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Regional Innovation Systems: A Literature Review

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ABSTRACT

Though various authors have offered reviews of the Regional Innovation Systems (RIS) literature and some have described their personal intellectual voyage amongst the building blocks that constitute this area of scientific enquiry (for example, Cooke 2008), these often illuminating illustrations are nonetheless subjective and, thus, suffer from biases which pertain to the actor performing the analysis. The study proposed in this paper aims to overcome the aforementioned limitation by elaborating an objective review of the main contributions to the RIS field of research, highlighting the main themes studied and the principal approaches followed. The analysis has been conducted following the Author Co-citation method, applied to the literature regarding RIS present in the Social Science Citation Index (SSCI) of Thomson-ISI in the time span from 1990 to 2009. The results allow to trace an overview of how the RIS research area is actually composed, identifying six main research themes which characterize the field and varied approaches according to which each theme has been analyzed. Main contributions are positioned against each other in order to foster an increase in efforts from future research.

Keywords: *Regional Innovation Systems, Co-citation*

1. INTRODUCTION

Over the past two decades, studies regarding regional innovation systems (RIS) have gained increasing attention on behalf of academics, practitioners and policy makers. This surge of interest has been paralleled by widespread dissemination of the theme in academic literature. Though most of the contributors to this field of study share the broad underlying idea that

territorial agglomeration provides the best context for an innovation-based globalizing economy because of localized interactive learning processes and "sticky" knowledge grounded in social interaction, the approaches followed, the theories used as conceptual building blocks and the design of empirical analyses show a significant degree of heterogeneity. The variety of theoretical and empirical approaches to the study of RIS may be justified by the range of cultural backgrounds which distinguish the many authors whose work contributes to the development of the field – who range from economic geographers and management analysts to sociologists and political scientists.

Though, on the one hand, the rich array of perspectives used to study RIS poses the basis for fruitful cross-fertilizations between different theoretical approaches, on the other, it enhances the utility of taking a step back and drawing an overview of how the research area is actually composed, identifying the main research trends which characterize the field, as well as its boundaries and the core subject matters treated within it. This type of research is aimed to deliver a conceptual basis which may clarify the main characteristics of a field of study in order to foster an increase in the returns from future research efforts (Priem and Butler 2001). The aforementioned research may be conducted following a subjective approach, based on a qualitative analysis of the literature. Though this kind of analysis is often very illuminating, the more a field of study is differentiated the more it becomes difficult to keep abreast of the current trends and developments which are continuously taking place within it. Also, this approach often leads to studies which are influenced by the researcher's cognitive barriers and biases - which, in turn, reflect their education, their experiences and the social groups to which they belong (Acedo et al. 2006). Thus the subjective approach has two main drawbacks as, in first instance, it may lead to incomplete representations of the field analysed (Bettis and Prahalad 1986) and, in second instance, it tends to meld the description of what the field is with the prescription of what the field should be (Casillas and Acedo 2007).

In order to overcome the limitations of the subjective approach, in this paper we adopt an objective approach to the study of the area of research regarding RIS based on a bibliographical analysis of the scientific works that can be included within the field. In particular, at the basis of the Author Co-citation Analysis (ACA) (Small 1974; White and Griffith 1981) is the idea that both journal articles and books contain the knowledge which makes up the research field and, further, that the references of any scientific work are indicative of the theoretical and empirical bases on which the new scientific contribution rests. Thus, an analysis of the references and cross-references between authors allows to identify networks of authors and papers belonging to the same school of thought, trend or perspective. This method is a powerful procedure to study the structure of a scientific discipline and its main trends, and has been applied to many fields of research (Culnan 1986; Pilkington and Liston-Heyes 1999; Knight et al. 2000; Acedo et al. 2001, Ramos-Rodríguez and Ruíz-Navarro 2004; Acedo et al. 2006; Casillas and Acedo 2007; Nerur et al.. 2008; Distefano et al. forthcoming;). Given the variety of approaches and perspectives which distinguish the research area regarding RIS, we apply the ACA method in order to provide a panoramic view of the structure of the main contributions to the field, highlighting the main themes that are being scrutinized, the way they talk to each other and the links between them, whilst showing possible "research holes" which may orient future research endeavors. Finally, we hope this study may represent a user-friendly reference that may allow researchers who are new to RIS studies to gain rapid acquaintance with the field.

The rest of the paper is organized as follows: the following section introduces the concept of RIS and describes the variety of approaches which interact within the RIS literature. The third

section, describes the ACA method and how it works and, then, proceeds to illustrate its application to the RIS literature. In the fourth section the results of the application of the ACA method to the RIS field are illustrated. The results obtained are discussed in detail in the fifth section, whilst the sixth section draws from the results obtained to sketch a number of issues which are open for future research. The final section contains the main conclusions of the study.

2. THE ANALYSIS OF REGIONAL INNOVATION SYSTEMS AS A FIELD OF STUDY

Among academics, entrepreneurs and policy-makers consensus has long suggested that innovation is a crucial factor in generating economic growth and development. Equally, there is widespread evidence regards the uneven spatial distribution of innovative behavior between different geographical areas and, in particular, between different regions in the world. These recurrent patterns have brought social scientists and policy-makers to pay increasing attention to regions as designated sites of innovation and competitiveness in the globalizing economy (Florida 1995; Cooke et al. 1997), pushing research to focus on the interrelationships between technology, innovation and industrial location.

