keywords employed in our dataset, in order to identify the most common concepts studied in the RIS literature (see Figure 2). Altogether 1,868 keywords are employed in our dataset, being just 356 repeated in more than 2 documents. Therefore 1,515 keywords are just used in one article, which would point to not popular themes. Of the 356 recurrent keywords 60 deal with specific RIS case-studies in different countries or regions (China, Malaysia, Spain, Germany, etc.). The type of region housing the RIS would be another key feature of those works, providing an initial classification of the territory (Metropolitan area, Peripheral-region, Developing-countries). The main sector in the region is another common point in the papers (Biotechnology, Manufacturing, Food industry, Energy). The policies implemented in the regions are also mentioned in those papers that focus on the governance of the territory (Innovation policy, Regional De-

velopment policy, Technology policy). The dynamism of the innovation process involving regional players in the knowledge spread establishes another key point of the literature (Innovation, Innovation networks, Knowledge based systems, Knowledge transfer, Research and development, Technology transfer). And finally, as the main point of this work we find the stakeholders participating in those RIS and the relationships established between them (High technology industry, Institutions, Multi-national enterprise, Small and medium sized enterprise, Triple helix, Universities, Social capital, Public sector)³.

Figure 2. RECURRENT KEYWORDS EMPLOYED TO CHARACTERIZE THE ARTICLES



Source: Own elaboration.

Attending to the classification of the themes based on their tendency –Figure 1–, we provide below an initial photograph (see Figure 3), called strategic diagram, of the RIS literature for the whole period under analysis. The themes identified in the state of the art are grouped in 4 different categories (see captions in the figures):

³ Keywords dealing with specific territories (i.e. Malaysia, Tuscany, Skane, Spain, etc.), have not been considered in this work since the territory under study was already shown (Doloreux & Porto Gómez, 2017).

- **Type of Region:** Colored in dark grey we find different concepts related to the type of RIS. In this sense, we find that although all the works deal with Regional Innovation Systems, scarcely used concepts such as Peripheral Regions or Local Innovation Systems appear isolated themes that are new in the literature. Since all the works included in the dataset were forced to be related to RIS, it's obvious that the Regional Innovation System concept becomes a basic theme.
- **Stakeholders:** The key actors identified, painted in grey, belong to the 3 subsystems of a RIS. The Knowledge Subsystem would comprise those players contributing to the knowledge generation, such as Universities, Research Centers –apparently the main ones– and Vocational Training Centers, which are narrowly studied. The productive Subsystem includes not only the Firms employing the produced knowledge, but also startups founded by Entrepreneurs, which are mainly linked to technological spin offs from Universities. Finally, the institutional subsystem embraces the motor theme of the Government which is linked to the establishment of policies for the regional development and Facilitators, which appear as an emerging concept.
- **Policies:** The role of the policies, in dotted grey, introduced in the region to promote development is a key issue along the years. In general, the focus is set on Regional Development and Technology Policies but also the Policy Makers as different level institutions underlying the effect of multilevel policies, which is a transversal theme linked to other disciplines around Innovation theory.
- **Innovation or Knowledge Spread:** In light grey, we show the focus of the innovation process itself, which is mainly set on R&D and Technology. The knowledge spillover effect becomes an emerging concept in the literature which is gaining relevance. Finally, Innovation and Knowledge Transfer are transversal concepts for the literature.

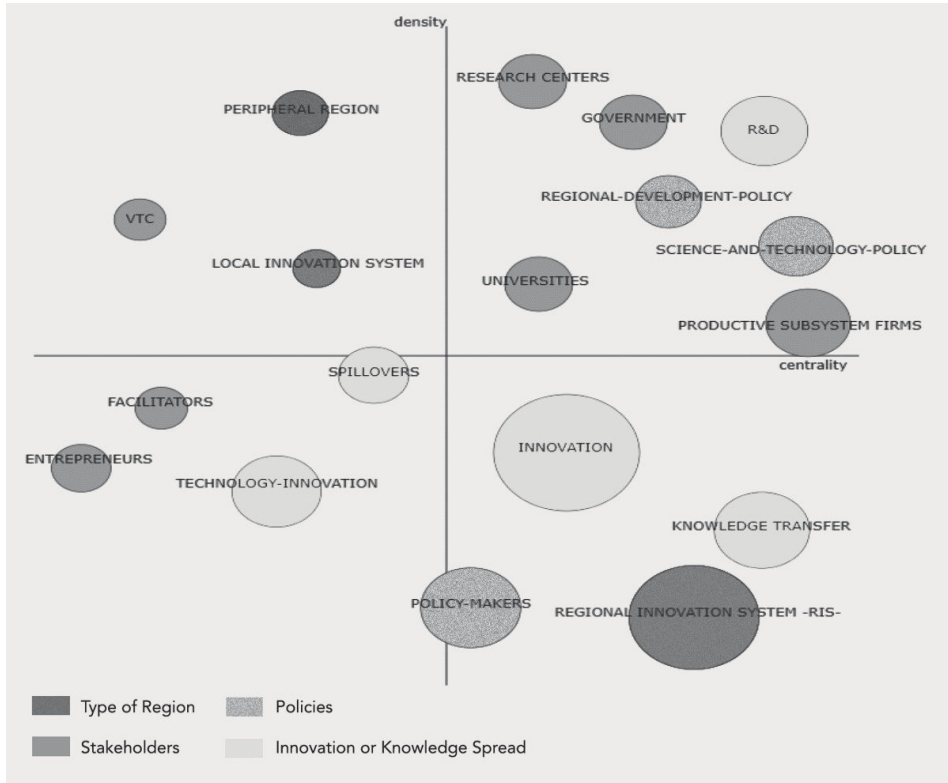
4.2. Strategic diagram and thematic network detection

Considering the previous general photograph, in order to highlight the most significant themes along the years, a strategic diagram is provided for each single period⁴.

In the 3 stages, RIS appear as a basic and transversal concept. However, the research themes with a higher or lower direct impact in the RIS field differ from one stage into another.

⁴ In each diagram the size of the sphere is directly proportional to the number of articles focusing on that theme.

Figure 3. **STRATEGIC DIAGRAM OF REGIONAL INNOVATION SYSTEMS LITERATURE. PERIOD OF ANALYSIS 1998-2015**



Source: Own elaboration.

First stage (1998-2005)

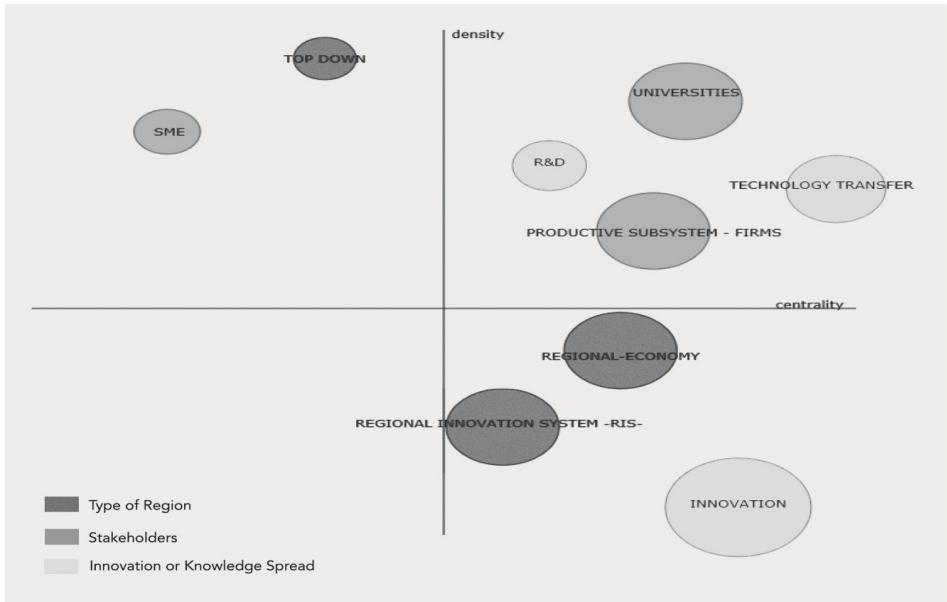
The first period includes 55 articles, which strongly motivates the low number of related research themes compared to the following periods (see Figure 4). Considering this phase as the birth of the RIS concept, the appearing themes are more general and transversal to other disciplines.

