Research Policy 38 (2009) 218–233

Research Policy

journal homepage: www.elsevier.com/locate/respol

Innovation studies—The emerging structure of a new scientific field

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ARTICLE INFO

Article history:
Received 29 October 2008
Received in revised form
19 November 2008
Accepted 18 December 2008

Keywords:
Innovation
Network
Invisible college
Inter-disciplinarity
Cognitive community

ABSTRACT

The scholarly literature on innovation was for a long time not very voluminous. But as shown in the paper, this is now rapidly changing. New journals, professional associations and organizational units within universities focusing on innovation have also been formed. This paper explores the cognitive and organizational characteristics of this emerging field of social science and considers its prospects and challenges. The research reported in this paper is based on a web-survey in which more than one thousand scholars worldwide took part.

1. Introduction

'Innovation' is one of those words that suddenly seem to be on everybody's lips. Firms care about their ability to innovate, on which their future allegedly depends (Christensen, 1997; Christensen and Raynor, 2003), and hoards of consultants are busy persuading companies about the usefulness of their advice in this regard. Politicians care about innovation too, how to design policies that stimulate innovation has become a hot topic at various levels of government. The European Commission, for instance, has made innovation policy a central element in its attempt to invigorate the European economy.[1] A large literature has emerged, particularly in recent years, on various aspect of innovation (Fagerberg, 2004) and many new research units (centers, institutes, departments, etc.) focusing on innovation have been formed. A web search in July 2007 identified 136 such units world-wide (within the social sciences) of which more than 80% were located in universities.[2]

The purpose of this paper is to explore the character of this emerging scientific field. Despite the popularity of the phenomenon, very little has been written on the community of scholars that study innovation and contribute to the knowledge base necessary for designing innovation policy. One of the reasons for this lack of attention may be that the field is not, or at least not yet, organized as a scientific discipline with departments, undergraduate, graduate and post-graduate teaching, curricula, textbooks etc. But as Whitley (2000, p. 302) points out, "scientific fields are no longer coterminous with academic disciplines". The hierarchical, homogenous, disciplinary community, centered around elite universities and departments, of the type described by for example Kuhn (1962), is only one among several ways to organize a scientific field. Becher and Trowler (2001, p. 27) for example conclude that "generalizations from data derived from elite academics in elite institutions have become increasingly tenuous". Arguably, what primarily characterizes the development of the academic world in recent decades, apart from its tremendous growth, is the increasing variety in how scientific work is organized and carried out (Knorr Cetina, 1999; Whitley, 2000; Becher and Trowler, 2001). Thus, the development of innovation studies as a scientific field is part of a broader trend towards increased diversification and specialization of knowledge that blurs traditional boundaries and challenges existing patterns of organization within science (including social science).

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[1] See, for instance, the Communication on innovation 'Putting knowledge into practice: A broad-based innovation strategy for the EU' adopted on 13.09.2006 (COM(2006)502) (http://ec.europa.eu/enterprise/innovation/index_en.htm).

[2] The search for the innovation research centers was done using all major search engines at once through Dogpile (http://www.dogpile.com). The main keyword for the search was 'innovation'. In addition at least one of the following keywords; center, centre, institute, unit, department, group, was needed for inclusion in the sample. Non-academic organizations, such as government agencies, TTOs, consultancy companies and the like (from domains such as .biz, .mil, .gov), were excluded.

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doi:10.1016/j.respol.2008.12.006

Although little has been written on innovation studies as such, there exists a large literature on the emergence of new scientific fields that we may use as inspiration in our research.[3] Thematically focused research communities, such as innovation studies, have been studied from a variety of perspectives: cognitive, organizational or actor (network) oriented, using different labels, such as 'specialisms' (Chubin, 1976; Becher and Trowler, 2001), 'epistemic communities' (Knorr Cetina, 1999) and 'scientific fields' (Whitley, 2000). We prefer to use the last (more general) term here. From a cognitive perspective, a scientific field may be defined as "all work being done on a particular cognitive problem" (Cole, 1983, p. 130). In this case it is mainly the common focus, understanding innovation for instance, and the accumulated knowledge that researchers in the field share, that serves to 'differentiate' (Merton, 1973; Hagstrom, 1965) the emerging field from other areas of science. That some degree of shared knowledge – or consensus – is necessary for a scientific field to thrive – and knowledge to accumulate – is generally acknowledged (Cole, 1983). But the extent of the required 'consensus' has been a matter of considerable controversy. While some of the early literature on the subject, following Kuhn (1962), assumed that a high degree of consensus (and – possibly – use of mathematics) was a prerequisite for success, and that scientific fields without such characteristics had bleak prospects (Pfeffer, 1993; Stinchcombe, 1994), other research found many of these assertions to be largely unsubstantiated (Cole, 1983; Becher and Trowler, 2001; Whitley, 2000). Hence, considerable disagreements – and lively debates – should not be seen as a threat to the survival of a scientific field as long as there is "some agreement about what the fundamental questions or issues are and as long as there are some agreed upon ways of resolving theoretical and methodological disputes" (Pfeffer, 1993, p. 617).

The latter points to the need for organization: without a separate communication system, such as conferences and journals, common standards (for what is good work and what is not) and a merit-based reward system (that promotes the good work), a scientific field will be unlikely to survive for long (Whitley, 2000). Not only because knowledge accumulation would be difficult under such circumstances (Cole, 1983; Pfeffer, 1993) but also because without such a "reputational system of work organization" (Whitley, 2000, p. 7) – or 'academic autonomy' as Merton (1973) puts it – the emerging scientific field would not be legitimate in the eyes of the rest of the academic world. Hence, 'legitimation' (Merton, 1973) through the establishment of appropriate institutions and organizations is an important aspect of the establishment of a new scientific field. This is easier said than done, however. In fact, the advocates of the emerging field – the academic entrepreneurs (Van de Water, 1997) – are often met with considerable skepticism, if not outright resistance, from the academic establishment, particularly from participants in neighboring scientific fields (or disciplines) that (perhaps rightly) may see this a fight about power and resources (Hambrick and Chen, 2008).[4] As a consequence, scholars in emerging scientific fields seldom start the search for 'legitimation' by attempts to establish permanent organizational units or departments in elite universities, where this type of resistance may be expected to be strong, but tend to choose less prestigious locations and organizational forms in the fringes of the established academic world. This held for sociology, for instance, in its early phase (Merton, 1973, p. 52), and it also applies – as we shall see – to innovation studies.

As pointed out by Granovetter (1985, p. 504) "most behavior is closely embedded in networks of interpersonal relationships". That this also goes for the behavior of researchers should come as no surprise. In fact, there exists a large number of studies (see Chubin, 1983 for an overview) demonstrating that scientists tend to work together in relatively dense networks or groups, so-called 'invisible colleges' (de Solla Price, 1963; Crane, 1969, 1972), often centered around a small number of prominent academics who play an important role as sources of scholarly inspiration, providers of resources and 'gatekeepers' to external networks. While in the early phase of this research many studies took inspiration from Kuhn (1962), and concentrated on studying the social structure of rapidly changing scientific fields, it soon became clear that such dense groups are not reserved to emerging fields, but are in fact prevalent throughout science (Griffith and Mullins, 1972). The interesting question for our research is therefore not so much whether such dense groups of interacting scholars do in fact exist, but rather how these groups link up with one another into something that (perhaps) may be characterized as a distinct scientific field. As pointed out by Crane (1972), scholars are normally connected to several different networks at the same time through links of various strengths. Of particular importance for our research, therefore, is to identify the less frequently used but still very important 'weak ties' (Granovetter, 1973) that may contribute to bringing scholars from these many smaller groups together into a larger scholarly community.

The structure of the paper is as follows. After a brief introductory overview of the development of the field of innovation studies (Section 2) we proceed in the following sections to the main topic of this paper, which is an analysis of the cognitive and organizational characteristics of the field today. Sections 3 and 4 present the survey of researchers in innovation studies, in which more than one thousand scholars worldwide took part. This survey constitutes the empirical basis for the analyses that follow. In accordance with earlier research (see above) we adopt the hypothesis that the innovation studies field is composed of a large number of networks (or groups) of closely interacting scholars bound together by what is usually called 'strong ties', e.g., work-relationships, and we use recent advances in formal social network analysis (Newman and Girvan, 2004) to verify this. However, as pointed out above, the primary challenge is not so much to establish this fact as to identify the factors that contribute to embed such smaller groups into broader ensembles. Our hypothesis, which we explore in more detail in Section 5 of this paper, is that such smaller groups are embedded in broader 'cognitive communities' that are bound together by a common scientific outlook and a shared communication system, e.g., cognitive and organizational aspects. If this can indeed be verified, the natural question to ask is if the scientists in this area, or at least the great majority of them, belong to the same cognitive community. Or is the field more an association of different (perhaps competing) cognitive communities? In the latter case, what is it that contributes to keeping the field together? How likely is the field to continue to thrive? We explore these questions and discuss the relationship to other areas of social science in the final section of this paper (Section 6).

2. The emergence of innovation studies as a scientific field

It is our hope that this paper may be of interest also to readers outside the field of innovation studies proper, and therefore we have – as background information for the analyses that follow – included a brief description of the historical development of the field. The well-informed reader will find little new here and may choose to proceed directly to Section 3. It should also be emphasized that such a brief text cannot do full justice to the many scholars that over the

[3] For overviews see Becher and Trowler (2001) and Whitley (2000).

[4] Much depends therefore on the ability of these entrepreneurs to overcome such resistance through making a persuasive case for the importance of the field, what Hagstrom (1965, p. 215) called "utopias to legitimize their claims and to form the basis for identification" and mobilize the necessary resources (Hambrick and Chen, 2008) for the fields' continuing development.