The surge of interest regards the factors and dynamics underlying regional competitiveness in fields as diverse as political science, economic geography and business economics, has resulted in the emergence of a number of concepts which, in different ways or with different emphasis, underscore the processes and dynamics underlying the localization of innovative activities within confined territorial areas. Amongst these it is possible to recall the following: "learning region"[1] (Morgan 1997; Florida 1995); "innovative milieu"[2] (Maillat 1998); "industrial district"[3] (Becattini 1992; Scott 1988); "local productive system" (Courlet 2001); "cluster"[4] (Porter 1990, 1998, 2003; Maskell 2001; Iammarino and McCann 2006); "technopole"[5]; "regional innovation

[1] The learning region (Morgan, 1997; Florida, 1995) is a region that functions as a collector and repository of knowledge and ideas, and provides an underlying environment or infrastructure which facilitates the flow of knowledge, ideas and learning. The critical elements defining the learning region concept are knowledge, customers and suppliers, inter-firm relations and networks, and a high degree of rivalry between actors. Main dimensions of the learning region are the infrastructures that produce, foster and share knowledge.

[2] The innovative milieu (GREMI study group; Crevoisier, 2001; Maillat, 1998) is a concept which stems from the idea of localized learning and innovation processes, and explores the sociological and cultural dimensions of local competitive advantage. The basic assumption of this approach is that the environment (the milieu) is an essential component of innovation. Main dimensions of the innovative milieu are firms and know-how.

[3] The industrial district (Beccattini, 1992; Scott, 1988) concerns a particular form of agglomeration characterized by a localized thickening of inter-industrial relationships that is reasonably stable over time. In this view, firms are small, specialized, and rooted in a given territory. Innovation and learning result from cooperation, mutual dependence, and trust among local actors. Main actors of the industrial district are small and specialized firms.

[4] The cluster (Porter, 1990, 2003; Maskell, 2001; Iammarino and McCann, 2006). Clusters are intended as the geographical agglomeration or co-location pattern of firms, organizations and institutions interconnected and interdependent in their activities directed to the production of goods and services. The focus of the cluster literature is however on the concentration of inter-dependent and rival firms within the same or adjacent industrial sectors in a small geographic area – ie. on firms which operate in the same or correlated industries. Other actors are considered only if (and to the extent to which) they represent a stimulus to the upgrading of the cluster firms' performance.

[5] The technopole (Technopolis project in Japan and the Tecnolpolis policy in France) is an institutional infrastructure aimed to proactively foster industrial innovation activities and technology transfer, providing opportunities for institutional cooperation within and between university and industry. Main actors of the technopole are universities and industrial firms.

systems" (Cooke et al. 1997; Cooke 2001, 2004; Asheim and Isaksen; 2002; Malberg and Maskell 2002; Ashiem and Coenen, 2003; Wolfe 2003).
In this complex maze of partially overlapping theories, the relevance gained by the RIS literature may be justified in consideration of the capacity of its framework to embrace in a systemic manner and correlate a relevant number of the other concepts considered. Furthermore, in consideration of the fact that the establishment and formation of RIS plays a strategic role in the development of the endogenous capacity of regions to innovate in order to create competitive advantage, the full comprehension of the RIS concept has been considered a necessary passage towards the elaboration of effective RI policies and, thus, has increased the attention towards this field of research. It is not surprising, therefore, that the field under scrutiny presents a large range of different perspectives and approaches.
Until today, the analysis of the intellectual structure of the RIS field has been conducted according to a subjective and qualitative approaches (Cfr. for example, Karlsson and Andersson 2002; Carlsson 2003; Doloroux 2004; Boschma and Frenken 2005; Doloroux and Prato 2005; Cooke 2008). The study conducted in this paper uses objective tools of analysis, based on the ACA method of bibliometrics. The aim of the analysis that follows is to highlight the main trends within RIS studies, underscoring the different theoretical and empirical backgrounds which characterize the various streams of research, in order to complement the outlook provided by the subjective analyses of the RIS area of research.

3. METHODOLOGY: THE AUTHOR CO-CITATION METHOD

As stated above, in order to explore the structure of the RIS research domain so as to better understand its origins, current state of development, and future trends, in this paper we conduct a literature review according to the author co-citation analysis (ACA) methodology. ACA methodology is a bibliometric technique used to analyze publication patterns in a field or body of literature. Co-citation analysis makes it possible to map research on a topic and to identify the dominant approaches in the field, thus shedding light on social structures and uncovering the "vast interpersonal network that screens new ideas in terms of central theme or paradigm, permitting some a wide audience and consigning many to oblivion" (Crane 1972).
In co-citation analysis the data compiled are counts of the number of times two documents are jointly cited in later publications[6]. The analysis is based on the premise that authors cite papers they consider to be important to the development of their research. As a result, heavily cited articles are likely to have exerted a greater influence on the subject than those less frequently cited (Sharplin and Mabry 1985; Culnan 1986). It is assumed, first, that "highly" cited papers represent "important" concepts and methods in science; second, that "frequently" co-cited papers are related by content.
A graphic representation of published works that tend to be cited together by researchers helps identify research streams and other cluster of scholarly work. Studies focusing on cited works try to establish the general structure of the discipline (what types of works are dominant), as well as the discipline's boundaries and relations to other disciplines. Identifying co-citations can tell us,