The research in this stage pivots around 9 themes. As done in the previous section, we will explain these concepts attending to the same color classification:

- **Type of Region (Dark grey):** This period keeps a Top Down approach for the regional development, although this concept appears as an isolated issue. Regional Economy is a transversal theme to other research disciplines.
- **Stakeholders (Grey):** In this period we find 2 main stakeholders belonging to the Productive Subsystem –Firms and specifically SMEs– and Universities – Knowledge Subsystem–. While Universities and Firms are key or motor issues for the literature, SMEs are identified as a hardly treated concept.

- Innovation or Knowledge Spread (light grey): R&D and Technology Transfer are the motor themes that drive the knowledge in this stage. Innovation is a transversal issue to the literature in this period.

Figure 4. **STRATEGIC DIAGRAM OF RIS LITERATURE FOR THE PERIOD 1998-2005**

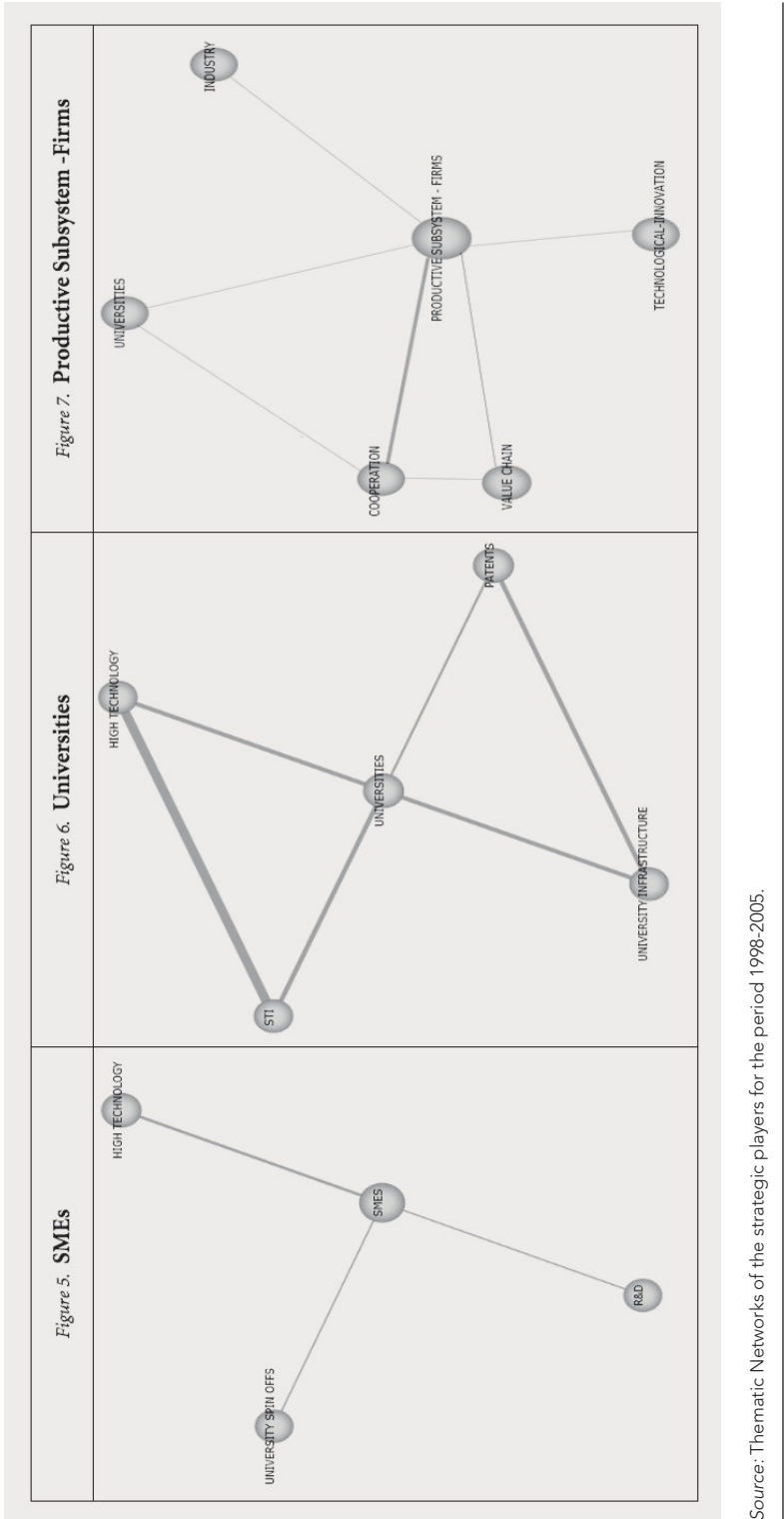


Source: Own elaboration.

Being the objective of this article the identification of the Knowledge Stakeholders and its evolution, we focus on the thematic network detection of these actors. In this sense, we will download to clarify the trends and terms prompting SMEs, Universities and Firms.

The SMEs (see Figure 5) in this period are strongly linked to the R&D projects performed in the Universities, from which new startups arise. In this sense, the focal points are R&D and High Technology.

Being R&D a motor theme of this period, the orientation of the features towards science and high technology is justified. The three stakeholders share a clear technology oriented motivation, in which innovation pursues the dissemination of science and technology (see Figure 6). Therefore, the cases under analysis in this period's articles deal with advanced manufacturing or biotechnology industrial sectors. In the same way that RIS underline the social and dynamism need to share knowledge, firms establish not only cooperation relationships around the value chain, but also with Universities (see Figure 7). As a result of their implication, patents and spin off are considered as possible indicators of the performance achieved.



Source: Thematic Networks of the strategic players for the period 1998-2005.