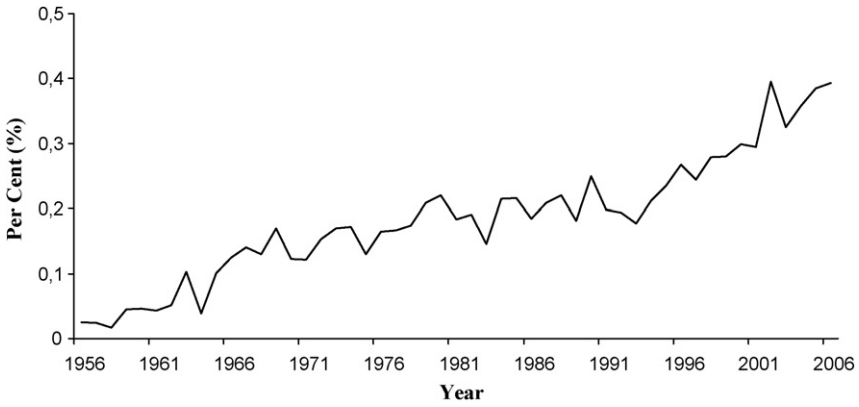

Fig. 1. Social science articles with 'innovation' in the title 1956–2006 (in percent of all social science articles). *Source*: social science citation index (ISI Web of Science).

years have contributed to the progress of the field.[5] For the benefit of the reader we added references to relevant survey articles and original sources.

Before 1960 scholarly publications on innovation were few and far between (Fig. 1).[6] The main exception to this rule was the work of the Austrian-American social scientist Joseph Schumpeter (1883–1950).[7] Working in the early days of social science, he combined insights from economics, sociology and history into a highly original approach to the study of long run economic and social change, focusing in particular on the crucial role played by innovation and the factors influencing it. In so doing he distanced himself from the (then) emerging neoclassical strand of economics, because it in Schumpeter's own words assumed that "economic life is essentially passive . . . so that the theory of a stationary process constitutes really the whole of theoretical economics . . . I felt very strongly that this was wrong, and that there was a source of energy within the economic system which would of itself disrupt any equilibrium that might be attained" (Schumpeter 1937/1989, p. 166). It was this 'source of energy', innovation, that he wanted to explain. His major theoretical treatise on the subject, "The theory of economic development", published in German in 1912 and in English translation in 1934, focused in particular on the interaction between innovative individuals, what he called 'entrepreneurs', and their inert social surroundings, while later works extended the approach to also take into account organized R&D (Research and Development) activities in large firms (Schumpeter, 1934, 1942).

Schumpeter's life-long advocacy for seeing innovation as the driving force behind economic and social change seemed almost a lost cause at the time of his death in 1950. Instead, the economics literature increasingly came to be dominated by highly mathematized, static, equilibrium exercises of the type that Schumpeter admired but held to carry little promise for improving our knowledge about the sources of long run technological, economic and social change. However, it soon became evident to researchers in the field that the explanatory power of the static approach was fairly limited, and this led to a search for new insights and approaches eventually also to a renaissance for Schumpeterian ideas. The scholarly interest in innovation increased steadily from around 1960 onwards, with particularly rapid growth since the early 1990s (Fig. 1).

This revival started in the USA. Already during early years of the Cold War the US leadership was well aware of the fact that the country's global dominance rested on technological supremacy and that the factors underpinning it needed to be catered for. Several initiatives, such as the establishment of the Research and Development (RAND) Corporation by the US Air Force, were taken to sustain these advantages. Although most of the research at RAND had a technological focus its leadership also placed emphasis on the need for understanding the factors affecting success or failure in R&D and innovation. Many researchers that came to be prominent contributors to the innovation literature were associated with RAND[8] and some of the most well known publications on the economics of R&D and innovation from this early period originated there (see, e.g., Nelson, 1959; Arrow, 1962). Another important topic for innovation researchers at the time, not only among economists but also sociologists[9], was the study of the factors affecting the spread of innovations, particularly in the large and economically important agricultural sector (Griliches, 1957,[10] Rogers, 1962), but also in other parts of the economy (Coleman et al., 1957; Mansfield, 1961[11]). A landmark was the collective volume "The Rate and Direction of Inventive Activity" edited by Richard Nelson (Nelson, 1962a,b), to which most prominent US innovation researchers at the time (at least among economists) contributed.[12] The volume focused on a number of topics, several of which continue to be central to the research agenda in this area, such as the sources of invention (Schmookler, 1962), the role of science for industrial R&D (Nelson, 1962a,b) and the allocation of resources to generation of new knowledge (Arrow, 1962). Among the contributors to the volume were also several young researchers who came to play a very important role for economic research on R&D and

[5] For a more comprehensive treatment see Martin (2008).

[6] For a historical perspective on innovation theory see Godin (2006).

[7] Another important scholar from the early years was the French sociologist Gabriel Tarde who through his "Lois de l'imitation" from 1890 (English translation 1903) came to influence later work by sociologists on the diffusion of innovations (see, in particular, Rogers, 1962, 2003).

[8] This holds for example for Kenneth Arrow, Burton H. Klein, Richard R. Nelson and Sidney Winter. See Hounshell (2000) for an extended account.

[9] For an overview of the sociological literature on diffusion of innovations see Rogers (2003), particularly chapter 2.

[10] The American economist (and econometrician) Zvi Griliches contributed over a period of more than 40 years a large number of studies on topics such as diffusion, social and private returns to R&D, spillovers and patenting (as well as other issues that are less relevant in this context). For an overview see Diamond (2004).

[11] Edwin Mansfield pioneered the use of firm-level information to explore various questions related to innovation and diffusion of technology (in the USA as well as abroad). He is particularly well known for a series of very influential books on these topics (see, in particular, Mansfield, 1968a,b). For an overview of Mansfield's work see Diamond (2003).

[12] The book was based on a conference convened by the National Bureau for Economic Research (NBER) at the University of Minnesota in the spring of 1960. Scherer (2005, p. 4) points to this conference as the "beginning point for scholarly interaction among (US) economists on technological change". He also mentions a later conference, convened by Edwin Mansfield at the University of Pennsylvania in May 1966, as important for the progress of the field.

innovation in the decades that followed, such as, for example, Zvi Griliches, Edwin Mansfield and Frederic M. Scherer.[13]

Although US researchers dominated the field during the early years[14], subsequently much of the growth occurred elsewhere. An important event was the formation of the Science Policy Research Unit (SPRU) at the (then newly established) University of Sussex in 1965 with Christopher Freeman as its first director. From the beginning, it had a cross-disciplinary research staff consisting of researchers with backgrounds in subjects as diverse as economics, sociology, psychology, and engineering. SPRU developed its own cross-disciplinary Master and PhD programs and carried out externally funded research. In many ways it served as a role model for the many centers/institutes in Europe and elsewhere that came to be established subsequently, mostly from the mid 1980s onwards. As mentioned previously, a web-search in July 2007 identified more than a 100 centers/departments worldwide devoted to innovation studies, the great majority of which were located in Europe.[15] According to the information on their web-pages, more than one third of these offer Master or PhD education (or both). Hence, from the early beginnings four decades ago, a sizeable teaching activity in innovation studies has emerged worldwide at the graduate and post-graduate level.

The research initiated at SPRU led to a large number of projects, conferences, and publications. An important initiative in the early phase was the SAPPHO project, focusing on factors explaining success or failure in innovation (Rothwell et al., 1974). Freeman's influential book "The economics of industrial innovation", which summarized the existing research on the subject, was published in 1974. Eight years later the book "Unemployment and Technical Innovation" appeared, one of the first studies to apply a system-approach to the role of innovation in long run economic and social change (Freeman et al., 1982). Freeman later followed this up with an analysis of the innovation system in Japan (Freeman, 1987). He was also instrumental in setting up the large, collaborative IFIAS project which in 1988 resulted in the very influential collective volume "Technical Change and Economic Theory", edited by Giovanni Dosi, Freeman, Nelson, Gerald Silverberg, and Luc Soete (both Dosi and Soete were SPRU PhD graduates).

The growth of the community associated with research and teaching in this area also led to the creation of several new journals, conferences and professional associations. "Research Policy", the perhaps most central academic journal in the field (see later), was established in 1972, with Freeman as the first editor. More recent additions to the publication outlets in this area include for example "Economics of Innovation and New Technology" (1990), Journal of Evolutionary Economics (1991) and Industrial and Corporate Change (1992). A professional association honoring Schumpeter's name, the International Schumpeter Society (ISS), founded in 1986, hosts an international conference every two years for scholars working in the Schumpeterian tradition. The Technology and Innovation Management Division (TIM) of the (American) Academy of Management, which meets annually, was formed in 1987. In addition, the Danish Research Unit for Industrial Dynamics (DRUID), initially a relatively local Danish affair, has since 1995 hosted an annual conference with broad international participation.

During the last few decades the literature on innovation has grown very voluminous (Fig. 1) and to summarize it in a few pages is a hazardous task. However, to get at least an impression of how the scholarly literature in this area has developed,[16] we decided to explore the references in articles published in the journal Research Policy between 1979 and 2006.[17] This choice was dictated by the fact that Research Policy is the only specialized journal in this area that has been around for a relatively long period of time (all others were established in the 1990s), and the finding that the journal according to the respondents to our survey (see later) is the most important publication channel for scholarly work on innovation. It seems reasonable to assume that the authors of articles in this journal will reference the most important contributions of relevance for their topics. Although the authors' preferences and topics may vary, some contributions will be referred to many times simply because these are regarded as 'central' for innovation studies more generally. We will take these highly cited references as representative for the 'core' literature in innovation studies. Table 1 reports the five most cited references in Research Policy during three successive time periods starting in 1979. In addition we include the five most cited 'classics', i.e., citations during the whole period 1979–2006 to books or articles published before 1975.

Among the 'classics' (Table 1, panel A), i.e., older works that that continue to be highly appreciated, only two were published before 1960, both by Schumpeter. This confirms Schumpeter's central role as a source of inspiration in this field. His favorite topic, the role of innovation in long run economic development, has continued to attract attention from scholars in this area. Examples of later contributions on this topic include Freeman et al. (1982) and Nelson and Winter (1982). The latter in particular came to exert a large influence (Table 1, panel C and D). Drawing on evolutionary theorizing and insights from organizational science (Simon, 1959, 1965), Nelson and Winter developed a radically enriched theoretical perspective on the micro-foundations of economic growth, emphasizing the heterogeneous character of firms and the 'organizational knowledge' that they posit, influencing later research in a number of different areas (Meyer, 2001).