[6] Cited references for a paper A would include scholarly publications appearing in any journal that cites the paper A. Each cited reference has a unique identifier that forms the basis to record the co-citations between a pair of papers. A co-citation occurs between two papers, say A and B, when a cited reference to paper A (which could have been published in any journal) also cites paper B. That is, the number of cited references of A that match the cited references of B gives the frequency of co-citations between A and B.

through factor analysis[7] for example, what the major factors and groups are within the field and how they vary across journals and over time. We can also graphically illustrate what the most influential citations are for each of the factors, how they are related, how strong their relationships are, and how far removed they are from, or central they result regards, the factor groups they belong to. Co-citation studies can show us what topics, authors, journals, and research methods were central, and peripheral, to the field, and how they may have changed over time.

Our analysis, following the method prescriptions (McCain 1990), comprises six steps: (1) selecting the unit of analysis; (2) retrieving co-citation frequencies; (3) compiling the raw co-citation matrix; (4) converting the raw co-citation matrix into a correlation matrix; (5) multivariate analysis; and (6) interpreting the findings.

The unit of analysis can be defined in terms of articles or authors, depending on whether the analysis aims to identify the structure of specific or broad fields of inquiry (Culnan 1986). In particular, for the studies targeted at specific research areas (as in our case), it is preferable to analyze articles in order to avoid the results being biased by the fact that the same author may have published in different fields (Acedo et al. 2006). In the work that follows, this method allows us to identify the connections between the most influential contributions regarding the concept of Regional Innovation Systems (RIS) in order to represent them systematically within a unitary framework, underscoring the way these scientific contributions relate to each other. Also, this kind of analysis will highlight the presence of fragmentation and specialization between different research streams if these are present, providing indications for future research which may foster the development of unifying perspectives within the RIS field.

We based the analysis on the Social Science Citation Index (SSCI) of Thomson-ISI, with a time span from 1990 to 2009, available on the on-line database and consistent with the aim of our analysis. This database, which covers over 1,700 of the world's leading scholarly social sciences journals in more than 50 disciplines, provides access to bibliographic information, author abstracts, and cited references. The analysis was performed in September 2009. Given the aim of our analysis, we defined a criterion to search for papers. The criterion adopted considered three keywords: "RIS", "Regional Innovation System(s)s" and "Regional System(s) of Innovation". The search was performed by selecting the papers whose title, abstract, and keywords matched our criterion. By screening the Thomson-ISI SSCI database according to the above search criteria, we obtained a set of 211 contributions. Among these, we selected only published articles (excluding proceedings, or working papers) and only journals whit impact factor in the fields of business, management, economics, and geography. Given our interest in defining the hard core of the discipline, and following the example of previous works with similar time spans, we selected all those articles that have been cited at least 30 times[8]. This resulted in a total of 13 articles. So as to avoid the risk of excluding important articles, and to cover all the developments within the research field, it seemed preferable in this stage to form a core of works as large as possible, while ensuring that this core is made up only of documents that can truly be considered as shaping the knowledge in the RIS field. Thus, it was decided to add other papers which could

[7] Factor Analysis is based on seeking a linear combination of variables such that the maximum variance is extracted from the variables. It is by far the most common form of factor analysis and it is generally preferred for purposes of data reduction (translating variable space into optimal factor space).

[8] This practice's main weakness is the use of a relevance criterion that favours older documents to the detriment of more recent ones that might have had a greater impact on the theory. This entails a static view of the theory, and does not capture the new trends being shaped in the most recent years.

be considered important to the development of the research subject analyzed, by searching for those articles that: (a) had cited Freeman (1995), or Cooke et al. (1997), or Cooke (2001) (as an a priori indicator of their link to the RIS research field)[9], or (b) had cited two of the 13 articles in the initial set, and (c) had been cited more than 30 times in the 1990–2009 period (relevance criterion). In this way, 24 articles were selected to serve as the starting point for subsequent analysis (see Table 1).