Second period (2006-2010)

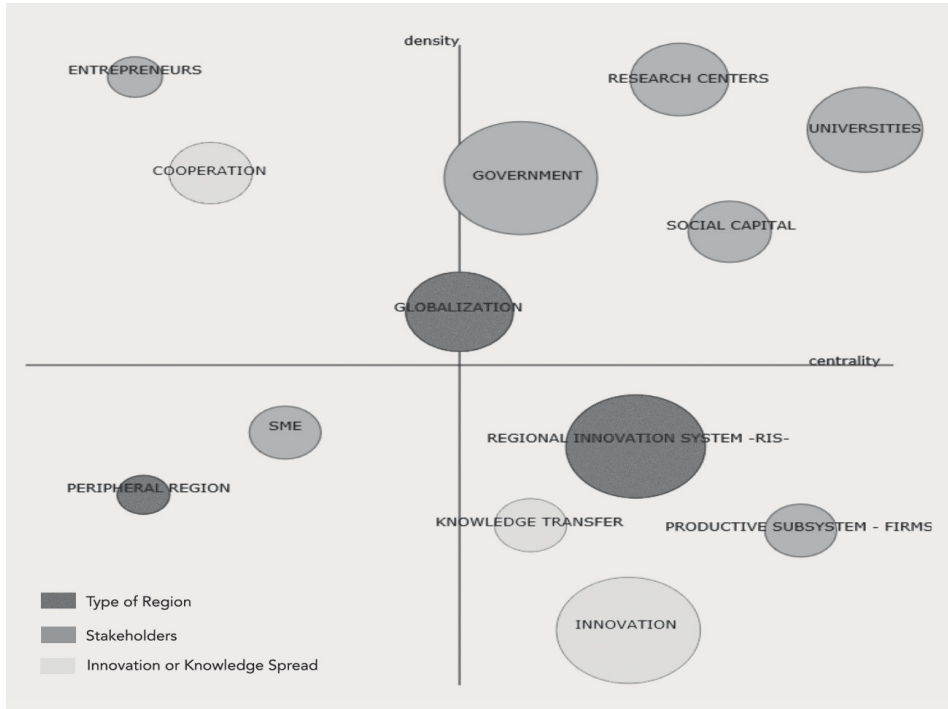
The number of articles published during this second period duplicates the papers of the first one. In this way, the number of research themes appearing in this stage exhibits an important growth and introduces new possible related concepts (see Figure 8).

The development and blooming of the RIS concept presents 13 themes distributed in the four quadrants, providing not only motor or basing themes but also new approaches in which the literature can deep into. Following the previous classification, we explain below the RIS storyline for this period:

- **Type of Region (Dark grey):** In this period, peripheral regions shyly appear as a new possible type of territory in which RIS could be established. However, the mainstream of the literature still focuses on metropolitan RIS, also underlying the need to establish global relationships and the need to promote global innovations.
- **Stakeholders (Grey):** Besides the Productive Subsystem –Firms, which in this stage become a basic theme, SMEs strengthen their appearance in this period, turning into an emerging theme. In the productive subsystem of the RIS appear also the Entrepreneurs, still linked to technological start-ups. On its behalf, the knowledge subsystem is assembled by Universities and Research Centers, which focus the innovation activity on R&D. They are key stakeholders for the RIS literature in this stage. Finally, the institutional subsystem is formed by the Government, arisen as a strategic player, does not only focus on the Policies but also starts evaluating the performance. Also, Social Capital, underlying the role of Regional and Firm Associations, Facilitators and Chambers of Commerce, gains ground in the literature.
- **Innovation or Knowledge Spread (light grey):** Cooperation appears in the literature as a new concept, although as we have seen was linked to the firms' relationships in the previous period (see figure 7). In this stage, the discourse is oriented to the triple-helix and the relationships kept not only between firms and knowledge stakeholders, but also with government and institutional players. However, Innovation still focuses on the knowledge transfer importance, in terms of High Tech and R&D, for the RIS success.

Therefore, in this period, the focus is set on R&D and high technology and knowledge transfer relationships, although non R&D innovation activities appear as possible projects in the literature. As mentioned, RIS appear as a basic research theme, but still centered on metropolitan areas. Nevertheless, stakeholders involved in triple helix cooperation relationships enrich the literature in this period.

Figure 8. **STRATEGIC DIAGRAM FOR THE PERIOD OF ANALYSIS 2006-2010**



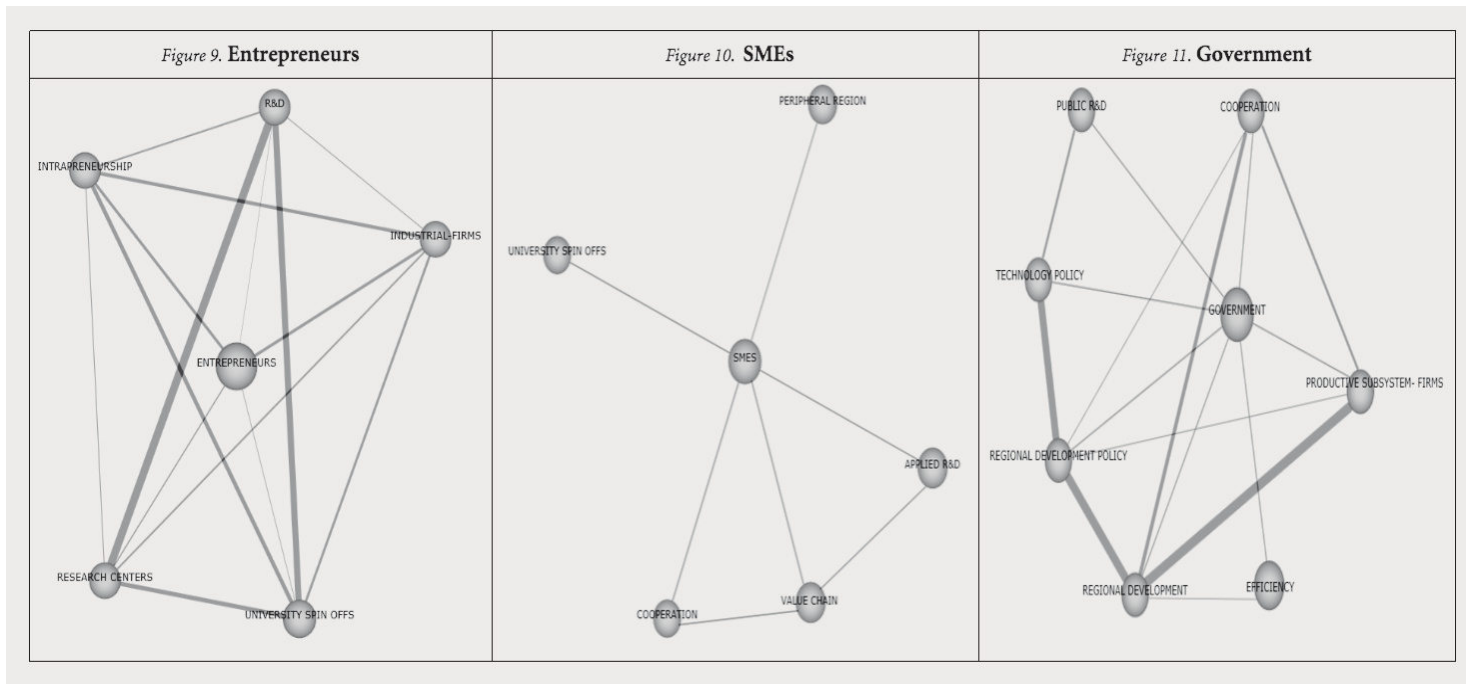
Source: Own elaboration.

But which are the research influences for the key stakeholders in this second period? As done in the first case, we will deep on the thematic networks of each player to exhibit the evolution in the literature. Each stakeholder of the previous strategic diagram has its own thematic network below, so that the line of argument of its player can be clarified.

