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ABSTRACT

In this paper I investigate the bibliometric structure of the literature on spin-off firms, in terms of topics addressed and links to and between scientific fields. The concept of 'spin-offs' has generated much interest both in the academic literature and in policy debates due to the perceived importance for innovation and economic renewal. At the same time, when reading academic articles, one is struck by the diversity and lack of definitions of the concept itself, as well as the multiple interpretations of the relevance of the spin-off phenomenon. By analyzing the bibliometric structure of spin-off literature I try to remedy some of these problems. The dataset consists of 215 source articles and 2397 cited authors. The source articles are academic papers published between 1957 and 2006 with 'spin-off' in the title and identified through the Web of Knowledge database. The bibliometric structure is analyzed firstly from a direct perspective where the source documents that make up the spin-off literature are analyzed, and secondly from an indirect perspective where the documents cited by the source documents are analyzed. I investigate which topics are addressed in the spin-off literature and which are the leading authors and journals, as well as changes over time. By doing this I attempt to uncover which scientific fields are linked to the spin-off concept.

The results are inconclusive as to whether the spin-off literature has become an independent field. Most authors contribute only one source article, which leads to a situation where the community redefines the concept continually, rather than using one core definition. However, network analysis of co-occurrence data does reveal some core literature, which unites the different sub-components. First, there are two main scientific fields which the spin-off literature draws upon: the financial field, and the entrepreneurship/innovation field. A dynamic analysis suggests that over time the focus has shifted in favor of the latter. Second, the link to more general literature in economics of innovation is less pronounced in the entrepreneurship/innovation field than what is perhaps expected. An explanation may be that the field is mainly drawing on empirical studies, which do not necessarily help the conceptual understanding of the spin-off concept. However, it appears that the entrepreneurship/innovation field is influenced by the resource-based view of the firm, evolutionary theory and an emerging entrepreneurship literature.

1. INTRODUCTION

The spin-off concept has received vast coverage in academic as well as in popular press. For example, a simple Google Internet search of the term ‘spin-off’ generates over 4 million hits.¹ Yet, it appears that the spin-off literature lacks conceptual clarity and it is difficult to identify distinctive contributions to the literature.

A quick glance at the spin-off literature reveals great heterogeneity in terms of theory, data and methods – i.e. the backbone of scientific inquiry. In the academic literature the spin-off concept has been treated in relation to a number of different issues. For example: companies implement programs to manage employees and make graceful exits through spin-offs (Chesbrough 2002); universities and government agencies see spin-offs as a means to leverage research results (Wright, Lockett, Clarysse et al. 2006) as well as engines for regional renewal (Lindholm Dahlstrand 1997a); and stock owners turn to spin-off arrangements to surface hidden assets, to break up conglomerates or just to streamline unrelated businesses (Copeland, Weston and Shastri 2005). When a concept is used in such a variety of environments it is natural to ask questions such as: Is the concept used with the same underlying meaning? Is the same fundamental logic applied across time? Or perhaps, is the concept used in distinct discourses with very different meaning? Conceptual clarity in social science is often sought by reviewing major contributions in the literature, following a logic of comparison and contrast. This method leaves room for the researcher to analyze several variables at the same time, which is a great advantage when the literature is diverse. However, the analysis is necessarily limited by the interpretative capacity of the researcher. Analyzing the bibliometric structure of a specific body of literature offers an alternative and more formal approach. Recently, for example, the current status and development of the entrepreneurship literature were studied using bibliometric techniques (Cornelius, Landstrom and Persson 2006; Reader and Watkins 2006).

The *raison d'être* of this paper is twofold. First, I hope to contribute to the understanding of the development of the spin-off concept itself. This purpose assumes that the search for definitions and classifications is an integral part of the advancement of science. Advancement is here seen as a process where concepts become building

¹ <http://www.google.com> November 9, 2006

blocks for a defined field of study, which over time accumulate and increase the total knowledge base. Second, due to recent interest from government agencies in promoting spin-off formation, we ought to have a clear understanding of how the concept is interpreted in the literature in order to be able to predict and assess the effects of such schemes.

The use of bibliometric techniques allows me to analyze how a whole community of researchers has approached the spin-off concept. As the title of the paper suggests, I investigate the bibliometric structure of the spin-off literature, i.e. the body of literature which addresses the spin-off concept. By doing this I attempt to uncover which scientific fields are linked to the spin-off concept, in order to identify the structure of the “fragments” (cf. Reader and Watkins 2006) of spin-off research. More specifically, I attempt to answer the following research questions:

1. Which are the leading authors and journals that directly (by publication) contribute to the spin-off literature, and how has it changed over time?
2. Which are the leading authors and journals that indirectly (by citation) contribute to the spin-off literature?
3. Which topics are addressed in the spin-off literature?

Concepts are abstractions of the ideas or objects which they try to capture, as they omit the differences and focus on what is common or identical. In research, concepts are the basic elements we use to form propositions. For example, in the proposition “Large firms are more innovative than small firms”, the researcher must carefully define three concepts: large firm, small firm and innovative. Concepts do not exist in reality, but are formed or abstracted from reality by human intervention. Nonetheless, concepts are crucial in our understanding of reality. In essence, concepts are the building blocks of theory and the starting point for all investigations in the social sciences (Bryman 2001). Analogously, a theoretical concept is to the researcher what the brick is to the bricklayer. It is the building block the researcher uses to advance science. As the world around us changes, we sometimes feel obliged to invent new concepts to better describe what we see and to advance science. However, well-defined concepts are needed to build robust theory. Following Bulmer (1984), concepts are categories for the organizing of ideas and observations. We use concepts to explain phenomena in the form of independent variables, where the phenomenon

(the dependent variable) is a concept in itself that needs to be defined in order for other researchers to evaluate, compare and conclude from previous results. In this paper the conceptual analysis is made indirectly by analyzing the bibliometric structure of the spin-off literature.

The paper is organized as follows. Section 2 provides a brief overview of the spin-off concept in terms of how it has been addressed by different authors in previous literature. Section 3 addresses method and research design, discusses bibliometric methods and introduces the specific dataset analyzed. Section 4 presents the results. Finally, in section 5, I draw conclusions and point to implications.