Table 1: The set of articles

Freeman C., ***Cambridge Journal of Economics***, Feb. 1995 (P1)
Cooke P., Uranga M. and Extebarria G., ***Research Policy***, Dec. 1997 (P2)
Cooke P., ***Industrial and Corporate Change***, Dec. 2001 (P3)
Carlsson B., Jacobsson S, Homen M. and Rickne A., ***Research Policy***, Feb. 2002 (P4)
Acs Z.J., Anselin L. and Varga A., ***Research Policy***, Sep. 2002 (P5)
Cooke P. Uranga M. and Extebarria G., ***Environment and Planning A***, Sep. 1998 (P6)
Asheim B.T. and Isaksen A., ***European Planning Studies***, Jun. 1997 (P7)
Muller E. and Zenker A., ***Research Policy***, Dec. 2001 (P8)
Rantisi N.M., ***Regional Studies***, Aug. 2002 (P9)
Asheim B.T. and Coenen L., ***Research Policy***, Oct. 2005 (P10)
Oinas P. Malecki E., ***International Regional Science Review***, Jan. 2002 (P11)
Sternberg R., ***European Planning Studies***, 2000 (P12)
Humphrey J. and Schmitz H., ***Regional Studies***, Dec. 2002 (P13)
Cantwell J. and Janne O., ***Research Policy***, Mar. 1999 (P14)
Malmberg A., ***Progress in Human Geography***, Sept. 1996 (P15)
Romijn H. and Albaladejo M., ***Research Policy***, Sep. 2002 (P16)
Lawson C. and Lorenz E., ***Regional Studies***, Jun 1999 (P17)
Malerba F., ***Research Policy***, Feb. 2002 (P18)
Bunnell T.G. and Coe N.M., ***Progress in Human Geography***, Oct 2003 (P19)
Wolfe D.A., Gertler M.S., ***Urban Studies***, May 2004 (P20)
Coe N.M. and Bunnell T.G., ***Global Networks***, Oct 2003 (P21)
Sydow J. and Staber U., ***Regional Studies***, May 2002 (P22)
Boscham R.A. and Frenken K., Journalo of Economic Geography, Jun 2006 (P23)
Boscham R.A., Regional Studies, Dec. 2004 (P24)

Each of the 24 articles was paired with every other author in Table 1 and the co-citation frequency of each pair was computed from the total references in the Social Sciences Citation Index (SSCI) online. The result of this procedure was a 24 by 24 matrix of co-citation counts, an extract of which is presented in table 2.

This co-citation matrix is symmetrical and its diagonal values are zero, since no paper can cite itself. In order to standardize the data, as well as decreasing the number of zeros, the Pearson correlation matrix was estimated (Moya et al. 1998; Rowlands 1999). It serves as a matrix of inter-article "proximities"[10].

[9] This choice is justified as Freeman (1995), Cooke et al. (1997) and Cooke (2001) are the three articles mostly cited among those identified in the first round of the retrieving process.

[10] Here the correlations are defined as measures of similarity: the higher the positive correlation, the more similar two papers are in the perceptions of citers (McCain, 1990).

Following analogous studies (Culnan 1986; McCain 1990), we continued to apply three multivariate statistical techniques: multidimensional scaling (MDS), cluster analysis, and factor analysis.

Table 2 – Sample co-citation matrix.

	Freeman, 1995	Cooke et al., 1997	Cooke, 2001	Carlsson et al, 2002	Acs et al., 2002	Cooke et al., 1998
Freeman, 1995	9	14	1	7	1	6
Cooke et al., 1997	14	13	10	11	4	6
Cooke, 2001	1	10	8	2	0	7
Carlsson et al, 2002	7	11	2	12	2	2
Acs et al., 2002	1	4	0	2	4	0
Cooke et al., 1998	6	6	7	2	0	7
Asheim, Isaksen, 1997	4	7	7	2	1	6
Muller, Zenker, 2001	1	1	0	1	0	0
Rantisi, 2002	2	7	1	1	0	1
Asheim, Coenen, 2005	0	2	1	0	0	1
Oinas, Malecki, 2002	0	9	3	2	0	1
Sternberg, 2000	2	0	0	0	1	3
Humphrey, Schmitz, 2002	1	1	2	0	0	0

Multidimensional Scaling consisted in projecting the papers on map, using the data from the correlation matrix as input data. The values obtained exhibit a good fit (STRESS=0.12 and RSQ=0.93) and permit us to state that the map is a good approximation of reality (see Figure 1 in Appendix). The purpose of this analysis is twofold. On the one hand, MDS shows co-citation links among contributions. Points positioned at the center of the map represent contributions linked to many different schools of thought and thus with heterogeneous citation profiles. On the other hand, MDS reduces the data space, by positioning the articles on a bidimensional space, making it easier to interpret the relative positioning of the clusters of contributions.

Next to MDS a hierarchical cluster analysis was applied to the data. This technique allows to obtain a series of groups (or clusters) of significantly related documents. Hierarchical clustering determines the belonging to a group by analyzing the distance between pairs of documents in the multidimensional co-citation space. In our study applied to RIS literature, cluster analysis clearly shows five groups of papers. In order to better visualize and frame them in a conceptual space, the clusters were superimposed on the MDS graph.

Along with the two previous techniques, we also employed a correspondence factor analysis of the co-citation matrix in order to reveal the "hidden" subject matter. Factor analysis can give us yet another piece of information on the structure of the field. If a structure is present in the data it will show by being decomposed in its constituent factors (i.e. sub-fields of research or areas/perspectives). The relevance of Factor Analysis in this context is based on the notion that papers which are related to one another will, in general, be repeatedly cited together in subsequent publications, while works which are rarely or never cited together will not. If this assumption is true, then Factor Analysis can use the co-citation entries to determine which contributions are grouped together and therefore share a common element. It does so by producing a number of "factors", each of which captures a common element of the documents that are grouped together. It is also capable, by producing numerical indicators of the relevance of the factors (i.e. eigenvalues), of telling us something about the relative importance of these

underlying elements[11]. This analysis was carried out using the varimax rotation, following previous works (Rowlands 1999). The rotation of the axes carried out in the process of factor analysis aims to obtain factors endowed with theoretical significance, as well as to achieve the simplest possible factorial structure (Hair et al.1999).