In parallel with work on the innovation-growth nexus, a rich literature on innovation in different contexts gradually emerged. As mentioned previously, an early synthesis of much of this work, which became widely diffused, was Freeman's "The economics of industrial innovation" from 1974. Among the topics emphasized in this literature were the factors influencing investment in R&D and innovation (Arrow, 1962), the sources of invention and innovation (Schmookler, 1966) the great differences across industries and sectors (Pavitt, 1984) in how innovation, including appropriability conditions (Teece, 1986), operates, and the important role that firm-level capabilities play for innovation and learning (Cohen and Levinthal, 1989, 1990). Another important contributor, whose analyses of technological, institutional and economic change paved the way for a broader, more systemic analysis of innovation, was the economic historian Nathan Rosenberg (Rosenberg, 1976, 1982[18]). During the 1990s a new approach, using the concept "national systems of innovation", emerged (Lundvall, 1992; Nelson, 1993).[19] Rather than focusing on various aspects of innovation in isolation,

[13] Management, which later came to host many students of innovation, appears not to have had an equally strong focus on innovation in the early years of the development of the innovation studies field. See, however, Woodward (1958) and Burns and Stalker (1961) for possible exceptions to this trend, and Martin (2008) for an extended account.

[14] Some European researchers entered the field early, however. See, for example, Carter and Williams (1957, 1958), Posner (1961) and Freeman et al. (1963, 1965).

[15] See Fig. 3 for details.

[16] See Granstrand (1994) for an early bibliographical study of parts of this literature.

[17] Another commonly used approach is to base exploration of the 'core knowledge' of a scientific field on analyses of the contents of textbooks (Cole, 1983). In the present case, however, there are not many such textbooks around. Often, teaching in this area seems to be based on collections of articles, sometimes published as so-called 'handbooks', a recent example of which is Fagerberg et al. (2004). We also analyzed the references in the latter. This yielded a smaller set of references and for a single year only. However, in other respects the results were not qualitatively different from those reported here.

[18] The Rosenberg books are collections of papers, most of which were previously published. Some date back to the early 1960s.

[19] The first use of the concept was Freeman (1987). For an overview see Edquist (2004).

Table 1
Innovation studies: influential works.

	Citations in Research Policy	Type/journal
(A) 'Classics': Titles published before 1975, citations from 1979 to 2006		
Freeman (1974) The economics of industrial innovation[a]	117	Book
Schumpeter (1942) Capitalism, Socialism and Democracy	77	Book
Arrow (1962) Economic Welfare and the Allocation of Resources for Innovation	76	Book Chapter
Schmookler (1966) Invention and Economic Growth	71	Book
Schumpeter (1934) The Theory of Economic Development	57	Book
(B) Citations 1979–1988		
Freeman (1974) The economics of industrial innovation[a]	24	Book
Schmookler (1966) Invention and Economic Growth	23	Book
Nelson and Winter (1977) In search of a useful theory of innovation	20	Research Policy
Rosenberg (1976), Perspectives on Technology	18	Book
Freeman et al. (1982) Unemployment and Technical Innovation: A Study of Long Waves and Economic Development	15	Book
(C) Citations 1989–1998		
Nelson and Winter (1982) An Evolutionary Theory of Economic Change	64	Book
Pavitt (1984) Sectoral patterns of technical change: towards a taxonomy and a theory	44	Research Policy
Freeman (1974) The economics of industrial innovation[a]	43	Book
Rosenberg (1982) Inside the Black Box: Technology and Economics	41	Book
Teece (1986) Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy	41	Research Policy
(D) Citations 1999–2006		
Nelson and Winter (1982) An Evolutionary Theory of Economic Change	96	Book
Nelson (1993) National Innovation Systems: A Comparative Study	80	Book
Cohen and Levinthal (1989) Innovation and Learning: The Two Faces of R&D	68	The Economic Journal
Lundvall (1992) National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning	66	Book
Cohen and Levinthal (1990) Absorptive Capacity: A New Perspective on Learning and Innovation	63	Administrative Science Quarterly

[a] Citations to the three different editions of this book (including Freeman and Soete, 1997).

this approach favors a more holistic perspective, emphasizing the role of interaction between different actors and how this interaction is influenced by broader social, institutional and political factors.

In short, over time we see a distinct 'core literature' developing with certain key themes, approaches and central contributors. Hence, the literature-based evidence put forward here may be consistent with the hypothesis of a new scientific field emerging, and this interpretation gets further backing by the observation that several new organizations and channels of communication devoted to the field have been formed during the last decades.

3. Exploring the grass-roots: a web-based survey

In the previous section we provided some evidence that might be consistent with the hypothesis of a new scientific field emerging. However, it would be premature to draw strong inferences about the social organization of the field from a small sample of literature and the observation that some organizational resources have emerged. Arguably, to provide more solid evidence we need to approach the practitioners in the field and ask them what they themselves think about the matter.

In many cases it may be relatively easy to identify those active in a scientific field. For example, in their recent study of the strategic management field, Hambrick and Chen (2008) were greatly helped by the fact that a society exists (Strategic Management Society) and there is a journal (Strategic Management Journal) especially devoted to this field. Although we have been able to point to a range of relevant associations, conferences and journals, these are not as clearly defined as in the case of strategic management, and it cannot be excluded that there are other resources of this type that are equally or more appreciated by the relevant population. Therefore we chose to select our sample of scholars through a 'self-organizing' survey (see Appendix B) the results from which we present in more detail below. In doing so we followed Cole's definition of the "unit of analysis" as "a community of scientists who identify themselves as such and who interact" (Cole, 1983, p. 130). Hence, respondents who did not consider themselves to belong to innovation studies, or failed to demonstrate links to other scholars in the network, were excluded from the sample.

The web-based survey was carried out between January 2004 and July 2005. The initial (starting) sample contained 98 names, identified mainly by studying reference lists in relevant survey articles/books and lists of project leaders in relevant international research programs. Given that the authors of this study both have an economics background, and come from two small European countries (Norway and The Netherlands), we paid particular attention to the need to avoid a bias in those directions. The scholars in the initial sample came from 16 different countries and three different continents. North America had the biggest share (23%) followed by the UK and Ireland (20%) and France (10%). No other country had more than 7% of the initial sample. The disciplinary composition of the initial sample is difficult to verify exactly, because we did not always have that information when we sent out the invitations to participate. But emphasis was placed on including a fair amount of scholars from other disciplines than economics, such as, for example, geography, history, management and sociology. As a consequence of this, at an early stage in the collection of the data the share of economists in the sample was well below what it subsequently became (when the sample had become larger).[20]

The recipients were sent an email, asking them to fill in a questionnaire, and submit it electronically.[21] Respondents who identified themselves with innovation studies were asked for relatively detailed information about themselves and the persons with whom they cooperate (at various levels of intensity). We asked for email addresses along with these names, but also searched ourselves for email addresses when these were not given. The persons named by the respondents then received the same

[20] As responses started to come in the share of respondents with an economics background increased and eventually stabilized at the level reported below. This happened after a few months.

[21] See Appendix B for detailed information about the questionnaire.

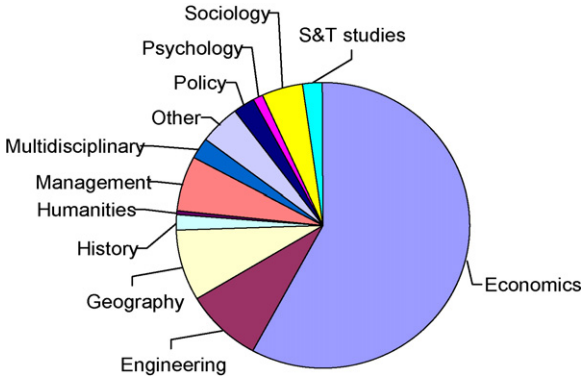

Fig. 2. Educational (disciplinary) background of respondents.

invitation to participate in the survey by filling in the questionnaire (this method is known in the literature as a combination of the 'name generator mechanism' and 'snowball sampling', see Lin, 1999).[22] In this way the community of innovation scholars was allowed to 'self-organize'. In addition to identifying their collaborators, the respondents were asked questions about their sources of scholarly inspiration, important publishing outlets and their favorite 'meeting places' (organizations/professional associations).

We took stock of the database in July 2005. At that time, there were 5199 names included, of which 3484 had been approached with an invitation to participate in the survey (for those remaining we were not able to identify an email address, or we identified the persons as deceased). 1115 responses were obtained, implying a response rate of 32%, which we consider to be quite satisfactory. About one fifth (218) of these respondents said they did not consider themselves to be working in innovation studies, or, in a few cases, did not report any strong links with one or more of the respondents. The analysis in this paper is based on the responses from the 897 remaining respondents.

One of the questions focused on the respondents' educational background, their 'native discipline' as it was phrased. Fig. 2 shows answers to that question. The most common disciplinary background was clearly economics (58% of the respondents). After economics, engineering (under which heading we include also the natural sciences) was the most common disciplinary background (9%), followed by geography (8%), management (6%) and sociology (5%). Fig. 3 similarly gives the distribution of the respondents over world regions. As is evident from the figure, Europe (71%) joined by North America (17 %) dominate the sample.

When presenting earlier versions of this paper at conferences and seminars we have frequently been asked how representative these numbers are. In particular, reactions to our results have pointed to the relatively low share of North Americans. However, it should be noted that the purpose of the exercise has been to reach scholars that identify themselves with "innovation studies". There may well be scholars doing research on innovation that do not identify with this label (and our survey has also encountered some of those). In most cases this will be scholars that feel more at home in their chosen disciplines than in a cross-disciplinary field of the type we are exploring here. To the extent that research on innovation in North America has a tendency to take place within existing disciplinary contexts, rather than the type of cross-disciplinary environments that have emerged in Europe and elsewhere, this may well explain the relatively low share of North Americans in the final sample.

Another way to shed light on this issue is to look at the response rates for scholars from different geographical contexts. The final sample contained respondents with email addresses from 71 different domains, which in most cases correspond to countries.[23] US scholars, however, tend to come from "edu" or "com" domains, which had response rates of 22% and 23%, respectively, well below the average of 32%.[24] If we adjust our estimate of the number of North Americans in the sample for the difference in response-rate, the share would be a bit higher, approximately 24% . To have something to compare these numbers with, we also made a geographical breakdown of the 136 research centers within innovation studies previously identified (through the web). The results (Fig. 3) showed that 26% of these centers were located in North America compared to 57% in Europe. Thus, the available evidence indicates that innovation studies as a field is especially popular in Europe (and among scholars initially trained in economics).