2. OVERVIEW OF THE SPIN-OFF CONCEPT

The American Heritage Dictionary (2004) defines spin-off as: (1) A divestiture by a corporation of a division or subsidiary by issuing to stockholders shares in a new company set up to continue the operations of the division or subsidiary; i.e. the new company formed by such a divestiture. (2) Something, such as a product, that is derived from something larger and more or less unrelated; a byproduct. (3) Something derived from an earlier work, such as a television show starring a character who had a popular minor role in another show.

A reading of popular press and academic journals gives more flesh to debate of multiple meanings of the spin-off concept. A spin-off is often seen as a new organization, or entity, that is formed by a split from another organization, or entity. In common language we speak of ‘spin-offs’ from television shows when we mean a new show which is based on another, or when a former actor of a popular show starts his or her own show (the sitcom *Fraiser* is a spin-off from *Cheers* and there are several spin-offs from the drama series *CSI*). In the academic literature we speak of ‘spin-offs’ when a new firm is formed from a university research group, when an employee leaves his or her company to start a new firm, or when a firm is split up in independent parts. Sometimes the spin-off concept is used to denote the civilian spillovers that come from military or government research. The common denominator for the spin-off concept appears to be ‘the formation of something new based on something existing’. However, in business and economics literature the

spectrum runs from divestitures of whole business units to university researchers who bring some idea from the laboratory to start their own business.

Academic spin-off literature has addressed the concept from several different perspectives. Table 1 below provides some examples of how literature has dealt with the spin-off concept.

*** INSERT TABLE 1 ABOUT HERE ***

Some authors discuss the effects of spin-offs, mainly at the regional level (Dorfman 1983; Lindholm Dahlstrand 1997a), some turn to unique characteristics of spin-offs such as high degrees of survival, growth and technology transfer (Utterback 1974; Oakey 1995; Lindholm Dahlstrand 1997b), and yet others concentrate on generating classification schemes for spin-offs by focusing on the reason for spin-off or the origin of the spin-off (Lindholm Dahlstrand 1997a; Parhankangas and Arenius 2003; Mustar, Renault, Colombo et al. 2006). An important distinction concerning origin is the one made between spin-off firms originating from universities or from established firms, i.e. university spin-offs (McQueen and Wallmark 1982; Link and Scott 2005; Lockett, Siegel, Wright et al. 2005; Wright et al. 2006) or corporate spin-offs (Kudla and McInish 1981; Seward and Walsh 1996; Lindholm Dahlstrand 1997b; Parhankangas 1999; Chesbrough 2003; Parhankangas and Arenius 2003; Sapienza, Parhankangas and Autio 2004). Age and maturity of the analyzed ventures or firms seem to be a factor as well. One stream of literature is concerned with young (or even embryonic venture) firms (Roberts and Weiner 1968; Cooper 1971; Roberts 1991), whereas another stream is analyzing issues around later-stage spin-offs, mainly divestments of mature businesses (Kudla and McInish 1981; Woo, Willard and Beckstead 1989; Woo, Willard and Daellenbach 1992; Ito and Rose 1994; Ito 1995; Seward and Walsh 1996; Rose and Ito 2005). When it comes to the young firms, the spin-off mechanism is seen as an alternative way to generate new firms by shielding new ventures from the initial hazards through incubation within established firms (Garnsey 1998; Parhankangas and Arenius 2003). Klepper (2001) attempts to explain the spin-off phenomenon in terms of four different theoretical perspectives: agency theories, organizational capabilities theories, employee learning theories, and theories of the heritage of spin-offs. For mature firms the reason for spin-off is coined in terms of balancing the costs of managing a diversified business, increasing the leverage on core competencies, and providing an efficient internal labor market (Ito 1995).

3. METHOD AND RESEARCH DESIGN

Method

Bibliometrics is the mathematical and statistical analysis of communication in the form of documents. Bibliometric techniques involve the counting and analyzing of written communication (Pritchard 1969). This kind of quantitative analysis of documents was started in the 1920s and 1930s by the works of Lotka (1926) who analyzed the frequency distribution of scientific productivity; by Gross and Gross (1927) who published a citation study to aid in the decision-making of which chemical journals a small college should purchase; and by Bradford (1934) who analyzed the frequency distribution of papers over journals. Modern bibliometrics is generally attributed to deSolla Price (1963) and his work on exponential growth models of scientific literature.

More recently, bibliometric analysis has been used to analyze linkages between patents and the structure of scientific fields (Small 1977; White and Griffith 1981; White and McCain 1998). Publication data can be used to evaluate academic performance. Previous research has applied bibliometric analysis to e.g. measuring publication in leading management journals as a measure of institutional research performance (Stahl, Leap and Wei 1988), mapping the development of strategic management as a field (Martinsons, Everett and Chan 2001; Ramos-Rodriguez and Ruiz-Navarro 2004), investigating the problems for operations management to develop into a distinct discipline (Pilkington and Liston-Heyes 1999) and analyzing the cognitive structure of cardiovascular research (Jarneving 2001).

The data sources in bibliometrics are e.g. books, monographs, reports, theses and papers in serials and periodicals; these documents are termed source documents. The data input to bibliometric studies is the information that can be found in documents or specific parts of documents, e.g. the author name, title, keywords and the reference list. Scientific papers published in refereed journals usually have the highest status due to the assumed quality they carry. Thus, referred scientific papers are the preferred unit in bibliometric studies, as “the scholarly journal is the major formal channel in which research and other scholarly activities are recorded and communicated” (McCain 1991). The basic measures in bibliometric studies are counts, e.g. publication counts, author and co-author counts and the number of citations of an author, journal or other bibliometric unit. There are four dimensions of

bibliometrics that can be analyzed (Kärki and Kortelainen 1998). First, the producers of documents: authors or groups or authors, departments, research areas or countries. Second, the products themselves, documents in the form of journal papers, conference papers, books, patents, or aggregates such as journals or conference proceedings. Third, key words used in titles or classification codes. Fourth and finally, citations.