3.1 Results

Table 3 shows the publishing journals for the 24 most co-cited works in the Regional Innovation System research domain.

Table 3: The set of articles

Journal	**Number of articles**	**%**
Research Policy	8	33%
Regional Studies	5	21%
Progress in Human Geography	2	8%
European Planning Studies	2	8%
Others	7	29%
Total	**24**	**100%**

The inspection of the journals on which the most cited papers are published reveals various interesting points:

1. A management journal, Research Policy, is the most influential in the field. One third of the most important articles has been published there;
2. One third of the articles has been published in geography journals as Regional Studies (1/5 of the total) and Progress in Human Geography;
3. There is a strong prevalence of conceptual articles and qualitative methods.

Results of the analysis are depicted in Figure 1 (in Appendix) where the Multidimensional Scaling Map and the five groups of papers obtained through the clustering procedure are shown. The grouping of the authors represented on the graph elaborated through multidimensional scaling was obtained on the basis of the results generated from the cluster analysis (using Ward's hierarchical method). The map shows: 1) positions of papers with respect to the map's axes; 2) identifiable paper groups which represent research topics/lines of research; 3) location of these groups with respect to each other; 4) proximities of papers within groups and across group boundaries ("border papers"). Commentary on each point follows.

1) Although the construction of the axes is arbitrary, the position of the papers on the map suggests a meaning for the axes. In the RIS field of studies, the framework obtained seems to suggest that the horizontal axis refers to the "level of analysis on which the paper focuses regards the study of the production of innovation". In particular, the levels of analysis range from the

[11] Although the use of cluster and factor analysis may prove to be redundant, each one of them possesses a specificity that allows us to grasp additional aspects of the relationship between the papers. The strength of factor analysis can be found in its ability to detect common, underlying dimensions on which variables or objects may be located, while the strength of the cluster analysis method lies in its ability to indicate group membership. In relation to this paper, we use cluster analysis to identify different topics inside the RIS literature, while we use factor analysis to highlight the different research approaches used to study these issues.

more micro or individual level of analysis on the left side of the graph, to the more macro or social level of analysis which characterize the papers located on the right side of the framework. With respect to the vertical axis, the works located in the quadrants above the horizontal axis analyze the "Regional Innovative Capacity". While those below the horizontal axis, are mostly related with "Firm Innovative Capacity".

2 and 3) through cluster analysis, papers are grouped together on the basis of correlation relationships; thus generally papers within each group share the same topic or issue. Figure 1 (in Appendix) depicts the five major groups found. Papers within group boundaries share similar co-citation profiles. This 'relationship' only means that papers address the same broad questions, without necessarily agreeing with each other on their findings. Furthermore, papers and groups of papers near the external areas of the map are generally related, through co-citation, to fewer neighbors. Clearly the similarity among papers also depends on how they were perceived by the authors who have, for one reason or another, cited the papers together. Given these premises, the proximity between the papers within group boundaries can provide interesting information. Starting from the bottom right area and proceeding clockwise, the groups identified are the following:

- Group A is focused on Systems of Innovations (Lundvall 1985). It is composed of eight articles, which are generally strongly cited, but their position in the map indicates that they cannot be identified as central in the RIS literature. Actually they deal with a wide range of innovation systems, from National Innovation Systems (Freeman 1995) to Regional Innovation Systems (Acs et al. 1997; Cooke et al. 1997; Asheim and Isaksen 2002), from Technological System (Carlsson et al. 2002) to Sectoral Innovation Systems (Malerba 2002). Papers in this group are focused on the idea that understanding the linkages among the actors involved in innovation is key to improving technology performance. An analysis of the main contributions to this group suggests that innovation and technical progress are the result of a complex set of relationships (i.e. a system) among actors producing, distributing and applying various kinds of knowledge. Papers in this group are not recent (7 out of 8 have been published between 1995 and 2002) and generally focus on definitional issues. Of particular interest is the position of the group with respect to the axes. Most papers are in fact located on the right hand side of the map, the main theme treated pertaining to the characteristics of the different systems of innovation. Regards the authors, it is worthwhile saying that all are economists, with Freeman and Cooke being among the founders of the systems of innovation field of research.
- Group B assembles three papers focused on Regional Systems of Innovation, from a regional science and economic geography perspective. The analysis of the main contributions suggests that the idea and content of RIS follow discoveries made by regional scientists, economic geographers and innovation analysts and are conjugated with three fundamental dimensions. The first dimension is related to local specificity. They try to understand the effect of local specificity of a region on economic development. The second dimension focus on institutions. In particular, local institutions play a fundamental role on economic development. The third dimension is about knowledge flows which take place inside formal relationships among local private and public institutions. Interestingly, the group is also characterized by a significant homogeneity in terms of approach (institutional approach) and all authors are geographers. Furthermore, the group has a central position in the map meaning that papers within this group are generally evenly cited by all the other groups. From these findings it is clear how the recent but constantly growing interest for regional development

and innovation issues pushed scholars to broaden the traditional span of research on location and agglomeration theories by drawing on typical subfields of the innovation literature.