Strong and weak ties may play quite different roles when it comes to fostering scholarly interaction (Granovetter, 1973). Strong ties, we assume, tend to bind scholars together in relatively small groups characterized by strong interaction between group members, and – at least for most group members – a relatively modest amount of interaction with members of other groups. Weak ties, however, may counteract this tendency toward insularity by embedding such smaller groups in broader communities characterized by shared cognitive frameworks, sources of scholarly inspiration, 'meeting places' and publication channels.

To explore the role of strong ties,[25] e.g., student-supervisor relationships, links to colleagues within the own institution and co-authorship (independently of where these co-authors work), we adopt a method developed by Newman and Girvan (2004). Assume, for instance, that a network consists of pockets of dense (or 'thick') interaction (e.g., groups) linked together by a smaller number of cross-group links. The more efficient a particular cross-group link is in bringing groups together, the more 'busy' it will tend to be. What the Newman-Girvan method does, then, is to identify these 'busy' cross-group links (so-called 'edges') and eliminate them one by one using an iterative procedure. As a consequence, the network will split into successively smaller groups characterized by dense internal interaction. To find out when to stop partitioning, Newman and Girvan calculate an index of 'community strength'[26], which reflects the amount of within-group interaction in a network relative to what should be expected to occur at random. The maximum value of the index is assumed to reflect the optimal partitioning of the network.

Fig. 4 presents the community-strength indicator for our network at different levels of partition. The indicator rises sharply in the beginning, indicating strong support for the idea that strong

[22] A related survey aimed towards 'evolutionary economists' (an important strand within innovation studies) was carried out earlier by Verspagen and Werker (2003, 2004). Of the persons in our initial sample of 98 scholars, 21% had also responded the "evolutionary economists" survey. Hence, the overwhelming majority of the scholars that received the initial invitation to participate in the "innovation studies" survey were "new" relative to the earlier survey. When our survey 'encountered' a respondent of that earlier survey, we invited this respondent to revise her answers to the earlier survey (in light of our broader focus) and answer some additional questions.

[23] Hence, the number of domains (or countries) included in the final sample was more than four times that of the initial sample. For 30 domains, more than 10 requests for participation in the survey were sent out. The response-rates varied, from 18% in Japan (lowest) to 63% in Turkey (highest). Most stayed within a much more narrow band, however. Response rates for countries not included in the initial survey did not deviate significantly from those that were included.

[24] Canadian scholars, however, had a response rate well above the average, 40%.

[25] We assume that a link exists if at least one of the participants in a relationship reports it.

[26] Newman and Girvan (2004, p. 8) call this an index of modularity. It measures 'the fraction of the edges in the network that connect vertices of the same type (i.e., within-community edges) minus the expected value of the same quantity in a network with the same community divisions but with random connections between the vertices' (a vertex is what we call a network member). The index ranges between zero (no community structure) and unity (maximum value, strong community structure).

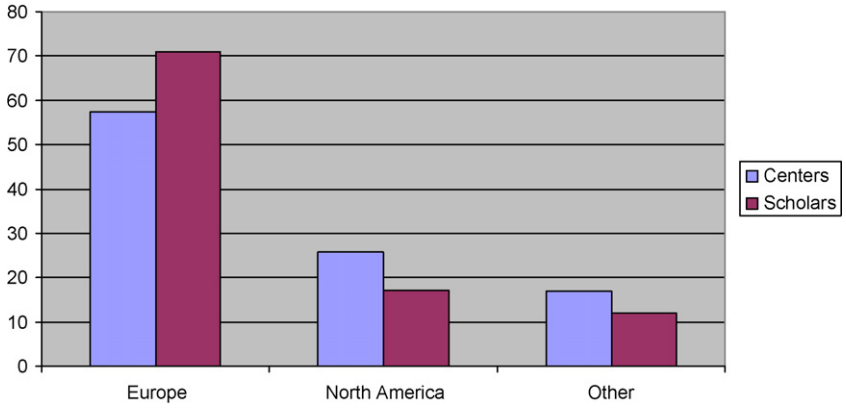

Fig. 3. Distribution of the total sample over world regions.

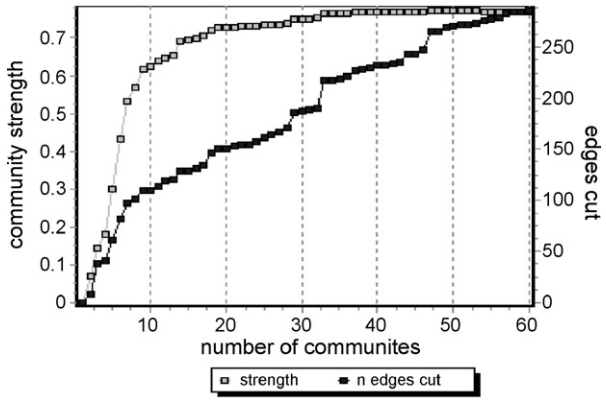

Fig. 4. Community strength.

ties tend to lead to the formation of smaller groups characterized by dense internal interaction. It peaks at 47, implying that an average group has slightly more than twenty members. The group size varied a lot, though, from three to 61 members. The smaller groups tended, naturally, to be rather concentrated both in terms of disciplinary background and geographical spread. Highly cross-disciplinary groups were typically medium-sized and with large variations in geographical reach. The largest groups were often geographically dispersed but quite concentrated in terms of disciplinary orientation. Detailed information on the membership, location and disciplinary orientation of the 47 groups may be found in Table A1 in Appendix A to this paper.

4. The role of 'weak ties'

Having answered affirmatively our first research question (about the existence of smaller groups defined through strong ties) we now move to the central topic of this paper, namely what binds these groups together (and to what extent). To explore this, we take into account the information supplied by the respondents on sources of scholarly inspiration, favorite 'meeting places' and the most important publication channels. In each case, the respondent was asked to mention five (ranked from most important to least important). Table 2 reports the most frequent answers in each category (e.g., those mentioned by at least 5% of the respondents). The column 'share' counts the percentage share of respondents that include a particular source of inspiration, meeting place or publication channel among the five most important ones. The column 'Herf' displays the corresponding value of the (inverse) Herfindahl index. This index reflects the extent to which a source of inspiration, meeting place or publication channel is widely shared among the smaller groups (large values), or appreciated by one or a few groups only (small values). The more widely shared, the larger the index will be.[27]

Table 2
The most important sources of scholarly inspiration, meeting places and journals (above 5%).

	Share	Herf[a]
(a) Scholarly inspiration		
Joseph Schumpeter	15.9%	21.2
Richard R. Nelson	13.8%	19.8
Chris Freeman	8.8%	17.5
Bengt-Åke Lundvall	6.6%	13.8
Nathan Rosenberg	6.5%	15.7
Keith Pavitt	6.4%	14.6
Giovanni Dosi	6.2%	17.0
Karl Marx	5.5%	11.8
Zvi Griliches	5.2%	10.0
(b) Meeting places		
International Schumpeter Society (ISS)	15.5%	12.9
Danish Research Unit for Industrial Dynamics (DRUID)	13.7%	14.2
European Association for Research in Industrial Economics (EARIE)	5.6%	12.6
Academy of Management (AOM)	5.1%	13.1
(c) Journals		
Research Policy (RP)	45.6%	24.8
Industrial and Corporate Change (ICC)	19.3%	11.5
Journal of Evolutionary Economics (JEE)	14.4%	14.0
Economics of Innovation and New Technology (EINT)	13.8%	15.7
Structural Change and Economic Dynamics (SCED)	7.9%	12.2

[a] Inverse Herfindahl index (see note to Appendix A).

The most important source of inspiration is, perhaps not surprisingly, Joseph Schumpeter, followed by Richard Nelson and Christopher Freeman, who we have already identified (from our study of the scholarly literature) as being among the most influential scholars in this field. The three next scientists on the list, Bengt-Åke Lundvall, Nathan Rosenberg and Keith Pavitt, have also been identified as important contributors to the literature (Table 1). Pavitt succeeded Freeman as Professor at SPRU and editor of Research Policy. Giovanni Dosi, number 7 on the list, editor of the journal Industrial and Corporate Change (ICC) and author of, among others, a much-cited overview of the literature on innovation activities in firms (Dosi, 1988), also has a SPRU background. That Karl Marx comes next on the list may perhaps come as a surprise to some. However, in addition to being a social science classic, Marx' theorizing about the role of science and technology for economic growth has been recognized by many scholars as very relevant for subsequent work in this area (see, e.g., Rosenberg, 1974). In fact,

[27] The formal definition of the inverse Herfindahl index is $1/\sum_{i=1}^{n} s_i^2$, where s_i^2 is the squared share of a particular weak tie in community i.

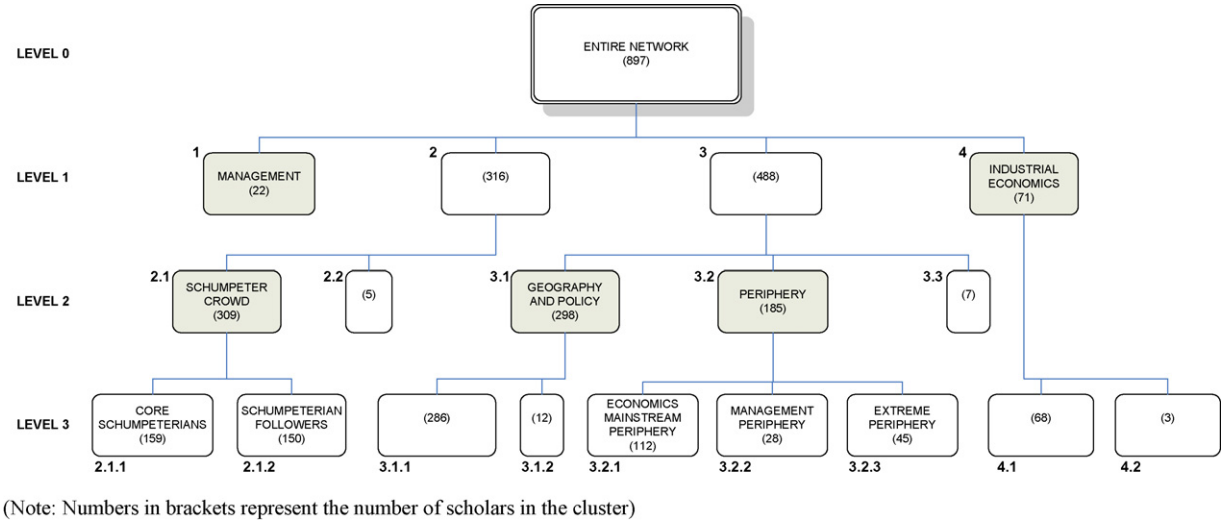

Fig. 5. Clusters of innovation scholars (*Note*: numbers in brackets represent the number of scholars in the cluster).