An important assumption in bibliometrics is that the analyzed literature reflects research activity and quality. The reason for this assumption is that the formal communication is seen as an important part of scientific undertakings and endeavors. In terms of quantity or quality of research, it can be argued that the number of publications of an individual, research group or university is a proxy for quantity of research output, whereas citations can be seen as the impact the research has had on the work of other researchers. Citations can thus be seen as a second peer review representing the adoption of knowledge by the scientific community. The list of references in a paper published in an academic journal is thought to describe the content of the paper in a detailed, precise manner (Garfield 1979) and citations in such papers are believed to be indicators of scholarly impact (Westney 1998). The citing articles can be seen as the research front of the selected field and the cited articles as the intellectual base of that field (Persson 1994).

Broadly, the most common techniques are citation and co-citation analysis. The logic of citation analysis is that citations form simple and explicit links between papers (Garfield 1979). Taken together, these links form scholarly flows of knowledge. Citation analysis is based on the assumption that authors cite prior work, which they deem important, in both positive and negative ways. Thus, frequently cited documents are said to have a greater influence on the progress of science than less cited documents (Culnan 1987; Tahai and Meyer 1999). A major shortcoming with all bibliometric studies using citation analysis is that not all citations are directly linked to the quality of the previous work. Glänzel and Schoepflin (1999) list 15 different reasons for why citations are given: paying homage to pioneers, giving credit for related work, identifying methodology, providing background reading, correcting one's own work, correcting the work of others, criticizing previous work, substantiating claims, alerting to forthcoming work, providing leads to poorly disseminated, poorly indexed, or uncited work, authenticating data and classes of facts, identifying original publications in which an idea or concept was discussed,

identifying original publications or other work describing an eponymic concept or term, disclaiming work or ideas of others, disputing priority claims of others. However, the citations of utmost importance for this study are those which cut across several papers. Thereby, some of the problems with citations for private and not scientific reasons are mitigated.

Co-citation analysis is one of the most commonly used bibliometric methods. It is a method which investigates similarity between works (McCain 1991). Small (1973) and Marshakova (1973) independently introduced methods for co-citation analysis. In co-citation analysis the basic measure is the count of co-cited works, i.e. how many times two works are cited in subsequent documents. When two references are co-cited, there is a link not just between the citing document and the cited document, but between the co-cited documents as well. The greater the number of times two references are co-cited, the stronger the relationship between the citations is. The mathematics of co-citation analysis is straightforward. Commonly a co-citation matrix is formed by the columns representing the citing papers and the rows the cited papers (the references). The co-citation count between two papers is then the scalar product of the corresponding rows.

A related method is bibliographic coupling. This was suggested by Kessler (1963) and measures the similarity between two papers by the number of joint references in them. Whereas co-citation analysis measures the relationship between cited documents, bibliographic coupling measures the relationship between source documents. The similarity between co-citation analysis and bibliographic coupling becomes evident if we refer back to the co-citation matrix discussed above. Bibliographic coupling, i.e. the number of joint references between two articles, is calculated by the scalar product of the corresponding columns, whereas in the case of co-citation the row vector is used instead. It is commonly argued that bibliographic coupling is a measure of the research front, whereas co-citation analysis is a measure of the past structure of a research field (van den Besselaar and Heimeriks 2006). Thus, co-citation analysis is suitable for the purpose of this paper.

In the previous discussion of co-citation analysis, the cited documents have been the unit of analysis. However, co-occurrence techniques can be used with several different units. In addition to co-occurrence of documents, the co-occurrence of authors, journals and co-words is possible. Co-word analysis can be made on words

that appear together in titles, abstracts and other bodies of text (Callon, Law and Rip 1986). Methods for author co-citation analysis were suggested by McCain (1990) who argues that the “author set defines the scholarly landscape being mapped”, i.e. the ambition is to identify the prominent (cited) authors in a field or discourse. McCain (McCain 1991) argues that journal co-citation analysis can be used similarly to author co-citation for studying the structure of a specific subject literature, because journals can be “distinguished by their broad or narrow subject specialization, favored methodological orientations, institutional affiliations, relative prestige”, thus sometimes making them easier to interpret than authors. In addition, she argues that journal co-citation analysis is a method to remedy the problem that most data sources only provide the first author in the list of cited references.

Bibliometricians have elaborated methods to calculate similarity based on co-occurrence matrices. Various measures can be derived directly from the co-occurrence matrix, but it can also serve as input to different kinds of multivariate analysis such as cluster analysis, factor analysis and multidimensional scaling (MDS). MDS translates the similarity measures into a two-dimensional map to aid in the interpretation of relationships and groups. It is also possible to analyze and visualize the relationships between bibliometric units by calculating the whole network of relationships. In network analysis the interest lies with the relationship between units and the structural properties of the network rather than characteristics of the individual units themselves. The network is defined as the set of units, and network analysis is the mapping and description of the relationship between units. Network analysis has gained popularity especially within sociology in the form of social network theory (Wasserman and Faust 1994; Powell, Koput and Smith-Doerr 1996). In relation to bibliometrics it is possible to construct networks based on any unit where a co-occurrence matrix can be calculated, e.g. author and journal co-citation and co-word networks. From a bibliometric point of view, in analysis of the structure of a specific body of literature, observations of the relationship between bibliometric units are necessary. Thus, co-occurrence data on author and journal citations as well as keywords are the data points needed to analyze the bibliometric structure of the spin-off literature.

There are various quantitative methods at hand, as seen. In this paper I will use frequency and co-occurrence lists in the form of e.g. citation and co-citation analysis. I will analyze the major contributors to the field, the links between them and the

foundations for them, in terms of theories and/or research lines as well as the relatedness between different research streams, thus enabling the structure of the field to be pictured. The data source is comprised of academic papers which deal with the spin-off concept. Finally, combinations of data such as author, journal and keyword co-occurrence are complementary to each other.

Data

Bibliometric analyses are dependent upon the success of retrieving relevant information about the selected source articles. Luckily, today, there are online data sources available for bibliometric analysis. The largest, most commonly used and generally accepted source for bibliometric studies is the Web of Science database part of Thompson's ISI Web of Knowledge database. The Web of Science database consists of three separate ISI databases: (1) Science Citation Index Expanded; (2) Social Sciences Citation Index (SSCI); and (3) Arts & Humanities Citation Index (A&HCI). In this paper I use the latter two (SSCI and A&HCI).