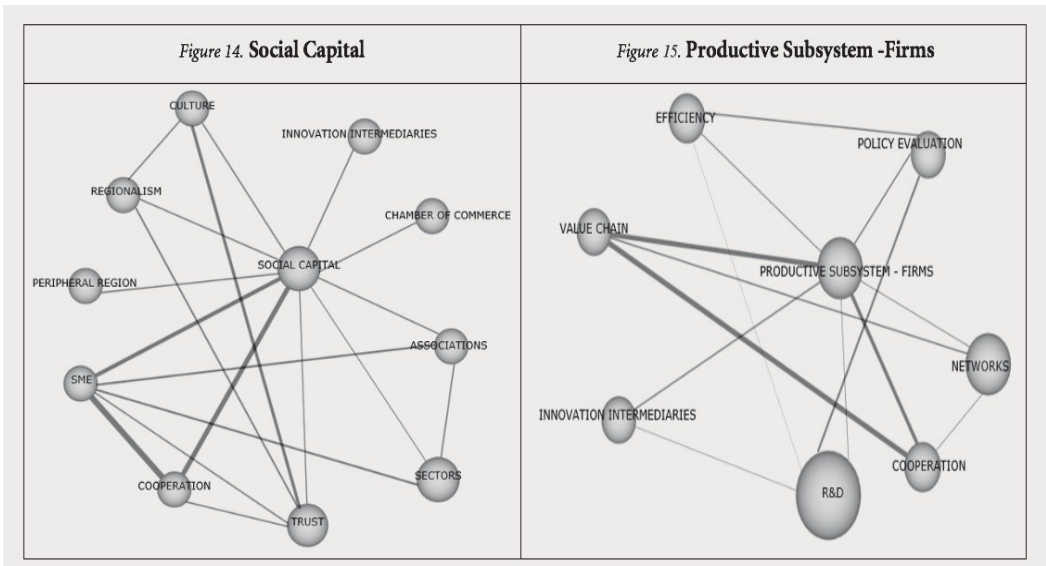
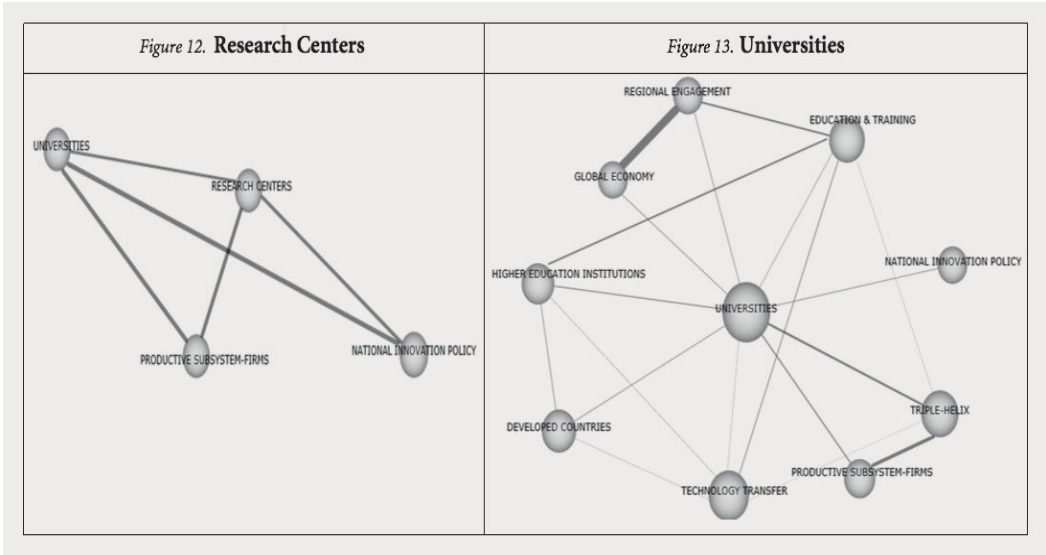
As we can observe in the figures 9 to 13, the innovation projects deal around technological and basic R&D although applied R&D –see Figure 10– settles the origin for a new type of innovation approach more focused on the firms’ needs. However, the main knowledge stakeholders are still the University (Figure 13) and private or public Research Centers (Figure 12), following a top down approach established by the National Innovation Policies.

However, the cooperation ties not only between Triple Helix stakeholders (Figure 13), but also between firms along the value chain and sectors are key for innovation transfer (Figure 9⁵, 10, 11, 14, 15).

⁵ The literature underlines cases of intra-entrepreneurship projects between firms inside the same RIS, which cooperate to promote a new organization to develop a new activity.



Source: Thematic Networks of the strategic players for the period 2006-2010.



Source: Thematic Networks of the strategic players for the period 2006-2010.

Policies gain relevance in this stage (Figure 11, 12, 15), although the focus is still set on Technology and has a National approach. However, with the appearance of innovation policies the evaluation of those policies' impact materializes (Figure 15).

The presence of Social Capital (Figure 14) in this stage provides a new insight of RIS, downloading the discourse not just to technology transfer, but also to informal relationships between SMEs located in peripheral regions which rely on trust. Other

stakeholders that could contribute to the promotion of same values and culture also contribute to strengthen the social capital such as Associations, Chambers of Commerce or Innovation Intermediaries.

In both Universities and Research Centers (see Figure 12 and 13), National Innovation Policies drive the path for the innovation promotion and development.

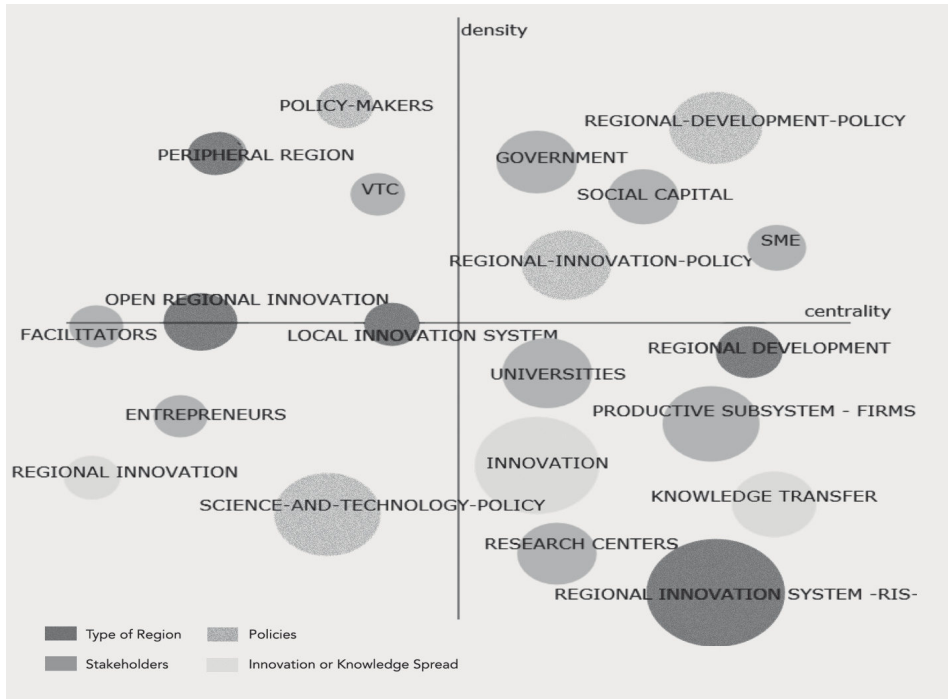
Third stage (2011-2015)

This final period includes the highest number of articles attending to the life cycle of RIS literature and therefore, the highest growth in the research themes (see Figure 16).