Table 3
Characteristics of main clusters of innovation scholars.

	Cluster 1 Management	Cluster 2.1 Schumpeter Crowd	Cluster 3.1 Geography and Policy	Cluster 3.2 Periphery	Cluster 4. Industrial Economics
Number of groups	3	13	14	11	5
Number of scholars	22	309	298	185	71
Most important conferences	AOM, DRUID	ISS, DRUID	DRUID, ISS	NBER, AOM	EARIE, ISS
Conference bias	AOM, EGOS	ISS, DRUID, EMAEE, EAPE	RSAI, RSA, IAMT	NBER, R&D Man.	EARIE, ISS
Most important sources of inspiration	Nelson, Griliches	Schumpeter, Nelson	Schumpeter, Lundvall	Griliches, Schumpeter	Griliches, Schumpeter
Inspiration bias	None	Schumpeter, Freeman, Nelson, Rosenberg, Simon, Pavitt, Dosi, Winter, Smith, David	Lundvall, Porter	Griliches	Griliches
Most important journals	RP, MS	RP, ICC	RP, JEE	RP, RAND	RP, AER
Journal bias	JPIM, MS, SMJ	RP, JEE, ICC, EINT, SCED	RS, Technovation	AER, RAND, R&D Man.	EINT, AER, RAND, JIE
Most important disciplines	Sociology (27%), Management (18%), Engineering (18%), Economics (10%)	Economics (68%)	Economics (40%), Geography (20%), Engineering (10%)	Economics (61%), Engineering (11%)	Economics (93%)
Most important locations	North-America (73%)	South Europe (26%), Central Europe (19%), UK and Ireland (19%), North Europe (12%)	Central Europe (34%), North America (16%), North Europe (15%), Latin America (10%)	North America (31%), Central Europe (26%), South Europe (16%)	Central Europe (39%), South Europe (23%), North Europe (17%)

Marx' contribution was acknowledged as an important source of inspiration already by Schumpeter (1937/1989, p. 166).[28] The final entry in the sources of inspiration list is Zvi Griliches, a mainstream economist and econometrician from the United States, who as previously mentioned is the author of a series of influential papers on issues such as diffusion, patenting and R&D (Griliches, 1957, 1979, 1990).

Among the favorite meeting places, two stand out, the International Schumpeter Society (ISS) and the Danish Research Unit for Industrial Dynamics (DRUID). Both are, as noted, of fairly recent origin, dating back to 1986 (ISS) and 1995 (DRUID) respectively. These two meetings attract around three times as many scholars in this area as the two next entries on the list, the European Association for Research in Industrial Economics (EARIE) and the (American) Academy of Management (AOM), both fairly well established events catering for large audiences transcending innovation studies proper. As for journals, Research Policy (RP), the oldest and most established journal in the field, is by far the most popular among the respondents. Four other (specialized) journals also get high marks (although far behind Research Policy): Industrial and Corporate Change (ICC), Journal of Evolutionary Economics (JEE), Journal of the Economics of Innovation and New Technology (EINT) and Structural Change and Economic Dynamics (SCED). It is noteworthy that all four are fairly recent (started during the 1990s).

5. Cognitive communities

The descriptive evidence reported above may give some hints on the social organization of the field. For instance, we have been able to identify some leading academics, some of whom have a common background (from the Science Policy Research Unit – SPRU – at the University of Sussex) and a clear relationship to some of the leading journals in this area (Research Policy and Industrial and Corporate Change in particular). Does this imply that the scholars in this area should be seen as part of a common social organization, characterized by a shared cognitive framework and communication system, e.g., what we have termed a 'cognitive community'? Or is the field composed of several (perhaps competing) communities of this type?

[28] See Fagerberg (2003) for a discussion of the sources for Schumpeter's theorizing (including the inspiration from Marx).

We shall assume that a cognitive community of the type discussed above is characterized by a specific combination of leading academics (sources of inspiration), publishing outlets and meeting places. To test for the existence (or lack) of one or more such combinations, we use the information given by the respondents to produce a vector of ('weak tie') characteristics for each of the forty-seven groups previously identified.[29] We then apply hierarchical cluster analysis[30] to explore the question of how (and to what extent) these 'weak links' contribute to embed the small groups defined by strong ties into one or more clearly distinguishable cognitive communities. Hence, groups that have similar scores on similar 'weak ties', will tend to be clustered together into larger wholes.

Fig. 5 reports the results of the cluster analysis. Rather than focusing on a single number of clusters, the figure displays various levels of the hierarchical breakdown. We chose to focus the discussion on seven clusters (from levels 1 and 2 of the hierarchical analysis). Two of these seven clusters are very small, however, with only five and seven members, and will be disregarded in the following. This leaves us with five main clusters (shaded). Table 3 reports some characteristics for these five clusters. In each case we report the two most important sources of inspiration, meeting places and journals (e.g. what the scientists in the cluster value most). In addition we report the *bias* in these assessments, i.e., significant, positive deviations in these assessments from those of the rest of the sample (at the 5% level of significance). We also report the size of the cluster and its disciplinary and geographical orientation (shares of 10% or above of a discipline or region are reported).[31]

Cluster 1 (Management) is a relatively small community, in which sociologists and management scholars are strongly present, with a geographical bias towards the USA. Members go to the American Academy of Management (AOM) and DRUID meetings. They also like the European Group of Organizational Studies (EGOS). Apart from Research Policy they see management journals as the most relevant publishing outlets, particularly Journal of Product Innovation Management (JPIM), Management Science (MS) and Strategic Management Journal (SMJ). Sources of inspiration generally get a low score. Although this community contains only a small share (around 7%) of the scholars in the sample with an educational background in management, we chose the 'management' label in this case because the members are so strongly focused on management journals and conferences.

Cluster 2.1 (Schumpeter crowd) is a large community with more than 300 members. Although most of them are economists by training, there are also many scholars with a multidisciplinary orientation or a background from other social sciences. The community is particularly strong in Europe. Members share a strong interest in the meetings of the International Joseph Schumpeter Society (ISS) and DRUID. They are also much more likely than others to participate in other meetings with an evolutionary leaning, e.g., the European Meeting for Applied Evolutionary Economics (EMAEE) and the European Association for Evolutionary Political Economy (EAEPE). Josef Schumpeter is their main source of inspiration, and they value him more highly than do members of any other community. They also show strong appreciation for a number of other well-known scholars with a Schumpeterian or evolutionary leaning, such as Richard R. Nelson, Christopher Freeman, Nathan Rosenberg, Keith Pavitt, Giovanni Dosi, Sidney Winter and Paul David. Other important sources of inspiration include the organizational theorist Herbert Simon and Adam Smith. Among the journals they fancy, Research Policy and Industrial Change and Corporate Dynamics (ICC) deserve particular mentioning, but they are also very fond of the Journal of Evolutionary Economics (JEE), Economics of Innovation and New Technology (EINT) and Structural Change and Economic Dynamics (SCED). At a lower level of aggregation this cluster divides into two, one with very high values on most indicators ('core Schumpeterians'), and another with essentially the same distribution of characteristics but lower absolute values ('Schumpeterian followers').

Cluster 3.1 (Geography & Policy) is comparable in size to the previous one. Although the DRUID and ISS meetings receive most attention in this community too, what particularly characterizes the members is their pronounced interest in the regional science meetings, especially the Regional Studies Association (RSA) and the Regional Science Association International (RSAI). They also like the meetings of the International Association for Management of Technology (IAMOT). 80% of the geographers in our sample belong to this community, as do 48% of the sociologists and 42% of the management scholars. Hence, this community is arguably more cross-disciplinary in its orientation than the 'Schumpeter crowd' or the network as a whole (the economists are actually in a minority in contrast to the sample as a whole). It also has a more dispersed geographical basis (for instance the majority of the Latin-American scholars in our sample belong to this community). The members have high esteem for Schumpeter's work. However, what really characterizes this community compared to the rest of the sample is the importance attached to inspiration from Bengt-Åke Lundvall and Michael Porter, two scholars that in different ways have done influential work on spatial issues and related policy matters. Regarding journals, members share the general enthusiasm for Research Policy, and hold the Journal of Evolutionary Economics (JEE) in high esteem. They also like Regional Studies (RS), consistent with their interest for spatial/regional issues, and Technovation (which is more oriented towards management).

Cluster 3.2 (Periphery) contains around one fifth of the members of the total network. Among all the clusters this contains the members that are least interested in taking part in meetings/associations. Neither the ISS nor the DRUID seems to appeal to its members. The highest values were reported for the National Bureau of Economic Research meetings (NBER) and the Academy of Management (AOM). They also like the R&D Management Activities meetings. Hence, its members have few if any meeting-places in common with the members from largest communities of our network. In this sense the members of this cluster constitute a periphery of the network, hence the label. US scholars are more inclined to take part here than in the sample as a whole. Scholars with an economics background dominate but a range of other disciplines are also present (although in smaller numbers). They like Schumpeter but what particularly inspires them is the work by Griliches. Their preferences for journals also differ from the sample as a whole (and in particular from those of the Schumpeter Crowd) by emphasizing (in addition to Research Policy) economics mainstream journals such as the American Economic Review (AER) and Rand Journal of Economics (and, also, R&D Management). At a lower level this cluster divides in three, with one group consisting of mainstream economists, a second of management scholars and a

[29] We include the 15 most frequent answers to each question. This gives a vector with three times 15, e.g., 45, elements. In constructing the vector we use a 9 – 5 scoring method in order to eliminate the strong element of progressivity that would result from a 5 – 1 scoring method. However, we have also experimented with the latter method, and the results are qualitatively similar. If an element was not listed by a respondent, it gets a score of zero.