- Articles in group C, the most numerous with nine papers, seeks to move beyond existing conceptualizations of Systems of Innovation in two key respects. First, by introducing a non-territorially bounded dimension to the study of innovation and by emphasizing a network perspective and the significance of innovative networks that extend beyond firms. Second, by focusing on the tacit knowledge flows that take place among individuals beyond any formal relationship. Articles in this group represent very well the main trend that is emerging in the latest years: the interest regards the extra-regional side of regional innovation. In this vein, external relations of actors are key elements that transcend all existing systems of innovation. This group contains relatively recent contributions and can be considered as the integration of the evolutionary economic geography approach with the knowledge and organizational learning perspective, originating from the management field. Among the authors belonging to this group, Bunnel and Coe are present with two articles, both dealing with networks that extend beyond firms and physical place as the locus of innovative activity.
- Group D is composed of two articles written by Boschma (2004) and Boschma and Frenken (2006). These contributions focus on regional competitiveness. They both apply an evolutionary approach and argue that the competitiveness of a region depends on intangible, non-tradable assets based on a knowledge and competence base embedded in a particular institutional setting that are reproduced and modified through the actions and repeated interactions of actors.
- Finally, group E, includes two papers that attempt to understand the role of different types of knowledge in favoring the firm's learning and innovation processes. For this thread of research, since the single firm represents the main object of analysis, it is important to recognize the role of regional and local interactions in the creation of firm's innovative capability.

Empty regions in the two dimensional space represent two types of significant information: differentiation or dissociation between clusters on the one hand, and/or the significant absence of objects on the other hand. The former reveals the existence of large differences among groups; the latter means that certain themes have been overlooked by almost all authors. For example, it is interesting to note that there is a vast empty region on the lower central portion of the MDS map. This seems to suggest the need for more in-depth research on the firm's innovative capacity and its proactive role within the overall system of innovation.

4) Articles having positive correlation with other papers across group boundaries deserve further study. The papers in question create a bridge between two research themes and often borrow new ideas from other groups to improve or extend the research of the groups they belong to. Often, new research areas are created across the boundary of different research groups.

In particular, factor analysis allows us to identify the factors explaining most of the variance observed and to identify groups of strongly correlated papers in order to allow us to define the structure of the field of research. We have considered that a contribution should be included in a trend when its loading is equal to or greater than |0.5|, and if the loading is greater than |0.7| then the paper is of great relevance within the corresponding paradigm. Table 4 (in Appendix) shows the results of this analysis. As can be observed, all of the information is summarized in six factors (explaining 78,5% of the variance). All 24 papers, but one (Muller and Zenker 2001) loaded on at least one factor. Significantly, most of the contributions are loaded with a weight greater than |0.7|, corroborating the relevance of these works within their respective paradigms.

Likewise, it can be observed that one article (Cooke et al., 1997) exhibits considerable loading on more than one factor (greater than |0.5|). This work is of even greater interest, as it represents a bridge between paradigms, thus helping us to understand their evolution and the ties that have been forming between the different research trends.
The interpretation of the factor analysis is based on what the papers represent in terms of scholarly contribution and intellectual association. If the cluster analysis showed five, well recognizable, broad topics that characterize research on Regional System of Innovation, factor analysis is useful to interpret the intellectual connections among papers as well as their epistemological and theoretical backgrounds. Factors can be interpreted as the "approaches" or "interpretative lens" adopted as a basis for the elaboration of a piece of research. Thus the results of the factor analysis, presented in Table 4 (in Appendix), reveal how and to which perspectives the RIS literature is intellectually indebted. By analyzing the loadings on each factor, it was possible to infer the perspectives they represented. The careful scrutiny of the papers considered for each factor suggests the identification of the 6 factors according to the following definitions: (1) Regional Science; (2) Economics of Innovation; (3) Social Embeddedness; (4) Evolutionary Economic Geography; (5) Knowledge and Organizational Learning; (6) International Business.

4. THE RIS FIELD OF RESEARCH: AN OVERVIEW

The results obtained from the author co-citation analysis conducted above reveal a number of distinct traits which characterize the RIS field of research. Firstly, the discipline appears varied in relation both to the particular themes treated and to the interpretative lenses adopted to study RIS, reflecting to some extent the multiple backgrounds of the authors who have contributed to this body of literature. The MDS map and the cluster analysis performed vividly illustrate the richness of themes treated - which range from the definitional issues underlying the RIS concept and the comprehension of the linkages between the different actors within RIS, to more "spatial" and social studies in which the specific institutional characteristics of territories are highlighted, to analyses whose focus is on the different types of knowledge which characterize a territory and how this feeds firm innovative capacities, to the evolutionary focus on knowledge and competences embedded in particular territories, and finally the network approach that extends RIS reasoning to the linkages between different territories. The position of the different papers within the clusters along the axes of the map also illustrates that the themes treated are often further enriched by a variety of approaches according to which each one is considered, which range from micro to macro level perspectives and from major focus on regional innovation to firm innovation. This array of themes and approaches which characterize the RIS literature may be considered positively, as the interface and confrontation between different stances often fosters a more through explanation of phenomena than single monolithic approaches. However, in order to take advantage of the richness of perspectives within the field there is the necessity to avoid excess fragmentation, whilst facilitating mutual fertilizations between diverse approaches.
In this regard, the presence of a number of works (Malberg 1996; Asheim and Coenen 2005; Cantwell and Janne 1999) in the central area of the MDS map is to some extent comforting, as they represent pieces of research that serve as a basic reference for the field. However, these papers, rather than being eclectic in their approach or unifying for the entire branch of studies, are each one strongly representative of a part of the field, highlighting the main blocks of research that are present in the RIS literature: in particular, the institutional approach of the economic geographers; the definitional positivist perspective of the economists; and the

extension on the RIS reasoning beyond self-contained territories that emerges from the fusion between evolutionary perspectives in economic geography with organizational learning studies. Thus, though the central area of the map is not void, there is still the need for the elaboration of unifying research which may serve as a platform of mutually shared concepts and theories for the entire RIS field of enquiry.