- Type of Region (Dark Grey): Non metropolitan *innovation* systems gain relevance during these years, in which local studies –local and peripheral regions– gather strength. Open Innovation literature penetrates in a relevant way Innovation System literature, underlying the need to establish open and flexible territorial boundaries, but also sectoral ones.
- Policies (dotted Grey): In this third stage, policies gain importance so as to promote the Regional Innovation Systems of the territories. Although located in different quadrants, and then with a different tendency in the RIS literature, we identify 4 different types of policies: Policy Makers with a higher view on public policy institutions, Regional Innovation policies, Regional Development policies in a broader vision towards the society and its needs, and Science and Technology Policies focusing on the challenges to be achieved.
- Stakeholders (Grey): In this stage, a new stakeholder appears in the literature: Vocational Training Centers (VTC). With a slow entrance linked to local innovation systems in peripheral areas, they are looked not only as training centers for workers, but also as technological consultants for SMEs. Therefore, they might be considered innovation facilitators. On the other hand, we identify an evolution of the previously identified players. While in the second stage, Universities and Research Centers were motor themes in the literature, the push to non-technological or basic innovation, downplays the role of these knowledge stakeholders, which turn into transversal themes linked to other disciplines. The participation of the Government and Public Institutions is totally related to policies for the innovation promotion and its evaluation.
- Innovation or Knowledge Spread (light grey): Finally, as mentioned, innovation in this stage is less linked with R&D and high technology. It introduces a new approach for regional and local innovation and knowledge transfer between local stakeholders, although underlines the need to avoid lock-in effects so that all possible knowledge sources are taken into account.

In summary, this stage provides a new approach for RIS literature downloading to local innovation systems, in which the focus is not set on high tech R&D but in the knowledge spread for innovation projects between all possible stakeholders, underlying the importance of policies to evaluate and promote strategies for the regional development.

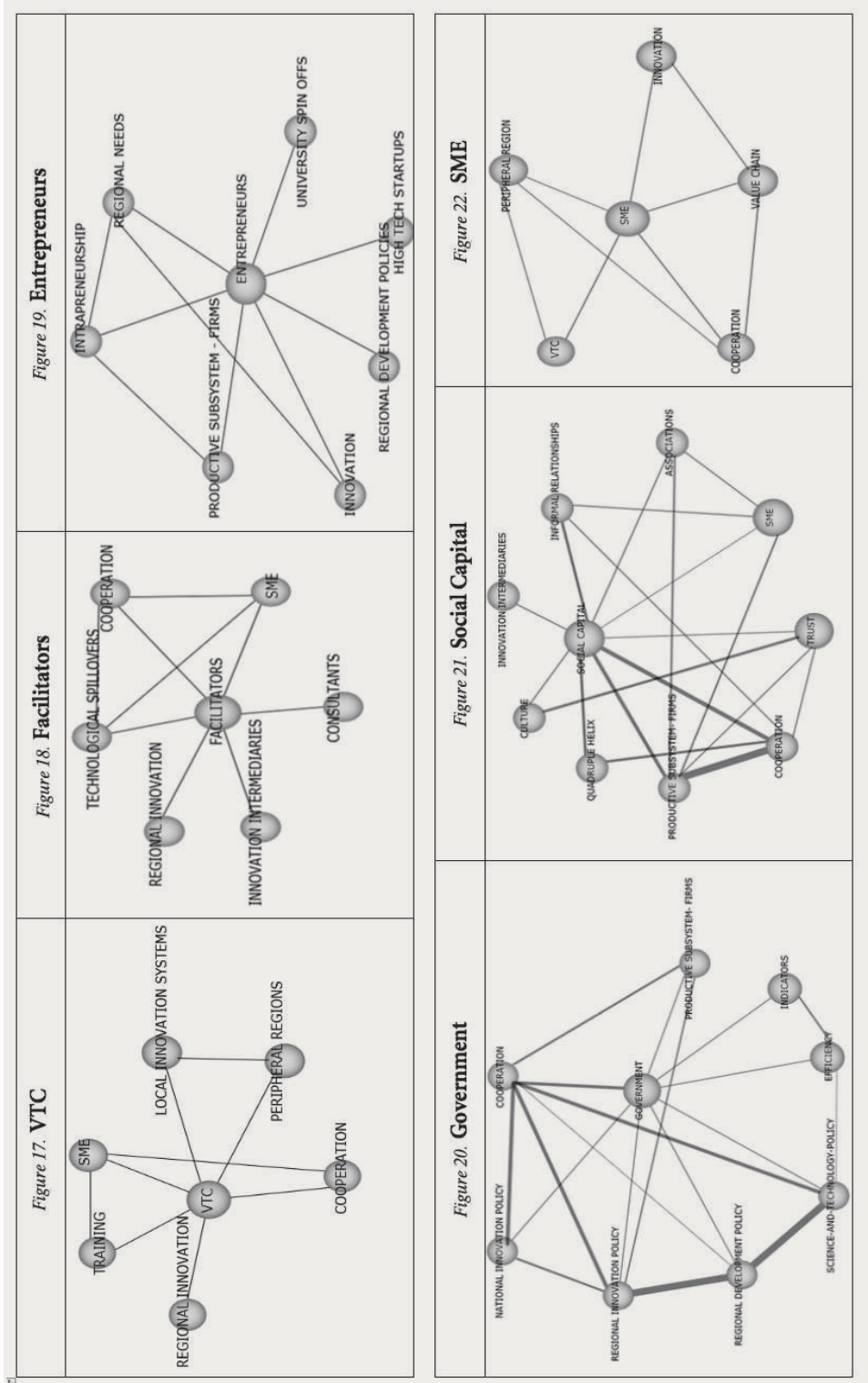
Figure 16. **STRATEGIC DIAGRAM FOR THE PERIOD OF ANALYSIS 2011-2015**



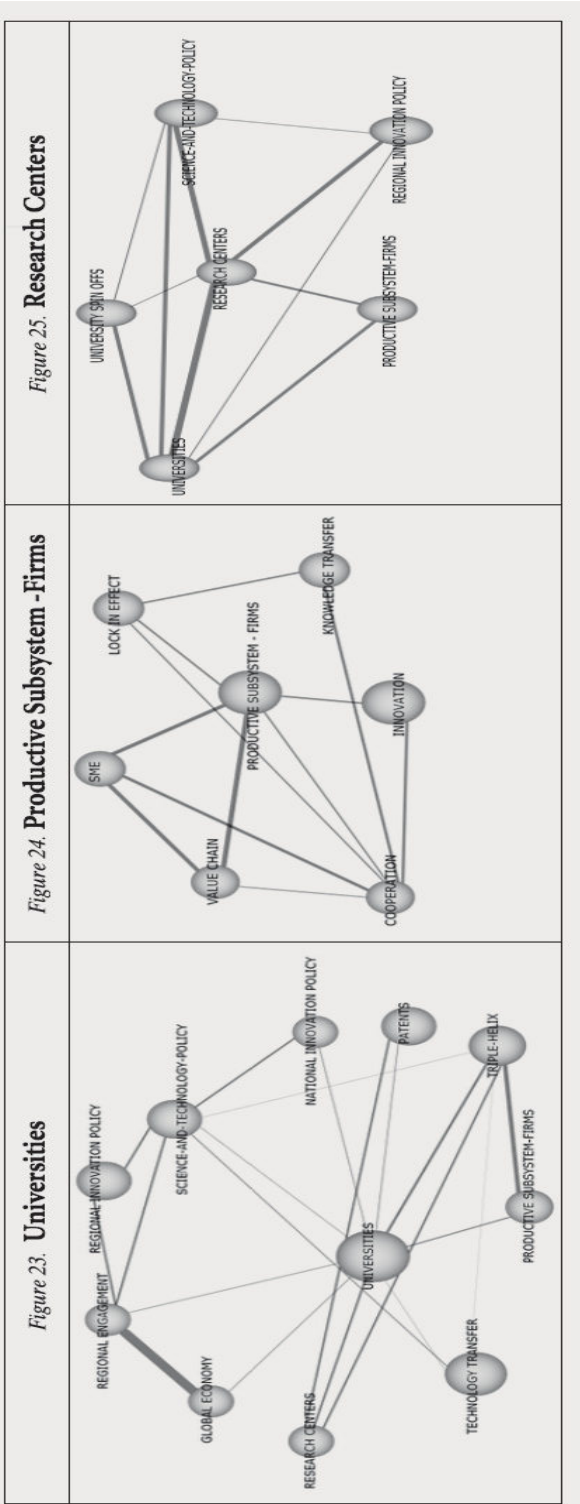
Source: Own elaboration.