Often in bibliometric studies the analyzed input of data, say a research field, is defined by a set of journals or papers. The research design in this paper is different, though. Here, there is no research field *a priori* which can be defined by a set of journals or papers. The approach here is more explorative and bottom-up, with the mission of finding the common ground for how authors perceive, use and interpret the spin-off concept. Thus, the body of literature investigated in this paper is defined by the set of papers that addresses the spin-off concept.

Data were collected from the Web of Knowledge database in October 2006. The spin-off search string was entered in the Title field (TI) using the advanced function of the Web of Knowledge database. Variants such as 'spin-off', 'spinoff', 'spin-out' and 'spinout' were included. Because of the design of the search function, 'spin-X' was included, where X is a wild (arbitrary) character. Thus, the resulting list had to be cleaned and the resulting dataset that was analyzed consists of 215 source articles. A number of bibliometric data were retrieved from the Web of Knowledge database: (1) identification of the source (journal title, publication year, volume and first page number); (2) names of all authors; (3) full title of the paper; (4) keywords; and (5) cited references. It is important to note, however, that the cited references only contain the first author, year of publication, journal title, volume and first page.

From this information it is possible to identify the particular publication. However, for some bibliometric analysis (author citation and co-citation analysis) only first-author information is used.

The bibliometric fields including the cited references for each identified article were exported and the bibliometric information was merged into one file. The bibliometric file was analyzed with the Bibexcel software. Bibexcel is bibliometric software developed by Professor Olle Persson at Umeå University, Sweden. I used Bibexcel version 2006-01-27. The first step was to convert the Web of Knowledge file into Bibexcel Dialog format. The resulting file is structured as follows (Table 2):

*** INSERT TABLE 2 ABOUT HERE ***

Bibexcel is then used to extract the list of references and the corresponding source papers, which produces an output of the type:

ROBERTS, EB, 1991, V20, P239, RES POLICY

The number '3' denotes the Bibexcel number of the source article. The following fields are the author with initial, publication year and source (in this case a journal name). The next step is to extract the authors from the .out file. This is done by Bibexcel in conjunction with Microsoft Excel to produce an output of the type:

ROBERTS E

Again, the number 3 refers to the source article and is used by Bibexcel to link documents to each other. Publication year and source are now deleted. First author (including the first initial) reference is now the unit of analysis, and is used in the subsequent citation and co-citation analysis. Having made a new bibliometric file containing only the link between source article and first author reference, it is possible to produce a co-occurrence (co-citation) matrix based on the reference lists of the

source articles. The co-occurrence matrix will provide data on which first author pairs are found in any two reference lists (i.e. it performs a co-citation analysis). The output has the form:

25 HITE G\$26 SCHIPPER K\$27

This means the source articles cite the Hite-Schipper pair 25 times. The number following the \$-sign denotes the citation (or occurrence) frequency that can be used to normalize the co-occurrence matrix. The paired list is exported to the network visualization software Pajek (de Nooy, Mrvar and Batagelj 2005) using the intermediate software Text2Pajek. In Pajek it is possible to apply various filters to increase ability for meaningful interpretation. One such filter is to include only links of a certain magnitude (i.e. the leftmost number in the paired list). Visualizing should aid in interpreting the data material at hand in order to meet stated objectives. Here the objective is to identify the foundations of the spin-off literature. Thus, and in line with earlier bibliometric studies (McCain 1990), a threshold of five co-citations is used for the author co-citation analysis. The Fruchterman-Reingold and the Kamada-Kawai network algorithms are applied to visualize the co-citation network. These algorithms minimize system stress in the network. In the cases of journal co-citation and keyword co-occurrence, the standardized journal name and the supplied keywords are extracted and co-occurrence matrices are produced.

Another approach to analyze bibliometric relationships between documents is to investigate how source documents cite each other – if they do, that is. The idea is to find out whether any of the source articles represent the field of subfield. To do this, the Bibexcel function “Citation among docs” is applied. The function produces a matrix of the citing documents in the first column and the cited document in the second, thus creating pairs of source papers which are connected because one of them refers to the other. Using a Bibexcel key of the following type it is possible to pair different source articles:

Chesbrough, 2003, V32, P403

Finally a Pajek file is created to visualize the network of citations between source documents.

4. RESULTS

The objective of this paper is to analyze the bibliometric structure of the spin-off literature. The analysis of the bibliometric structure is made from two perspectives. First, from a direct perspective where the source documents that make up the spin-off literature are analyzed. Second, from an indirect perspective where the documents that are cited by the source documents are analyzed. The analysis is focused on which topics are addressed in the spin-off literature, which are the leading authors and journals, and changes over time. Table 3 below relates data source, unit of analysis and bibliometric technique used.

*** INSERT TABLE 3 ABOUT HERE ***

The rest of this section on results will be organized following the type of bibliometric analysis and will be presented in this order: citations among source documents, most productive authors of source articles, most preferred journals for source articles, co-occurrence of keywords in source documents, most cited authors, most cited journals, author co-citation analysis, and finally journal co-citation analysis.

Citations among source documents

First, we need to establish whether there is 'a' spin-off literature – i.e. whether there is one, more than one, or no spin-off literature at all. The direct citation links between the source articles are analyzed in order to establish whether these documents form a coherent body of literature. Figure 1 below illustrates the citations between source papers.

*** INSERT FIGURE 1 ABOUT HERE ***

For example, if Source Paper S1 cites References R1, R2 and R3 and Source Paper S2 cites Reference R4, R5 and R1, then S1 and S2 are linked through R1. These linkages indicate some kind of common ground. By replicating this procedure for all source papers and their references, it is possible to construct a network map of all citations among source papers. This network map points to the degree of cohesiveness of all source articles. I use the citation among source papers as a test that the selected sample of source articles actually represents something which resembles a field. A random sample of source papers is less likely to generate a cohesive network based on citations among the source papers. From the figure we can conclude that most source articles are in fact connected by citation to other source papers. I interpret this in two ways. First, the sample is more field-like than a random sample. Second, the field has some properties of cumulativeness, as new papers appear to build on previous works in the field. Further analysis will delve into the details of this field.