[30] We use SPSS 14.0.0 for the cluster analysis and Ward's Method for linking cases to clusters. This method is known to yield relatively balanced cluster sizes (see Kaufman and Rousseeuw, 2005).

[31] Because of the large number of respondents in Europe, we divide this group of countries further into five categories. The largest of these (in terms of respondents) is central Europe (Austria, Belgium, Switzerland, Luxemburg, Germany and The Netherlands), followed, respectively, by South Europe (Spain, France, Portugal, Greece and Italy), North Europe (Denmark, Finland, Sweden and Norway), and Anglo-Saxon Europe (United Kingdom and Ireland).

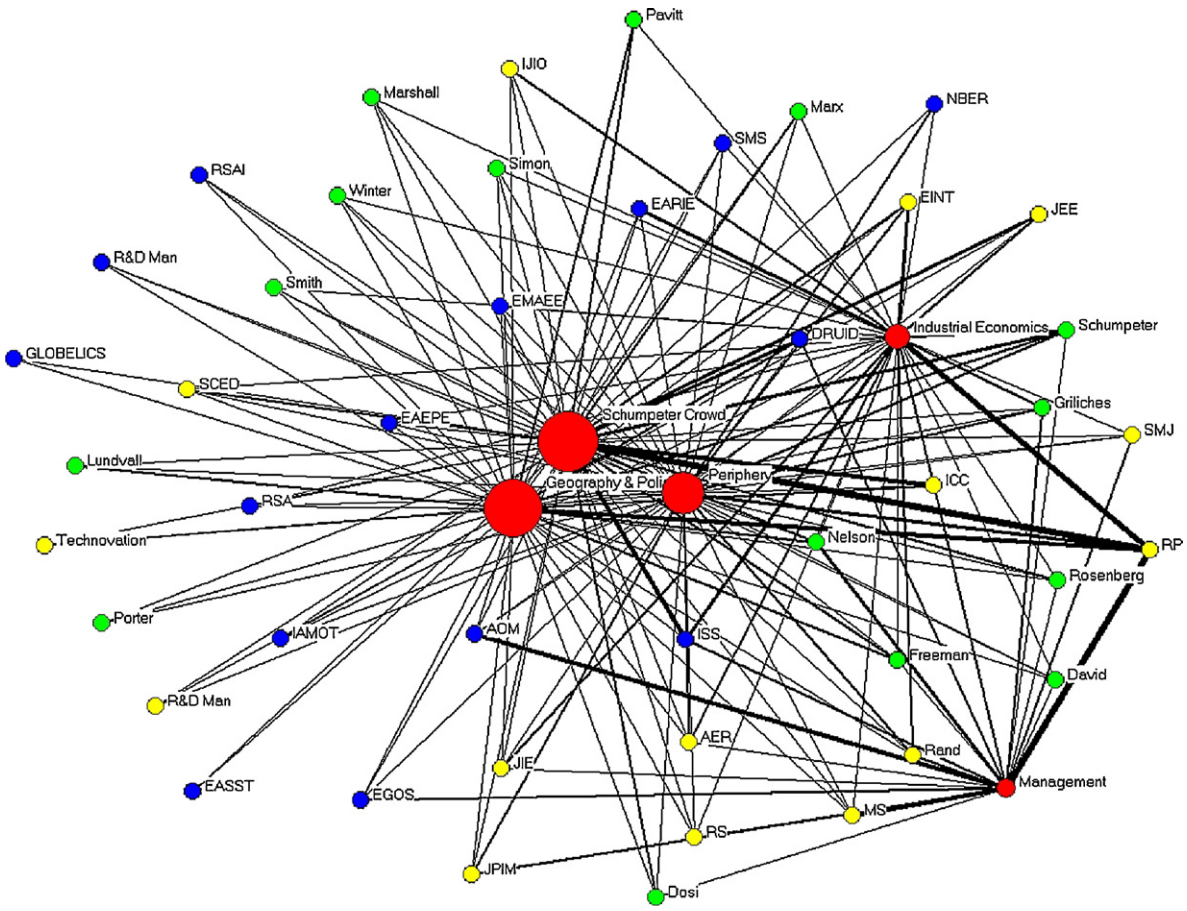

Fig. 6. Weak links between clusters (all links included).

third ('extreme periphery') with more mixed participation characterized by very low values – appreciation – of all factors taken into account by the present analysis, confirming their peripheral status in the network.

Cluster 4 (Industrial Economics). The members of this medium-sized community are predominantly economists by training (more than 90%) with a bias towards Europe. They hold the meetings of the European Association for Research in Industrial Economics (EARIE) in high regard. However, in contrast to the members of the previous cluster (with whom they otherwise have much in common) they also participate in the Schumpeter Society (ISS) meetings, thus connecting up with some of the larger groups of our network. As for the network as a whole they recognize the importance of Schumpeter. But what they particularly value highly is – as in the previous cluster – the inspiration from Griliches. Their interests in journals have also much in common with the members of that cluster, with a generally high appreciation of Research Policy supplemented by a taste for mainstream economics journals (AER, Rand) and – in this case – also the Journal of Industrial Economics (JIE). Compared to the sample as whole the members also hold the journal Economics of Innovation and New Technology (EINT) in especially high esteem (as do the 'Schumpeter crowd').

It is clear from the analysis that, consistent with expectations, 'weak ties' contribute to embed the many groups bound together by 'strong ties' in a smaller number of 'cognitive communities'. 'Scholarly inspiration' turns out to be an important feature in delimiting these communities. Apart from Schumpeter, the 'founding father' of this body of knowledge, who is highly appreciated by almost everybody (with the exception of the small 'Management' cluster), most sources of inspiration tend to be valued highly by one or a few clusters only. For instance, the 'Schumpeter Crowd' is closely associated with Nelson, Freeman and Dosi, the 'Geography and Policy' community with Porter and Lundvall and the 'Periphery' and 'Industrial Economics' communities with Griliches. However, as pointed out in the introduction to this paper, a thriving scientific field may learn to live with – and arguably even gain momentum from – such differences in perspective provided that there is some consensus on "what the fundamental questions or issues are" and "ways of resolving theoretical and methodological disputes" (Pfeffer, 1993, p. 617). Arguably, common meeting places and publication channels may play an important role in mediating such differences.

How well does this work in the present case? Figs. 6 and 7 illustrate the different roles that weak ties may play in linking communities together.[32] The figures treat the five clusters and the 'weak ties' that characterize them (e.g., sources of scholarly inspiration, meeting places and journals) as a network. The lines in the figures are links between a cluster and a particular 'weak tie', and the thickness of a line reflects how important ('busy') a particular link is. In Fig. 6 we include all positive links, no matter how important they are. What results is a densely connected network in which the five clusters of scholars are linked by many 'weak ties'. However, when the least important links are removed (Fig. 7), a clearer structure emerges. Most of the retained 'weak ties' now contribute to differentiate clusters from each other rather than to connect them. The two main communities, the 'Schumpeter

[32] The graphs are based on a spring-embedding algorithm (using Ucinet/Netdraw). The lines in the graphs reflect how the members of a cluster on average assess a certain weak tie. The medium cut-off value in Fig. 7 corresponds to one in every 7.78 members in a cluster giving a certain weak tie an average score on the 1–5 scale (and the other members giving it a zero score).

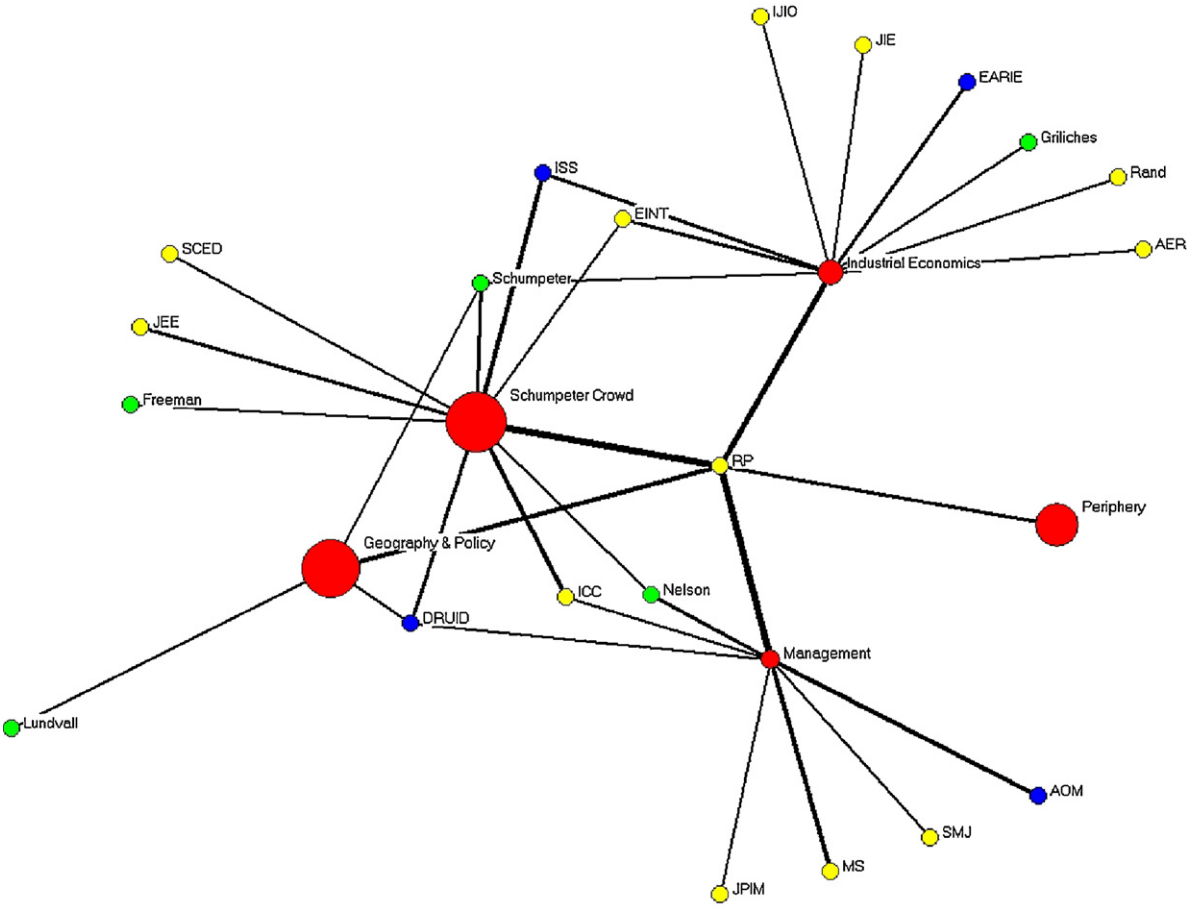

Fig. 7. Weak links between clusters, cut-off value = medium.