As done before, we will focus on each stakeholder so as to understand better their behavior and ties established between.

The third period includes as regional innovation player Facilitators (Figure 18) and Vocational Training Centers (Figures 17 and 22). These actors are strongly linked to regionally embedded SMEs (Figure 22) to boost innovation not in terms of R&D but of applied innovation projects linked to the firms' needs. Specifically, articles dealing with VTCs do not focus on the training competences but on cooperation ties established with SMEs in industrial regions to solve SMEs technical problems. This situation underlines again the impact of National and Science and Technology Policies in Universities (Figure 23) and Research Centers (Figure 25), which have less relationships with these kind of firms.



.../...



Source: Thematic Networks of the strategic players for the period 2011-2015.

In the same way, the increasing role of SMEs also impacts the figure of Entrepreneurs (Figure 19). While in the second period they were totally linked to high technology startups and university spinoffs, in this period the intra-entrepreneurship projects do also involve regional needs detected between the firms rooted in the RIS. However, once again, policies drive the performance of these players, motivating the rise of new firms due to strategic needs or to achieve performance indicators.

Policies become a strategic issue in this third period so the efficiency of the RIS is evaluated by Government and Public Policy Makers (Figure 20). Therefore, indexes become a critical topic to establish correct indicators attending to the characteristics of the territory. However, in general, all the politics row in the same way promoting cooperation relationships between stakeholders.

The informal relationships and the regional values strengthen this new local approach of the RIS, reinforcing the view of the Social Capital (Figure 21), which would include the role of actors contributing to regional innovation through trust and confident ties. This approach would be supported by the Quadruple Helix model which gains relevance in this period.

Finally, the productive subsystem (Figure 24) in which Firms are located, does not only focus on multinational or international firms, but also considers SMEs. It highlights the need to establish cooperation ties between SME, although it also points out the need to avoid lock in effect, for which all possible knowledge sources should be taken into account. In this sense, this third period pays more attention to the adoption of steps so that the RIS could evolve without becoming stagnant. To achieve that goal, all possible knowledge transfer sources are taken into account.

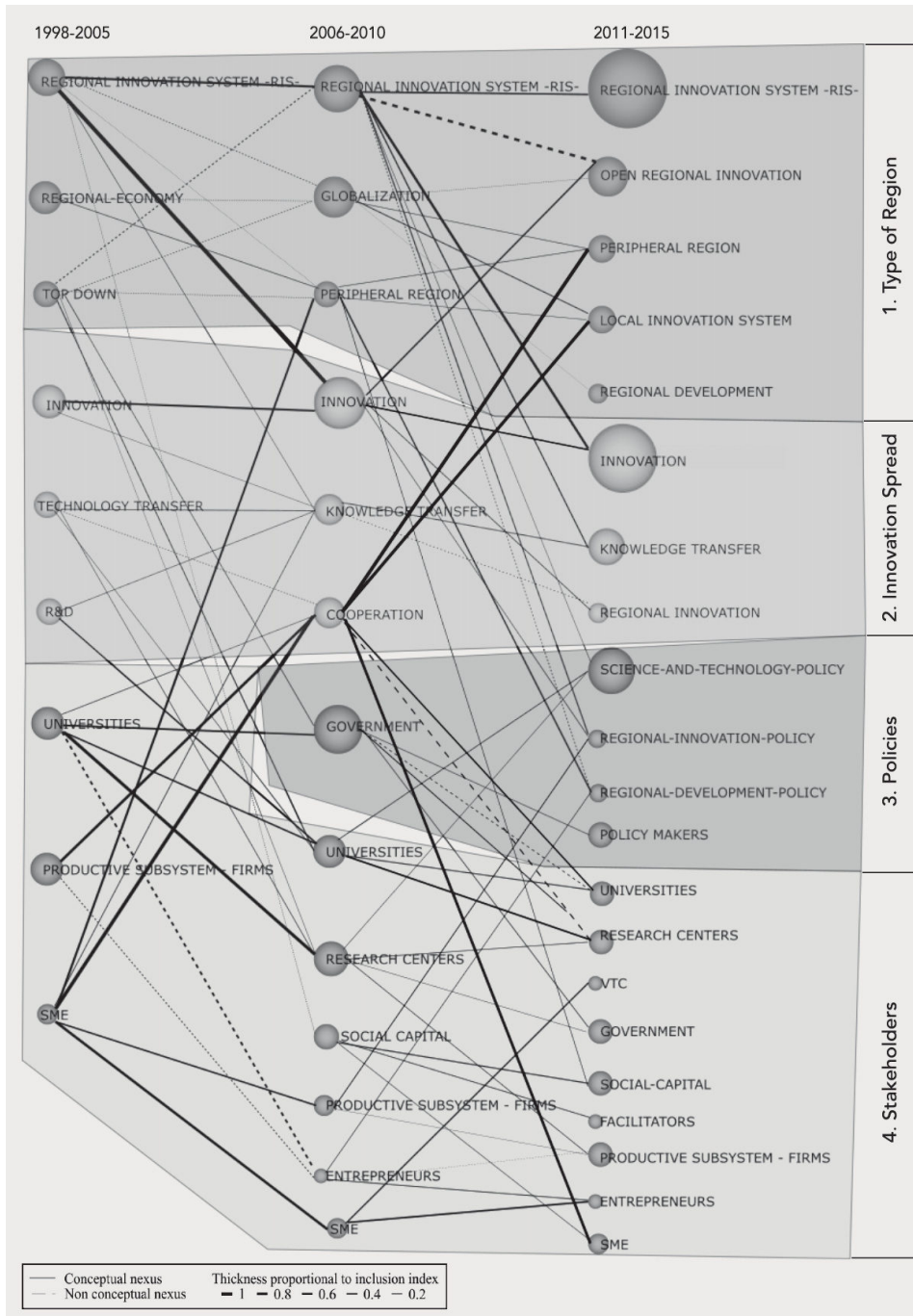
4.3. Network Evolution Diagram

Once we have detected the most relevant subthemes for each period, this final section provides a conceptual evolution diagram of the RIS literature (see Figure 26). As we have seen, there is an increasing tendency to study RIS as a territorial innovation model which lead to an important growth in the research subthemes around the main stream.

According to Figure 26, the state of the art apparently presents a great cohesion since the majority of the themes identified in each period come from a theme already acknowledged in the previous stage. In this sense, there are no gaps in the evolution of the thematic areas. Solid lines link themes from one period with issues in the following one.

Four thematic areas are identified attending to the classification already proposed in each period. The most representative one (4th area) deals with the Stakeholders taking part in each period, in terms of the number of items included, followed by the Type of Region (1st area), the Innovation Spread (2nd area) and to conclude, the innovation policies adopted (3th area). Looking at the proportional thickness index we can identify the intensity of the relationships between words employed in different periods.