Most productive authors of source articles

Another bibliometric method to analyze the characteristics of a body of literature is to investigate the authors of the source articles. The distribution of authors can have forms ranging from random to heavily skewed. For example, unique authors can write the majority of articles, where some fraction of the authors write more than one article; then the distribution follows from some random process. On the other hand, if a few authors write most of the articles, the distribution has non-random properties. Table 4 below lists the most productive authors of source articles.

*** INSERT TABLE 4 ABOUT HERE ***

Most source articles are written by authors who only enter the dataset once; only 23 authors (8%) contribute more than one article. There are various possible explanations for this pattern. If the distribution is fairly random (and the observed distribution has some properties of randomness), it can be explained by the following factors. First, it may be due to the fact that the spin-off literature is not a field in a traditional sense (cf. Pilkington and Liston-Heyes 1999). Rather, authors from various disciplines enter and exit, i.e. they pass the field leaving more or less imprint. Second, the field may be in an early, formative and experimental evolutionary stage, where various alternative

approaches are tested and evaluated. Third, of course, the distribution may have a selection bias in that the potential field is not fully captured with the chosen method. Nonetheless, the most productive authors have all chosen to be associated with the spin-off concept more than once. Thus, they can be said to represent core spin-off authors. Moreover, from the list of spin-off authors it is possible to discern various meanings of the spin-off concept. The top three authors, Wright, Lockett and Clarysse, are mainly associated with spin-offs in relation to universities (and they have several joint publications), whereas Chesbrough and Dahlstrand are more concerned with spin-offs in relation to firms. Kudla and McKinish provide yet another focus by writing about the valuation consequences of corporate spin-offs.

Most preferred journals for source articles

Analyzing which journals the source documents are published in also helps to characterize the body of literature of interest. In addition, this exercise will provide a first estimate of whether the spin-off concept is used with a narrow meaning in a single field or across several fields. In the next analysis, journals are used as proxies to uncover fields. Journals are assumed to have a limited scope, although there can be specialized as well as general journals. As can be seen from Table 5 below, the articles on spin-offs have been published in journals of quite different scope.

*** INSERT TABLE 5 ABOUT HERE ***

First, the largest number of articles were published in Journal of Taxation (J TAX) and the runner-up is Research Policy (RES POLICY), two quite different journals in terms of scope and audience. The former journal is specialized on the differences in and consequences of taxes. The former is broader in its scope yet focused on innovation and policy. Another striking feature is the long tail; 71 journals (67%) enter the dataset as source journals only one time. Thus, several spin-off articles are found in a few popular journals with different focus, although most articles were not published in the top journals but in the tail journals. Another observation can be made: the preferred journal for publication has changed dramatically. Research Policy, R&D Management (R&D MANAGE) and Technovation (TECHNOVATION), journals all within organization and innovation studies, only enter the list during the last time

bracket, 1996-2006. Journal of Taxation continues to be a preferred publication outlet while its relative share has diminished over time. This change may have two causes. First, new journals (such as Research Policy) have entered and drawn supporters from the original group of authors. Second, new groups of authors have entered the scene and prefer other journals for publication than previous researchers. Importantly, the latter suggest that the spin-off concept itself may be interpreted differently over time. This change is apparent from the journal publication top-list, although due to the long publication tail further analysis is needed to obtain more conclusive evidence.

Co-occurrence of keywords in source documents

Author and journal names provide some, although limited, information on the content of the source articles. By including a keyword analysis of source papers, we will hopefully acquire a more complete picture of the topics addressed in the spin-off literature. Thus, a co-occurrence analysis of keywords found in the source papers was performed. The co-occurrence of keyword network with a minimum of three co-occurrences using the Fruchterman-Reingold algorithm is depicted in Figures 2 and 3 below.

*** INSERT FIGURE 2 ABOUT HERE ***

*** INSERT FIGURE 3 ABOUT HERE ***

Two main components are identified. The two strongest components are created, in the left-most cluster, by the words ‘innovation’ and ‘start-ups’ and, in the right-most cluster, by the words ‘shareholder wealth’ and ‘announcements’. Other important keywords in the left component are ‘research and development’, ‘technology-based firms’ and ‘resource-based view’. It appears that there is a variety of topics discussed in relation to the spin-off concept. There are reasons to believe that separate discourses exist in the spin-off literature, as indicated by the clustering of topics addressed; at the same time, the literature is linked through common keywords. For example, the two main components are linked through keywords such as ‘performance’ and ‘diversification’.

Most cited authors

To delve deeper into the structure of the spin-off literature and the change over time, let us turn to citations. As discussed earlier, there are a number of reasons why an author cites other authors. First, to convince readers that one is on the right playing field. Second, to tell what has been done and what has not been done earlier, and point to areas which can be filled with new knowledge. Third, to express gratitude to others who have helped in writing the paper. In any case, by referring to a certain paper, journal or author, one indicates that it has had some impact on the writing of one's subsequent paper. Two kinds of citation analysis were carried out: author citation analysis and journal citation analysis. The analysis of citations is the first step to uncover the content and foundations of the investigated source articles. It also provides a first hint regarding what fields the spin-off papers draw upon, and which their authors wish to be associated with.

From the author citation analysis we recognize a top-list represented by Roberts, Shipper, Hite, Miles and Cooper, who all received more than 20 citations by the source papers over the observed time period (see Table 6 below). However, none of the five made the top five in all three sub-periods.

*** INSERT TABLE 6 ABOUT HERE ***

With this measure of longevity Miles is the only one that made the top five over two sub-periods. The most citations, in the most recent time period, 1996-2006, are given to Roberts and Cooper, who received the bulk of their total citations during this period.

Clearly, there has been a shift in what are the preferred references over time. The obvious interpretation of this pattern is that a reference changes either because the preferred description of a given phenomenon differs, or else because the phenomenon analyzed is distinctly different. Citation analysis, though, cannot differentiate between the two possible explanations.

Most cited journals

A pattern similar to that of the most cited authors is found when conducting the citation analysis on the journal level (see Table 7).