Crowd' and the 'Geography and Policy' clusters, continue to be well connected by, in addition to a common journal (Research Policy), scholarly inspiration from Schumpeter and a shared meeting place (DRUID). However, the 'Periphery' cluster, which used to be connected to the other clusters through a number of ties, only has one tie left to the other clusters, through the common appreciation for Research Policy (RP), confirming the peripheral role of the scholars in this cluster. Moreover, apart form Research Policy, there is at this cut-off level no direct link between the Management and Industrial Economics clusters. But both clusters continue to be well linked to the 'Schumpeter crowd' and, to lesser extent, also to the 'Geography and Policy' community.

This evidence illustrates that the two largest communities, the 'Schumpeter Crowd' and 'Geography and policy' themselves contribute to network integration. These two communities are, despite cognitive differences, reasonably well connected through common journals and meeting places. The rest of the network, then, link up with the core clusters in varying degrees (but not so much with each other). The periphery cluster is as noted particularly weakly linked to the rest of the network. It seems fair to say that this cluster consists of people who, despite acceptance of the 'innovation studies' label, have few if any intellectual links with people in the core of that field. Most likely the great majority of the scholars in this cluster feel more at home in the disciplines they come from than in innovation studies as described earlier (see the second section of this paper). Possibly, the latter may also hold for the (mono-disciplinary) 'Industrial Economics' cluster which may be better understood as a 'specialism' or subfield within economics than a current within a broader cross-disciplinary field. However, scholars in 'Industrial Economics' acknowledge the Schumpeterian influence on their subject and link up with the Schumpeter crowd through the Schumpeter Society and common journals. Thus compared to the 'periphery' there is a stronger connection in this case, intellectually and organizationally.

6. Conclusions, challenges and future prospects

As society develops and changes, needs for new types of knowledge emerge. Responding to such challenges, entrepreneurs within the scientific world from time to time try to develop new bodies of knowledge and establish institutions and organizations that facilitate the continuing progress of the emerging field. 'Innovation studies' is such a case and, as this paper has shown, a fairly successful one. Its rise to prominence is, however, a fairly recent event. For a long time there were very few scholars interested in innovation. Only one scholar from those early years, lasting up the 1960s, is still among the most influential today: Josef Schumpeter. Although his influence remained limited during his own lifetime, his ideas started to gain currency in the 1960s, as the general interest, among policymakers as well as academics, in technological change, R&D activity and innovation increased. One scholar who believed in the fruitfulness of the Schumpeterian perspective was Christopher Freeman, the arguably most important scientific entrepreneur in this field. He was the first director of what became the most well known organization in the field (located at a new university in the English countryside), founded what today is by far most respected journal and authored a number of influential books and papers that inspired new generations of researchers (many of whom were his own students).

Since the early 1960s the field has grown tremendously and today there are probably several thousand scholars worldwide that identify themselves with innovation studies.[33] Hence, the field has long passed the stage when it could possibly be analyzed as a so-called 'invisible college' (de Solla Price, 1963; Crane, 1972), e.g., a relatively small group of geographically dispersed scholars (normally less than a 100) characterized by common beliefs and very close interaction. As we have been able to show in this study, the field now consists of a large number of (small) groups of interacting scholars. To understand the dynamics of the field it is not sufficient to focus mainly on what happens within these smaller groups. What is of equal or larger importance is to understand the factors that contribute to link these smaller groups together into a broader scientific field and make continuing scientific progress possible. In exploring these factors we focused particularly on the roles played by meeting places, associations and conferences,[34] and journals in coordinating the activities of such groups and developing agendas and standards.

Using bibliographical evidence we were able to show that, over time, a core literature in innovation studies has emerged, centered around a small number of leading academics, who – as we have been able to demonstrate – are also recognized as such by the researchers who identify with the field. To some extent, therefore, there is a clearly recognizable cognitive platform that characterizes 'innovation studies'. This platform, however, is not equally shared by everybody. Using the concept of 'cognitive communities' we explored whether the field is composed of one or more communities characterized by a specific combination of scholarly inspiration, meeting places and journals. We found that one large group, consisting of about one third of our sample ('the Schumpeter crowd'), has the closest associations with the core literature, meeting places and journals within innovation studies. We may look upon them as the 'mainstream' in this area. Associated with this mainstream through common meeting places and journals, we find another large group of scholars ('Geography and Policy'), also about one third of the sample, with certain divergent characteristics in terms of appreciation for central scholars in the field, disciplinary focus and research orientation. The remaining parts of the network are less well integrated. Their cognitive orientations and preferences for meeting places and journals seem much more influenced by disciplinary settings than the interdisciplinary focus that has developed elsewhere in innovation studies.

Where is the innovation-studies field heading? Will it continue to prosper and, if so, in what form? As shown in the introduction, there does not seem to be a slowdown in the societal interest for the innovation phenomenon—on the contrary in fact, which may be seen as a good omen. However, the continuing interest in the society surrounding the academic world may also induce more established fields (or disciplines) within the social sciences to devote greater attention to this phenomenon. If so, one could foresee a reintegration of scholars within innovation studies into one or more of the existing disciplines. Since more than half of the scholars in this area have an economics education, the potential for this may be largest with economics. But among the social sciences, economics is also the one which is the most "tightly knit in terms of their fundamental ideologies, their common values, their shared judgments of quality, their awareness of belonging to a unique tradition and the level of their agreement about what counts as appropriate disciplinary content" (Becher and Trowler, 2001, p. 59) Some of the basic assumptions underlying this agreement seem to be at odds with those commonly accepted in innovation studies,[35] and this may make an integration of innovation studies into economics proper difficult since, as Becher and Trowler (2001, p. 59) point out, "within economics, those who question the basic axioms of the subject are liable to find themselves cast into a wilderness of their own (...), cut off and left to form an independent and self-sufficient community" (Becher and Trowler, 2001, p. 59). In fact, many of the most central contributions to innovation studies as identified in this paper are hardly referred to in core economics journals. A telling example is Nelson and Winter (1982), arguably the most important theoretical contribution in innovation studies within the last three decades and clearly the most cited one. Since its publication in 1982 this book has got 3550 citations in the Social Science Citation Index (SSCI), which is exceptional by any standard. However, these citations mainly occur in journals associated with organizational science, management and innovation studies proper, not in economics (which is Nelson's and Winter's own disciplinary background).[36]

These problems may be less severe in other fields within the social sciences, such as sociology, geography, and management, which traditionally have been more open to different perspectives. However, although sociological research has had a strong influence in innovation studies, the reverse does not seem to be true to the same extent. Geography is, as noted by Becher and Trowler (2001), very cross-disciplinary in its orientation and innovation clearly includes geographical aspects. But geography also includes much that has little to do with innovation. Thus, although the scopes of the two fields intersect they are also different.

Management is to some extent a cross-disciplinary field by default and firm-level innovation falls naturally within its portfolio. There has been an increasing interest in the management of innovation, as witnessed for example by growth of the "Technology, innovation and management" division (TIM) within the American Academy of Management Association (AMA).[37] Moreover, some central works in innovation studies are highly cited by management journals and vice versa. So between innovation studies and management there clearly is some common ground. However, the main inducement for the development of innovation studies, particularly in Europe, appears to have been the recognition of its wider social and economic impact and the perceived need for increased knowledge about what role policy may play. This policy-oriented focus has, for natural reasons perhaps, not attracted the same amount of interest in management. But private and public sector management are not entirely different matters, and if these bodies of knowledge start to integrate, innovation studies may perhaps follow suit?

Leaving such interesting but speculative issues aside it is fair to note that changes of this type usually meet with resistance and take a considerable amount of time. The most likely prospect for innovation studies in the years ahead may therefore be a continuation of its current existence as a cross-disciplinary, thematically

[33] Our survey identified over 5000 names. Among the respondents around 80% identified themselves with innovation studies. If our survey reached the entire relevant population (which it did not), and those that responded are representative, the population of researchers in innovation studies worldwide would be around 4000. We hold this estimate to be on the low side.

[34] See Soderqvist and Silverstein (1994) for an earlier take on these issues.

[35] For example, the assumption of 'representative' (cognitively identical) actors endowed with 'perfect knowledge' is commonly used in mainstream economics but not in innovation studies (see Nelson and Winter, 1982 for an extended account).

[36] According to Meyer (2001), Nelson and Winter's book has much more citations in management and organizational science journals than in economics journals. The only two economics journals among the ten journals with the highest number of citations to the book were Journal of Economic Behaviour and Organization and Journal of Evolutionary Economics, i.e., journals oriented towards organizational and/or evolutionary theory. The likelihood of a citation was six times higher in the Strategic Management Journal than in the American Economic Review.

[37] The Technology and Innovation Management Division (TIM) of the Academy of Management currently has over 2000 members, making it one of the larger divisions within the Academy of Management (see http://www.aomtim.org).

oriented scientific field. In this respect the most relevant question that the research undertaken here might lead to is the following: are the current institutions and organizations in the field strong enough to allow the knowledge of the field to evolve in a cumulative fashion? This may not have been a problem previously, but with the field's continuing growth (and diversity), one would expect these requirements to become more stringent. As we have shown, the only channel of communication that reaches the entire field is the journal Research Policy. There is no meeting place or association that spans the entire field. This may be the most challenging limitation for the field's continuing development.