The factor analysis shows that although RIS studies are intended as an independent area of research, its intellectual roots are wide spread, rendering it an interdisciplinary field of research in which insights are drawn from social, economic, cultural and political sciences. The six factors identified show the presence both of approaches which, to different extents and in diverse ways, underscore the role of social structure, institutions and contextualization in "real places" – regional science, social perspective and international management – and those which are more abstract and formal, or less "social"- knowledge based view and organizational learning, economics of innovation approaches, and the evolutionary approach. The intellectual heritages identified are diverse also regards their implicit behavioral assumptions – i.e. the agent rationality assumption –, ranging from the more rational utilitarian approach of the economics of innovation strand to the more rule guided behavior of the social and regional science studies. Finally, these approaches are different also regards their static or dynamic nature, ranging from the more dynamic stances of the evolutionary approach to the static economics of innovation studies.

The consideration of the significant epistemological diversity of the intellectual foundations of the major contributions to the RIS field suggests their reciprocal incommensurability. However, the scrutiny of the development of the field of studies in time suggests that there is a progressive shift of attention and approach and that the actual interchange of ideas is potentially greater than expected. In particular, the less recent works are mainly located to the right hand side of the map and are divided between the more socially oriented regional scientist and economic geography studies, on the one hand, and the more abstract and rational economics of innovation studies, on the other hand. As the evolutionary approach begins to surface the field, there is a progressive meld between the definitional concepts and ideas elaborated in the field 'till then and the more dynamic study of the role of knowledge and competences, allowing for the emergence of different strands of research which bridge static conceptual building blocks into more process oriented theories, both at the micro level of analysis - which are located on the far left hand side of the map -, and at the more macro level of analysis regarding the connection between different RIS and the opening of local networks in order to maintain the dynamic efficiency of the system.

Amongst the most interesting aspects of the analysis is the presence of a relevant empty area on the bottom right hand of the MDS map. This empty space suggests the absence of research which adopts a holistic view regards the role of single focus firms in the development of RIS. The area's position seems to suggest the need for an understanding regards the characteristics of the different RIS and the way these influence the capacity for single firms to contribute significantly to the emergence and performance of specific territorial systems. Recent studies regarding the anchor tenant hypothesis and their correlation with RIS studies could perhaps be an intriguing phenomenon to enrich this aspect of the economics of innovation.

5. CONCLUSIONS

Though various authors have offered reviews of the RIS literature and some have described their personal intellectual voyage amongst the building blocks that constitute this area of scientific

enquiry (for example, Cooke 2008), these often illuminating illustrations are nonetheless subjective and, thus, suffer from biases which pertain to the actor performing the analysis. The study proposed in this paper aims to overcome the aforementioned limitation by elaborating an objective review of the main contributions to the RIS field of research, highlighting the main themes studied and the principal approaches followed. The analysis has been conducted following the Author Co-citation method, applied to the literature regarding RIS present in the Social Science Citation Index (SSCI) of Thomson-ISI in the time span from 1990 to 2009. The initial data set counted 211 contributions, but the application of criteria which allow to screen out the research pieces which actually characterize and shaped the field left 24 foundational papers. The use of the ACA method of analysis has allowed to trace an overview of how the RIS research area is actually composed, identifying the main research themes which characterize the field, the varied perspectives adopted, as well as its boundaries and the core subject matters treated within the different clusters of research. This conceptual frame aids to clarify the main characteristics of the RIS field of study in order to foster an increase in the returns from future research efforts. The clear cut representation of the different research themes and approaches, as well as the temporal distribution of the scientific contributions, allows a user friendly introduction to the field for those who are new to it and hint towards fruitful areas of future research also for those who are more acquainted with this literature.

The analysis we propose is an initial study, which no doubt has much to gain from further development. In fact, given the rapidity with which studies regarding RIS evolve and the unremitting interest for this field of intellectual endeavor, future reviews are bound to include new trends which are constantly emerging. Also, the ACA method carried out in this paper delivers a static representation of the field as it is up to a specific date. It is of interest to understand the evolution of the field of studies from its genesis. In order to gain such a dynamic representation, multiple ACA studies could be conducted selecting smaller time spans (within the general 1990-2009 time period) and confronting the results obtained progressively. Further, the sociology of scientific communities and the influence they exert on the directions towards which the field moves, could be better understood through a systematic analysis of the backgrounds and perspective which characterize editorial board members of the principal journals on which foundational studies are published.