*** INSERT TABLE 7 ABOUT HERE ***

The difference is that one journal, the Journal of Financial Economics (J FINAC ECON), is the most cited journal in all sub-periods, and Journal of Finance (J FINAC) makes the top-five list in all sub-periods. A significant shift has occurred during the last ten years. Journals like Research Policy, Strategic Management Journal (STRATEGIC MANAGE J) and Journal of Business Venturing (J BUS VENTURING) are found in the top-five list. None of these three journals were found in the top five in the previous time periods. That is, journals representing innovation, entrepreneurship and strategy have become the most popular journals to refer to. This trend is even more evident if we turn to the twenty most cited journals. Then additional journals within these fields, as well as more general journals of organization studies, appear in the last time period: e.g. Administrative Science Quarterly (ADMIN SCI QUART), which was not cited at all in the previous time periods, and Academy of Management Journal (ACAD MANAGE J), which has almost all of its citations in the last time period. Journals such as Technovation, and Industrial and Corporate Change (IND CORP CHANGE), enter the top twenty. At the same time, some of the economics and finance journals fall behind, e.g. American Economic Review (AM ECON REV). Tax and law journals almost seem obliterated.

To conclude, the spin-off literature has indeed changed over time in terms of both author references and journal references.

Author co-citation analysis

A more advanced method is co-citation analysis. From the author co-citation analysis it is possible to grasp the relationship between citations and thus to uncover their structural properties. In Figure 4 below, I have used co-cited pairs of references as inputs in a network analysis, where all co-cited pairs are linked to each other. To make these co-occurrence networks, I have used Pajek (de Nooy et al. 2005), a

network analysis software which uses the input pairs to produce network pictures. Pajek models the system as a spring-embedded system and tries to minimize total system stress; thus units which co-occur often tend to gravitate towards the center of the network. In the co-citation figure below, I have used the Fruchterman-Reingold algorithm to minimize system stress. The size of each author vertex is proportional to the number of times it is co-cited, and the thickness of the arc between vertices is proportional to the strength of the cited pair (i.e. the number of co-citations).

*** INSERT FIGURE 4 ABOUT HERE ***

From the citation analysis earlier, we recall that Roberts and Schipper were the most cited. In other words, we could conclude that these authors were of particular importance for the development of the spin-off literature. However, we could say nothing about whether these authors treated the same phenomenon or the relationship between them. In the co-citation analysis, on the other hand, this is what we can begin to do. From Figure 4 below, we can clearly see that both Roberts and Schipper are central authors – but in separate networks. There is also a strong link between Roberts and Cooper as well as Schipper and Hite, i.e. the most and second most cited in each sub-network. It should be pointed out that the two networks in Figure 3 are not strictly decoupled as they appear to be in the figure. To increase the interpretability, only co-citation strengths of minimum 5 are included. This means that there are in fact links between the major network components, however weak. Thus, the two major network components correspond to quite distinct discourses. The right-most network component, where Roberts, Cooper, Shane and Radosevich are central, corresponds to an entrepreneurship/innovation spin-off cluster. The leftmost network component, where Schipper, Hite, Miles and Jensen are central, corresponds to a financial spin-off cluster. Moreover, it seems that the entrepreneurship/innovation cluster is heavily influenced by resource-based theory, as Penrose, Barney, Wernerfeldt and Teece are parts of this network component. The resource-based references are linked to other strategy references such as Porter, Prahalad and Christensen. Interestingly, the strategy references seem to gravitate towards the financial cluster to the left. Indeed, if co-citations of lesser strength than five are counted (the threshold level used in the

figure), the two main components are linked. The strategy literature then bridges the central parts of the two main components.

Journal co-citation analysis

Journal co-citation analysis is complementary to author co-citation analysis in two ways. First, it provides a robustness test of the first analysis, as it gives an opportunity to see whether the same two components, entrepreneurship/innovation and finance, are replicated when the unit of analysis is altered. Second, it may aid in the interpretation of citation links, as journals may carry field-specific information. In Figure 5 below, the journal co-citation network is depicted using the Kamada-Kawai algorithm.

*** INSERT FIGURE 5 ABOUT HERE ***

As in the case of the author co-citation network, two main network components are found. Again, the left-most component represents finance, and the right-most component entrepreneurship/innovation although quite diverse, as its main sub-component appears to be general management theory in the form of *Administrative Science Quarterly*, *Academy of Management Journal*, *Academy of Management Review*, *Organization Science*, and *Management Science*. Another strong sub-component is represented by *Research Policy* and *Journal of Business Venturing*, which together can be said to represent entrepreneurship, innovation and science policy.

The results from the journal co-citation analysis corroborate the results from the author co-citation analysis and the keyword analysis. Two main components are found: one is associated with finance, and the other with entrepreneurship/innovation influenced by the resource-based view of the firm.

5. CONCLUSIONS AND IMPLICATIONS

This paper was inspired by empirical observations that came from reading articles about the spin-off phenomenon: the widespread use of the concept, the often not so obvious theoretical underpinnings, and the fact that multiple meanings and

interpretations appeared to exist. To recapitulate, the concept of ‘spin-offs’ has generated much interest both in the academic literature and in policy debates due to the perceived importance for innovation and economic renewal. At the same time, when reading academic articles, one is struck by the diversity and lack of definitions of the concept itself, as well as the multiple interpretations of the relevance of the spin-off phenomenon. This is not necessarily a problem. The layman’s observations may be explained by a possibility that scholars from various fields use the spin-off concept with different meanings and interpretations. The lack of definition could also be due to commonly understood definitions in the field, whereby each article does not need to spend time and effort in replicating common knowledge. In that case, however, when all of the studies analyze and address the same underlying concept, in normal science (Kuhn, 1970) it would be possible to observe the cumulativeness of conducted research and the subsequent emergence of standard references to indicate field agreement. If, on the other hand, literature were not addressing the same underlying concept, there would be no field-specific learning but rather separate discourses. Another reason for lack of definition is, of course, that no definition exists, so that ad-hoc definitions are preferred. We could also think of a concept in search of a definition, in which case we would expect several rival as well as complementary interpretations of the spin-off concept. A bibliometric analysis is one way to systematize and hopefully uncover some of the structure of the spin-off literature. The longitudinal dataset developed in this paper allows me to address whether core definitions and interpretations have been launched through central articles, as well as to investigate the linkages amongst specific authors, journals, and research communities.