Figure 26. REGIONAL INNOVATION SYSTEM EVOLUTION DIAGRAM 1998-2015



Source: Own elaboration.

We observe a rough link in the Policies thematic area, which start in the second period due to the appearance of the Public Administration underling the need to establish policies and strategies to evaluate the territory.

In addition, as mentioned in each period we can identify again the relevance of R&D and high technology transfer for the Universities, as the key stakeholders in the knowledge generation and diffusion. Top Down regional approaches established by National Policies do also influence strongly Universities and Research Centers' performance.

On the other hand, once deeping into the Stakeholders evolution we might notice the scarce link between Regional Innovation Systems' items and Vocational Training Centers –VTCs– which as seen just appear in the third period, strongly linked to SMEs participation.

Another «independent» emerging concept emerges in the second period with the Social Capital appearance, which are slightly linked to the view of the regional economy. We should consider that in this second era, Social Capital was already engaged to the regional culture, so a common vision of the regional economy and its situation might establish common ties which lead into informal «trust» ties.

For its part, the view of Peripheral Regions as possible territories in which Regional Innovation Systems could be promoted by the role of SMEs, which need to establish cooperation relationships so as to achieve new knowledge sources, due to the low heed payed to them by the main knowledge stakeholders –Universities and Research Centers–.

5. DISCUSSION

This article reports on a science mapping analysis study to examine the evolution of the stakeholders appearing in the RIS literature over the 1998-2015 period in order to clarify the appearance of new players and the relationships established between them. The methodology employed should be questioned due to the inclusion of just keywords declared by authors, which is undeniable a limitation (Ho, 2013) that should be tackled in future research works. Authors choose subjectively the keywords that explain the content of their works, with terms that might not capture the essence and main results of their research, but of course, would influence the obtain results of a bibliometric analysis⁶.

341 documents published in peer-review journals indexed in SCOPUS shape the database under analysis. The research work was organized in 3 stages (Cobo *et al.*, 2011a): (a) a co-word analysis was performed to detect research themes in the RIS

⁶ In order to solve this issue, authors are actually working on a new procedure that would permit whole papers examination.

research; (b) through centrality and density indicators, a network analysis was performed to identify the relative importance of concepts relevant to the RIS research field; (c) an evolutionary map showing the relationships between the subthemes along the years was performed to detect the progress of the field.

Based on the initial search, the results show that there is a growing number of published articles since the birth of the concept in the early 1990 (Cooke, 1992), reaching 341 articles in 2015. This pattern appears to persist, as nearly fifty percent of the articles have been published since 2011.

The general photograph of the research (Figure 3) offers a broad approach to the view of the RIS concept. Besides pointing at the most frequent knowledge providers –Universities and Research Centers–, other players appear in scene to contribute to regional innovation, such as Facilitators, Vocational Training Centers, Entrepreneurs, Industrial Firms or Governments. These research themes contribute to the general guidelines suggested by Cooke (1998) in the introduction of its book by providing the foundations in defining, justifying and exemplifying the concept of RISs.

The co-word analysis performed points out the increasing tendency of enriching the literature with new approaches, which demonstrate the trend and provides new items for the nearby future. In this sense, till the third period 2011-2015, the state of the art focused on High Technology Innovations and in R&D projects, between international firms, Universities and Research Centers, which left few space for small firms in traditional industries to innovate and take active part in regional innovation movements.

Significantly, not even a work deals with the employees or the ties established between them and the schools they belong to, which could become a research line inside the informal relationships arising inside a RIS. Therefore, we could underline that the RIS literature has not deep into the role of workers in the innovation projects performed or even the role of non-high tech knowledge institutions, which could also play a role (Hommen & Doloreux, 2004). Could, in this sense, a future research line around RIS focus on the workforce contributing to the innovation? Other TIMs in the literature have deep into their possible influence (Huber, 2012).

RIS research has persistently pursued metropolitan regions to build the competitive advantage through cooperation ties between those stakeholders. The research explosion of the third period provides us a new perspective of the RIS model getting peripheral regions or local areas closer. In this sense, driving the attention back again to knowledge and especially to VTCs, we observe the influence of these stakeholders in local systems close to SMEs as innovation facilitators. However, no ties are established between them and innovation policies. Being apparently as several researchers have pointed (Albizu *et al.*, 2011; Olazaran *et al.*,

2013; Albizu *et al.*, 2017; Porto-Gómez *et al.*, 2017; Rodríguez-Soler & Brunet Icart, 2018), key players for innovation promotion, could they be considered when designing innovation policies? Could they become active members of R&D networks?

In the same way, the appearance of new knowledge players such as Facilitators or Vocational Training Centers might introduce new stakeholders with limited functions around too regionally rooted innovation systems. Their competences seemed to be link to the regional (mainly local) innovation promotion but which is their direct influence on firms and regions' competitiveness? How might Governments and Policy Makers take into account these new players? In this sense, a special consideration should be made on the evaluation of their performance, since common evaluation indexes, such as R&D Expenditure, Patents, or R&D devoted Workers might not be suitable.

On the other hand, RIS research has arisen in the third period the influence of policies to establish innovation strategies inside the regions. Apparently, RIS are strongly related to the policies adopted by public institutions. Although in all the stages, the need to establish cooperation ties with regional stakeholders is underlined, apparently policies do not promote knowledge subsystem interaction with local SMEs. In that sense, no «one-size-fits-all» scheme exists for RIS strategy which can be adopted in any region. Each policy should be customized to the features and specificities of each context.

Thirdly, an analysis was performed to identify the relative importance of concepts relevant to the RIS research field and their evolution through time. Based on the breakdown by themes, their structural evolution, and bibliometric indicators, the results show that the largest thematic using RIS and the one that has contributed the most to its development is innovation regardless of the investigated period. However, when we compare the evolution of the themes, the results show that the RIS concept has not really evolved too much over time. What we see is that related concepts from other, related fields are introduced. These subthemes seem to have a kind of indirect relation with the RIS research arena but they are not directly impacting on it (e.g. policies). So, we could apparently and timidly conclude, that we are dealing with old wine in old bottles.

In conclusion, this bibliometric analysis has presented an initial overview of the stakeholders appearing in each period of the RIS literature, based on the keywords chosen by researchers to describe their work.

This analysis has shown an extensive body of research on the front end of the process of developing both conceptual and empirical approaches dealing with innovation from the perspective of (subnational) territories with the objective to formulating and guiding public policy, but leaves major gaps on how such RIS develop, growth and ultimately transforms. The RIS concept which emphasis how regions

become innovative and the mechanisms in play suggest a broader research opportunity: what happens to regions once they become innovative? Two decades of research have examined the conditions and mechanisms as they work their way through different regions, but such research has not begun in understanding development path, adaptation and transformation of innovative regions, which leaves future researchers new opportunities.