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APPENDIX

Figure 1 - Multidimensional scaling and cluster

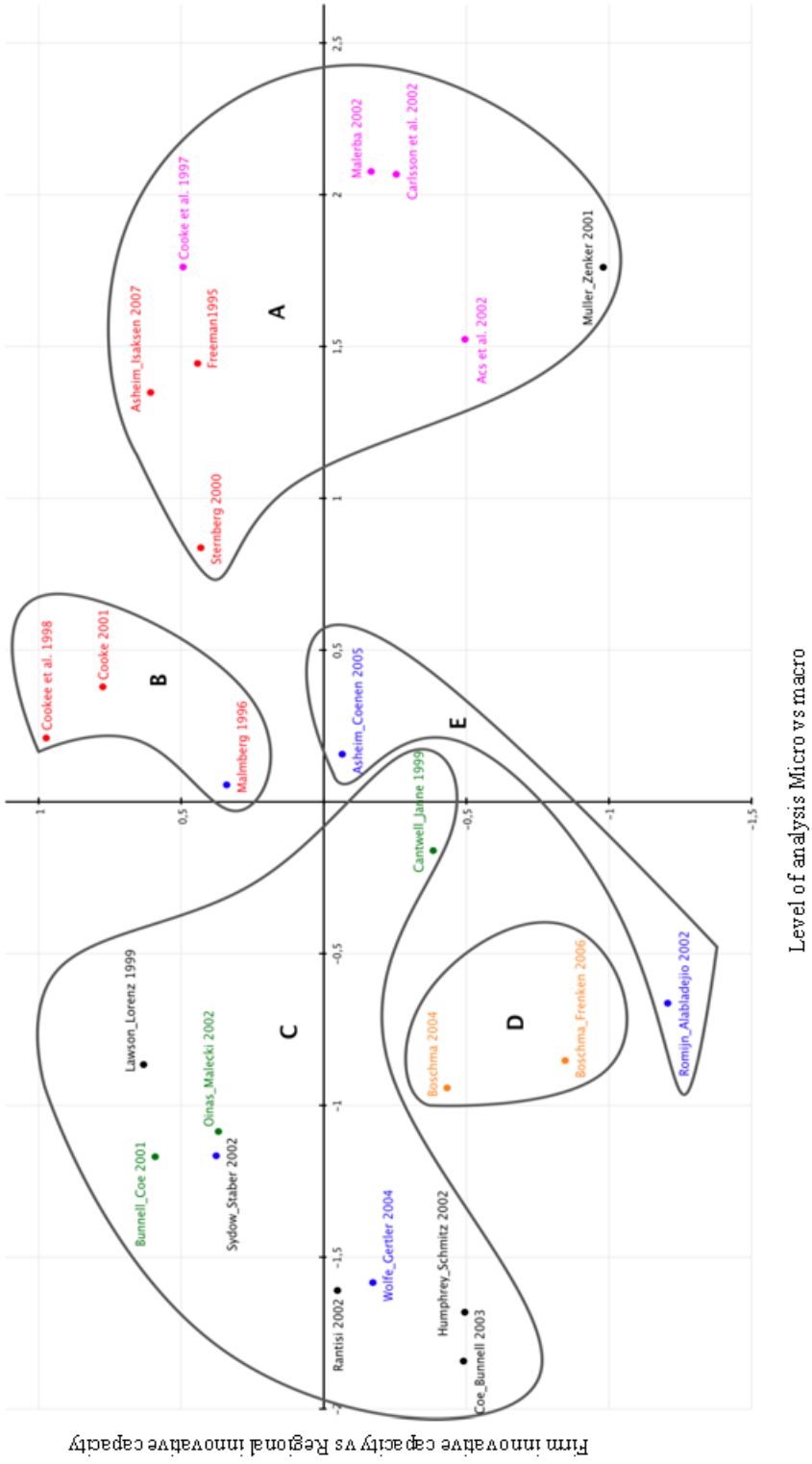

Table 4 – Rotated factor analysis - articles loadings[a]

	Perspectives					
	REGIONAL SCIENCE	**ECONOMICS OF INNOVATION**	**SOCIAL**	**EVOLUTIONARY**	**KNOWLEDGE**	**INTERNATIONAL**
Asheim and Isaksen, (1997)	,850					
Cooke, Uranga and Etxebarria (1998)	,828					
Malmberg (1996)	,741					
Cooke (2001)	,709					
Freeman (1995)	,602					
Sternberg (2000)	,595					
Malerba (2002)		,930				
Carlsson et al., 2002		,884				
Acs, Anselin ND Varga (2002)		,769				
Cooke, Uranga and Etxebarria (1997)	,598	,711				
Sydow and Staber (2002)			,830			
Humphrey and Schmitz (2002)			,753			
Rantisi (2002)			,744			
Coe and Bunnell (2003)			,640			
Lawson and Lorenz (1999)			,579			
Boschma and Frenken (2006)				,943		
Boschma (2004)				,936		
Romijn and Albaladejo (2002)					,803	
Asheim and Coenen (2005)					,771	
Wolfe and Gertler (2004)					,705	
Oinas and Malecki (2002)						,841
Cantwell and Janne (1999)						,819
Bunnell and Coe (2001)						,655

[a] *Rotation converged in 7 iterations.*
Extraction Method: Principal Component Analysis.
Rotation method: Varimax with Kaiser normalization.