The results are inconclusive as to whether the spin-off literature has become an independent field. For a concept that has received great attention in the policy debate, it appears that there are few dedicated articles which explicitly deal with the concept. Most authors contribute only one source article while a handful write three or more articles, which suggests that the spin-off field is populated by a large group of authors who enter and then quickly exit, never to return. This leads to a situation where the community redefines the concept continually, rather than using one core definition. However, a network analysis does reveal some core literature, which unites different sub-components.

First, there are two main scientific fields which the spin-off literature draws upon: the financial field, and the entrepreneurship/innovation field. This pattern is supported by similar results from the co-occurrence of keyword analysis as well as from the author and journal co-citation analysis. The entrepreneurship/innovation field relates the spin-off phenomenon to innovation, start-ups, research and development, and technology. The financial field has a quite different focus as it relates the spin-off phenomenon to shareholder wealth and stock markets. In their treatments of the spin-off phenomenon, the two fields are linked in areas concerning performance and diversification. The bridging function of the strategy literature is supported by this observation, and by the fact that well-known strategy authors are represented in both the entrepreneurship/innovation field and the financial field. In addition, the spin-off concept is used in the taxation literature. However, as the taxation articles are not equipped with a list of references, it is impossible by bibliometric co-occurrence techniques to grasp their links and contributions to other parts of the spin-off literature.

Second, it appears that the entrepreneurship/innovation field is influenced by the resource-based view of the firm, evolutionary theory and an emerging entrepreneurship literature. However, the link to classic literature in economics of innovation, such as Dosi, Freeman and Pavitt, is less pronounced than what is perhaps expected. The evolutionary character of innovation is nonetheless supported by links to Nelson and Aldrich. The centrality of quite empirical references such as Roberts and Cooper gives reason to suspect that the spin-off literature may draw on work which does not necessarily help the conceptual understanding of the spin-off phenomenon.

Third, over time the focus has shifted in favor of the entrepreneurship/innovation literature. Fourth and finally, the study also contributes to the bibliometric field in its application of network analysis. For example, the question of centrality is a key in network analysis and has important implications for bibliometrics as well. An object can be central in several ways, e.g. by being linked to many other objects (what we often consider as central). However, in network terms, an object can be central by means of linking other components to each other, i.e. lying 'on the road between' many other objects. In this paper we observe that the strategy literature seems to be

positioned in the latter way by linking the two main components, finance and entrepreneurship/entrepreneurship.

The results are perhaps not entirely surprising to someone well grounded in spin-off discourse. However, if bibliometric analysis enables us to replicate results from qualitative assessment, then we have made methodological progress. Thus, bibliometrics should be seen as complementary to traditional reading and interpretation of a given body of literature. In addition, we have provided a starting point for truly conceptual advances by pointing to the commonalities in terms of both strong and weak links that do exist in the spin-off literature.

This study is of course not without limitations. An obvious limitation is in how the spin-off literature is operationalized. It is clear that the method does not capture all papers addressing the spin-off concept. Instead I opted for a method that met the following two criteria. First, the method should be able to identify papers which with great probability address the spin-off concept. This criterion should work in favor of a more narrow definition of the spin-off concept. Second, there was need to introduce some variance in the sample in order to identify connections and patterns. The choice to operationalize the spin-off literature by means of articles with spin-off in the title met these two criteria. The authors of source articles had made conscious choices to use the spin-off concept. At the same time, there was great variance in the types of references used. Indeed this method limits the ground for the claim that the spin-off community redefines the concept continually because most authors only contributed one source article. Still, by means of co-citation analysis it is difficult to see that the spin-off literature should have developed into a field of its own. However, to increase the quality of such a claim, an appealing future path would be to consider how other literatures, beyond the spin-off literature, treat the spin-off literature in terms of citations.

To conclude, this paper has been explorative in nature, and has demonstrated that the spin-off literature is diverse in its bibliometric structure – although there are several commonalities, suggesting that the research community may in fact address the same underlying phenomenon. Exactly how the spin-off concept is defined is beyond the scope of a bibliometric method. However, the paper has provided evidence on which authors in specific scientific fields should be studied in more detail in order to conclude how the spin-off concept is defined in the spin-off literature.

Finally, I suggest that the spin-off literature stands at a crossroads where the spin-off concept can develop into one of the following: either into a distinct and generally agreed concept, which enables the researcher to address questions such as the ‘importance’ or ‘effect’ of the spin-off phenomenon; or into a broader concept with multiple interpretations, which allows the researcher to address challenging questions somewhere along the lines of innovation and the changing boundaries of the firm.

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TABLES AND FIGURES

Table 1. Definitions of spin-off

Reference	Definition of spin-off firm
Chesbrough (2002)	A new firm created to commercialize technologies from an established firm.
Chesbrough (2003)	A new firm created to commercialize research discoveries outside the main business of an established firm
Kudla and Mcinish (1981)	A new firm created when a parent firm distributes all the capital stock of a wholly owned subsidiary to its shareholders.
Lindholm Dahlstrand (1997a,b)	A new organization formed when an entrepreneur leaves a company to start a new firm on his own and must include the transfer of some rights from the existing legal body to the new firm
Parhankangas and Arenius (2003)	A new firm based on business ideas developed within a parent firm, where the establishment was initiated or allowed by the parent firm.
Rose and Ito (2005)	A new firm created when parts of the capital stock of a division of an established firm are transferred to the stockholders and the parent firm retains the rest.
Seward and Walsh (1996)	A new firm created when the existing asset base of a corporation is divided into two or more separate parts and where the current shareholders receive a pro rata distribution of separate equity claims on the assets of each new corporate entity.
Woo et al. (1992)	A new firm created when an established firm distributes all of the common stock it owns in a controlled subsidiary to its existing shareholders.
Wright, Lockett, Clarysse and Binks (2006)	A new firm created by the formal transfer of intellectual property rights from a university and in which the university holds an equity stake

Table 2. Bibliometric source file

PT- J|

AU- Chesbrough H|

TI- The governance and performance of Xerox's technology spin-off companies|

SO- RESEARCH POLICY|

LA- English|

DT- Article|

DE- technology spin-offs; governance; complementary assets|

ID- INTERNAL CAPITAL-MARKETS; VENTURE CAPITALISTS; CORPORATE; FIRM; COLLABORATION; CAPABILITIES; INTEGRATION; SUCCESSION|