Acknowledgements

We thank the participants at these events, two anonymous referees and the editors of this journal for useful comments and suggestions. Moreover, we are indebted to Ovar Andreas Johansson, Håkon Normann and Koson Sapprasert for excellent research assistance, Tommy Clausen for help in data collection and management and Diana Crane, Manuel Godinho, Magnus Gulbrandsen, Ben Martin, David Mowery, Paul Nightingale and Torben Hviid Nielsen for good advice. Responsibility for the views expressed and remaining errors and omissions is with the authors only. Earlier versions of this paper have been presented at the DRUID Summer Conference, Copenhagen, Denmark, June 18–20, 2006, the SPRU 40th Anniversary Conference, The Future of Science, Technology and Innovation Policy, SPRU, University of Sussex, September 11–13, 2006, the Academy of Management 2007 Annual Meeting, Philadelphia, PA, August 3–8, 2007 and seminars at the University of Oslo and the Norwegian Academy of Science and Letters.

Appendix A

See Table A1.

Table A1
Role of geography and discipline in the partition of the network.

Group	Number of scholars	Inverse Herfindahl region	Share of largest region	Largest region	Inverse Herfindahl discipline	Share of largest discipline	Largest discipline
1	11	2.7	0.55	North America	3.7	0.36	Sociology
2	61	3.9	0.34	UK and Ireland	2.1	0.67	Economics
3	23	1.3	0.87	North Europe	5.1	0.26	Economics/Engineering
4	8	1.0	1.00	Other (=Turkey)	1.0	1.00	Economics
5	17	1.7	0.76	North America	3.6	0.47	Economics
6	17	3.0	0.41	South Europe	1.6	0.76	Economics
7	22	2.4	0.59	Central Europe	6.4	0.23	Geography/Engineering
8	20	2.5	0.55	Latin America	2.2	0.65	Economics
9	8	2.5	0.50	Latin America	1.0	1.00	Economics
10	24	2.2	0.58	North America	3.1	0.50	Economics
11	3	1.8	0.67	UK and Ireland	1.0	1.00	Economics
12	35	2.2	0.66	North America	2.0	0.69	Geography
13	27	3.0	0.44	Latin America	3.4	0.44	Engineering
14	5	1.0	1.00	South Europe	1.9	0.60	Economics
15	22	2.5	0.50	North Europe	1.2	0.91	Economics
16	28	3.2	0.46	Central Europe	4.2	0.36	Management
17	45	3.7	0.44	South Europe	1.5	0.80	Economics
18	36	3.3	0.47	UK and Ireland	2.9	0.56	Economics
19	18	1.7	0.72	South Europe	2.1	0.67	Economics
20	31	4.0	0.35	Latin America	5.8	0.32	Economics
21	7	1.3	0.86	North America	2.0	0.57	Engineering
22	13	1.2	0.92	North America	1.2	0.92	Economics
23	18	1.7	0.72	Central Europe	1.1	0.94	Economics
24	17	1.9	0.71	North Europe	4.7	0.29	Management
25	36	5.8	0.25	Central Europe	3.9	0.39	Geography
26	23	2.0	0.70	South Europe	1.3	0.87	Economics
27	30	2.9	0.53	North Europe	2.1	0.67	Economics
28	48	2.6	0.56	Central Europe	1.2	0.90	Economics
29	18	2.6	0.56	UK and Ireland	1.6	0.78	Economics
30	3	1.8	0.67	UK and Ireland	3.0	0.33	Sociology/Policy
31	26	1.6	0.77	Central Europe	1.5	0.81	Economics
32	36	1.2	0.92	Central Europe	1.9	0.72	Economics
33	4	1.6	0.75	South Europe	1.0	1.00	History
34	6	1.0	1.00	Latin America	2.0	0.67	Economics
35	15	3.2	0.47	Central Europe	1.1	0.93	Economics
36	11	1.2	0.91	Central Europe	2.6	0.55	Economics
37	20	2.4	0.45	North/Central Europe	4.9	0.40	Economics
38	5	1.5	0.80	Central Europe	1.0	1.00	Economics
39	13	2.3	0.54	South Europe	1.2	0.92	Economics
40	7	1.0	1.00	Asia	1.7	0.71	Economics
41	16	1.3	0.88	Central Europe	2.7	0.56	Economics
42	17	3.0	0.47	South Europe	1.1	0.94	Economics
43	4	1.0	1.00	North America	2.7	0.50	Sociology
44	19	1.5	0.79	Central Europe	4.1	0.42	Economics

Table A1 (*Continued*)

Group	Number of scholars	Inverse Herfindahl region	Share of largest region	Largest region	Inverse Herfindahl discipline	Share of largest discipline	Largest discipline
45	6	3.0	0.50	Central Europe	1.0	1.00	Economics
46	12	2.2	0.58	Central Europe	2.0	0.50	Geography/Economics
47	6	2.0	0.50	UK and Ireland/South Europe	1.8	0.67	Economics

Note. The table provides information on the geographical and disciplinary composition of the forty-seven groups (identified through the application of the Newman–Girvan method) as reflected in the share of members coming from the largest region (discipline) in the group. The region (discipline) listed to the right of that number is the one with the largest share (when two are listed these are of equal size). In addition the table provides an indicator of the extent to which members are spread among many regions (disciplines) or tend to concentrate in one or a few regions (disciplines) only. This indicator – the inverse Herfindahl index – is defined as $1/\sum_j x_j^2$, where x_j is the share of either a region or discipline in the total membership of the group (for example, x_j could be the share of economists among the members of the group). The smaller the index, the more homogenous a group will be in terms of regions (disciplines). The minimum value of the index is unity, which means all members of the group belong to the same region (discipline). The index reaches its maximum value (identical to the numbers of regions (10) or disciplines (12)) when the members are spread equally among the alternatives.

Appendix B. Extract from questionnaire (questions used)

Your Name:

1. YOUR BACKGROUND

We would like to know a few details about your academic background.

1a) Which country do you consider to be your native country from a SCIENTIFIC point of view (e.g., if you are Italian by nationality, but pursued your entire scientific career in the UK, fill in "United Kingdom" here)?
Country:

1b) What is your current (main) affiliation?
Affiliation:
Country:

1c) In case you hold a PhD Degree, at which academic institution did you get it, who was your (main) supervisor, what is his/her current email address, and when did you obtain the degree (year)? In case you hold more than one PhD degree, please list the most relevant.
Institute:
Supervisor:
Email:
Year:

1e) Which academic discipline do you consider your native one (e.g., economics, sociology, engineering; please note that 'Innovation Studies' is not what is intended here)?
Answer:

2a. Do you consider yourself to be, or have been in the past, active in Innovation Studies?
Answer: Yes/No (Please delete the option that does not apply)
If you answered 'No' to both of the previous questions, you may now save the file and submit your results without answering the remaining questions. It is important for our research that you submit your results! You may submit your results by sending the saved file as an attachment back to us. Thank you for your cooperation!

2. YOUR NETWORK

The following questions will ask for names of people. We would like to give you a few general directions for answering these questions:

- The questions 2a–d refer to different (non-overlapping) types of contacts/relationships. This means, for example, that a person who would qualify as a possible answer to the first question below (2a. YOUR Ph.D. STUDENTS), should not be included as an answer in any of the following questions (2b–d). This even holds if you decided not to fill in the name of this person in the first question, because the person did not rank among the five most important people in the category. Also, never list the name of your PhD supervisor as an answer to any of the following questions, as that has already been reported (question 1).
- Always include those people that you consider to be most relevant to YOUR work on Innovation Studies, although the people you list may themselves be active/specialize in other areas.
- Always give priority to quality rather than quantity when listing relationships.
- List most important people in a category at position 1, least important people at position 5.
- A few directions for formatting the names. Please do not use any academic titles, so write "John Lennon" rather than "Prof. John Lennon" or "dr. John Lennon". Also, please write names in the order FIRST NAME - LAST NAME, e.g., "Mick Jagger", rather than "Jagger, M.". Finally, please give us as much detail as you reasonably can, i.e., provide full first names (if you know them) rather than initials (e.g., "Elvis Presley" rather than E. Presley"), and also provide middle initials if you know them (e.g., "Elvis A. Presley" rather than "Elvis Presley").
- The questions will ask for current email addresses of the people you list, and it helps us a lot if you can supply us with these. If this is not possible, please leave this field empty, but complete the rest of the answer.
- If there are less than five people who qualify the description given in the question, simply leave the appropriate number of rows empty.

IN THE QUESTIONS THAT FOLLOW RESPONDENTS WERE ASKED TO LIST UP TO FIVE ANSWERS, RANKED FROM MOST TO LEAST IMPORTANT (with email addresses if appropriate)

2a. YOUR PhD STUDENTS

In case you ever supervised PhD students, we would like to know who you consider to be the most influential of these. Please list up to five PhD students from those who have completed their dissertation.

2b. YOUR CO-WORKERS

We would like to know who you consider to be the most important co-workers with whom you have worked over your entire career. We define a co-worker as a person employed in the same organization as yourself, and who is/was a source of inspiration in the form of formal and informal discussions, exchange of ideas, commenting on papers, etc.

2c. YOUR CO-AUTHORS

We would like to know who you consider to be the most important external co-authors (working outside your own organization at the time of the joint work) whom you have worked with over your entire career. Please include also work outside scholarly journals, such as reports for contract research, etc., in your definition of a co-author.

2e. YOUR FRAME OF REFERENCE

We would like to know who you consider to be the most important people in your frame of reference. We define the frame of reference as those people who have inspired your own work, but do not fit names already considered for the above categories. A good example of a frame of reference

may be classic author who lived before your time (e.g., Adam Smith or Karl Marx). But this category can also include living people, for example those authors you frequently refer in your own work, but you have never been in contact with.

4. JOURNALS

Which academic journals do you consider CURRENTLY to be the best outlet for work on 'innovation studies' (most important first)?

5. MEETING PLACES

In case you regularly (on average at least once every 2 years) go to international meetings organized by professional associations or other organizations, which do you consider to be the best outlet for work on "innovation studies"?

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