BIBLIOGRAPHIC REFERENCES

- ABRAMO, G.; D'ANGELO, C. A. (2015): A methodology to compute the territorial productivity of scientists: The case of Italy. *Journal of Informetrics*, 9(4), 675-685.
- ALBIZU, E.; OLAZARAN, M.; LAVÍA, C.; OTERO, B. (2011): Relationship between vocational training centres and industrial SMEs in the Basque Country: A regional innovation system approach. *Intangible Capital*, 7 (2), pp. 329-355.
- (2017): Making visible the role of vocational education and training in firm innovation: evidence from Spanish SMEs. *European Planning Studies*, 25(11), 2057-2075.
- ARCHAMBAULT, E.; CAMPBELL, D.; GINGRAS, Y.; LARIVIÈRE, V. (2009): Comparing bibliometric statistics obtained from the Web of Science and Scopus. *Journal of the American Society for Information Science and Technology*, 60(7), 1320-1326.
- ASHEIM, B.T.; GERTLER, M.S. (2005): The geography of innovation: regional innovation systems. In *The Oxford handbook of innovation*. Oxford: Oxford University Press.
- ASHEIM, B.T.; SMITH, H.L.; OUGHTON, C. (2011): Regional innovation systems: theory, empirics and policy. *Regional studies*, 45(7), 875-891.
- ASHEIM, B.T.; GRILLITSCH, M.; TRIPPL, M. (2016): Regional innovation systems: past-present-future. *Handbook on the Geographies of Innovation*, 45-62.
- AUTIO, E. (1998): Evaluation of RTD in regional systems of innovation. *European Planning Studies*, 6(2), 131-140.
- BOYACK, K.W.; KLAVANS, R. (2010): Co-citation analysis, bibliographic coupling, and direct citation: Which citation approach represents the research front most accurately?. *Journal of the Association for Information Science and Technology*, 61(12), 2389-2404.
- CALLON, M.; COURTIAL, J.P.; LAVILLE, F. (1991): Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemistry. *Scientometrics*, 22(1), 155-205.
- CAMAGNI, R.; CAPELLO, R. (2013): Regional innovation patterns and the EU regional policy reform: Toward smart innovation policies. *Growth and change*, 44(2), 355-389.
- COBO, M.J.; LÓPEZ-HERRERA, A.G.; HERRERA-VIEDMA, E.; HERRERA, F. (2011a): Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology*, 62(7), 1382-1402.
- (2011b): An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the fuzzy sets theory field. *Journal of Informetrics*, 5(1), 146-166.
- COOKE, P. (1992): Regional innovation systems: competitive regulation in the new Europe. *Geoforum*, 23(3), 365-382.
- (2004): The regional innovation system in Wales: evolution or eclipse. In Cooke P, Heidenreich M, Braczyk H-J (Eds) *Regional innovation systems*, 2nd Edition. Routledge, London and New York, pp. 214-233.
- COOKE, P.; URANGA, M.G.; ETXEBARRIA, G. (1998): Regional systems of innovation: an evolutionary perspective. *Environment and planning A*, 30(9), 1563-1584.
- COOKE, P.; HEIDENREICH, M.; BRACZYK, H.-J. (Eds.) (2004): *Regional Innovation Systems*, second ed. Routledge, London.
- DOLOREUX, D.; PARTO, S. (2005): Regional innovation systems: Current discourse and unresolved issues. *Technology in society*, 27(2), 133-153.
- DOLOREUX, D.; PORTO GOMEZ, I. (2017): A review of (almost) 20 years of regional innovation systems research. *European Planning Studies*, 1-17.
- ETZKOWITZ, H.; KLOFSTEN, M. (2005): The innovating region: toward a theory of knowledge-based regional development. *R&D Management*, 35(3), 243-255.
- GLÄNZEL, W.; SCHOEPFLIN, U. (1995): A bibliometric study on ageing and reception processes of scientific literature in the social sciences. *Journal of Information Science*, 21: 37-53.
- GORRAIZ, J.; SCHLOEGL, C. (2008): A bibliometric analysis of pharmacology and pharmacy journals: Scopus versus Web of Science. *Journal of Information Science*, 34(5), 715-725.

- HJALAGER, A.M. (2002): Repairing innovation defectiveness in tourism. *Tourism management*, 23(5), 465-474.
- HO, Y.S. (2013): Comments on «a bibliometric study of earthquake research: 1900–2010». *Scientometrics*, 96(3), 929-931.
- HOMMEN, L.; DOLOREUX, D. (2004): 'Bringing labour back in: a «New» point of departure for the regional innovation systems approach?' in P. Flensburg, S.A. Hörte and K. Karlsson (Eds). *Knowledge Spillovers and Knowledge Management in Industrial Clusters and Industrial Networks*, London: Edward Elgar Publisher.
- HUBER, F. (2012): On the role and interrelationship of spatial, social and cognitive proximity: personal knowledge relationships of R&D workers in the Cambridge information technology cluster. *Regional studies*, 46(9), 1169-1182.
- LEE, P.C.; SU, H.N. (2010): Investigating the structure of regional innovation system research through keyword co-occurrence and social network analysis. *Innovation*, 12(1), 26-40.
- LEYDESORFF, L. (1998): Theories of citation? *Scientometrics*, 43(1), 5-25.
- MARTÍNEZ, M.A.; COBO, M.J.; HERRERA, M.; HERRERA-VIEDMA, E. (2015): Analyzing the scientific evolution of social work using science mapping. *Research on Social Work Practice*, 25(2), 257-277.
- MINGUILLO, D., TIJSEN, R.; THELWALL, M. (2015): Do science parks promote research and technology? A scientometric analysis of the UK. *Scientometrics*, 102(1), 701-725.
- MORRIS, S.A.; VAN DER VEER MARTENS, B. (2008): Mapping research specialties. *Annual review of information science and technology*, 42(1), 213-295.
- MURGADO-ARMENTEROS, E.M.; GUTIÉRREZ-SALCEDO, M.; TORRES-RUIZ, F.J.; COBO, M.J. (2015): Analysing the conceptual evolution of qualitative marketing research through science mapping analysis. *Scientometrics*, 102(1), 519-557.
- NAVARRO, M. (2009): «Los sistemas regionales de innovación. Una revisión crítica», *EKONOMIAZ. Revista vasca de Economía, Gobierno Vasco / Eusko Jaurlaritza / Basque Government*, vol. 70(01), pages 25-59.
- NEDERHOF, A.J.; NOYONS, E.C.M. (1992): Assessment of the international standing of university departments' research: A comparison of bibliometric methods. *Scientometrics*, 24: 393–404.
- NEDERHOF, A.J.; VAN RAAN, A.F.J. (1993): A Bibliometric Analysis of six economics research groups: A comparison with peer review. *Research Policy*, 22: 353–368.
- NOYONS, E. (2001): Bibliometric mapping of science in a policy context. *Scientometrics*, 50(1), 83-98.
- OLAZARAN, M.; ALBIZU, E.; LAVÍA, C.; OTERO, B. (2013): Formación profesional, pymes e innovación en Navarra. Vocational training, SMEs and innovation in Navarra. *Cuadernos De Gestión*, 13(1), 15-39.
- PORTO GÓMEZ, I.; ZABALA-ITURRIAGAGOITIA, J.; AGUIRRE LARRAKOETXEA, U.; VOCATIONS AND LEARNING (2017): <https://doi.org/10.1007/s12186-017-9187-6>
- RODRÍGUEZ-SOLER, J.; BRUNET ICART, I. (2018): Between vocational education and training centres and companies: study of their relations under the regional innovation system approach. *Studies in Continuing Education*, 40(1), 46-61.
- SUN, Y.; GRIMES, S. (2016): The emerging dynamic structure of national innovation studies: a bibliometric analysis. *Scientometrics*, 106(1), 17-40.
- TOIVANEN, H.; PONOMARIOV, B. (2011): African regional innovation systems: bibliometric analysis of research collaboration patterns 2005–2009. *Scientometrics*, 88(2), 471-493.
- VAN RAAN, A.F. (2005): Measurement of central aspects of scientific research: Performance, interdisciplinarity, structure. *Measurement: Interdisciplinary Research and Perspectives*, 3(1), 1-19.