AB- Companies that conduct internal research cannot fully specify the output from that research in advance. Inevitably, spillovers may result. A company might choose to create a technology spin-off company to realize value from such research spillovers. But how is such a spin-off to be governed? Effective spin-off governance structures in a highly uncertain environment must promote experimentation and adaptation, in order to unlock the latent value in a technology. These can conflict with structures intended to manage coordination with the parent firm's complementary assets This paper analyses 35 spin-off organizations that arose from the Xerox Corporation. Xerox's own initial equity position is negatively correlated with the subsequent performance of its spin-offs, but this is due not to their equity per se, but Xerox's practices in managing its spin-offs. Spin-offs with a higher percentage of venture capital investors on their Boards were associated with higher financial performance, while spin-offs with a Xerox insider as CEO were associated with lower financial performance. Qualitative interview data suggest that Xerox's practices caused its spin-offs to search locally near Xerox's own business, while spin-offs governed by outside investors' practices searched a broader space for commercializing their technologies. (C) 2002 Elsevier Science B.V. All rights reserved|

CI- Harvard Univ, Sch Business, Boston, MA 02163 USA|

RP- Chesbrough, H, Harvard Univ, Sch Business, Morgan Hall T-35,10 Soldiers Field, Boston, MA 02163 USA|

CD- AKERLOF GA, 1970, V84, P488, Q J ECON; AMRAM M, 1999, REAL OPTIONS MANAGIN; BARNEY J, 1989, P64, ACAD MANAGEMENT P; BHIDE A, 1992, V70, P109, HARVARD BUS REV; BLOCK Z, 1993, CORPORATE VENTURING; BOWER J, 1970, MANAGING RESOURCE AL; BRUDERL J, 2000, V30, P45, INT J SOCIOLOGY; BURGELMAN RA, 1983, V28, P223, ADMIN SCI QUART; BURGELMAN RA, 1983, V29, P1349, MANAGE SCI; CHESBROUGH H, 2000, V42, P31, CALIF MANAGE REV; CHESBROUGH H, 2002, IN PRESS IND CORPORA; CHESBROUGH HW, 1996, P65, HARVARD BUSINESS JAN; CHESBROUGH HW, 1999, V8, P447, IND CORP CHANGE; CHESBROUGH HW, 2002, IN PRESS BUSINESS HI; CHRISTENSEN C, 1997, INNOVATORS DILEMMA; DALTON DR, 1985, V28, P749, ACAD MANAGE J; EISENHARDT KM, 2000, V21, P1105, STRATEGIC MANAGE J; GARVIN DA, 1983, V25, P3, CALIF MANAGE REV; GAVETTI G, 2000, V45, P113, ADMIN SCI QUART; GERTNER RH, 1994, V109, P1211, Q J ECON; GOMPERS P, 1998, P99, UNPUB DETERMINANTS C; HELLMAN T, 1996, THEORY CORPORATE VEN; JAFFE AB, 1993, V108, P577, Q J ECON; JENSEN MC, 1993, V48, P831, J FINANC; LAMONT O, 1997, V52, P83, J FINANC; LEE C, 2001, V22, P615, STRATEGIC MANAGE J; LERNER J, 1995, V50, P301, J FINANC; MACMILLAN IC, 1989, V4, P27, J BUS VENTURING; MAULA M, 2000, AC MAN TOR CAN; PISANO G, 1997, 97105 HARV BUS SCH; ROBERTS EB, 1980, V58, P134, HARVARD BUS REV; SAHLMAN W, 1990, V26, P473, J FINANC ECON; SAPIENZA HJ, 1992, V7, P9, J BUS VENTURING; SCHARFSTEIN D, 1996, UNPUB DARK SIDE INTE; SHIN HH, 1998, V113, P531, Q J ECON; SILVERMAN B, 1999, V458, P1109, MANAGE SCI; SORRENTINO M, 1995, V10, P59, J BUS VENTURING; STEIN JC, 1997, V52, P111, J FINANC; TAGGART RA, 1987, V10, P177, J FINANC RES; TEECE DJ, 1986, V15, P285, RES POLICY; TRIGEORGIS L, 1996, REAL OPTIONS MANAGER; TUSHMAN M, 1997, WINNING INNOVATION; VONHIPPEL E, 1973, UNPUB EXPLORATORY ST; WESTPHAL JD, 1999, V42, P7, ACAD MANAGE J; ZAJAC EJ, 1990, V11, P217, STRATEGIC MANAGE J|

NR- 45|

TC- 3|

PU- ELSEVIER SCIENCE BV|

PI- AMSTERDAM|

PA- PO BOX 211, 1000 AE AMSTERDAM, NETHERLANDS|

SN- 0048-7333|

J9- RES POLICY|

JI- Res. Policy|

PD- MAR|

PY- 2003|

VL- 32|

IS- 3|

BP- 403|

EP- 421|

PG- 19|

SC- Management; Planning & Development|

GA- 643GN|

JN- RESEARCH POLICY, 2003, V32, N3, P403-421|

UT- ISI:000180853700005 ER ||

Table 3. Bibliometric analysis of authors, journals and keywords

Data source	Source documents (direct impact)		Cited documents (indirect impact)	
	<i>Count</i>	<i>Relational</i>	<i>Count</i>	<i>Relational</i>
Unit of analysis				
Keyword	No	Keyword co-occurrence	No	No
Change over time	No	No	No	No
Author	Most productive authors	Citations among source documents	Most cited authors	Author co-citation
Change over time	No	No	Yes	No
Journal	Most preferred journals	No	Most cited journals	Journal co-citation
Change over time	Yes	No	Yes	No

Table 4. Most productive authors of source articles

Count	Author ²
6	WRIGHT M
6	LOCKETT A
3	CLARYSSE B
3	CHESBROUGH H
3	KUDLA R
3	MCINISH T
2	KLOFSTEN M
2	SURLEMONT B
2	MORAY N
2	BLOOM G
2	HITE G
2	JACOBS R
2	DAHLSTRAND A
2	PIRNAY F
2	GREENE R
2	ALLEN J
2	OWERS J
2	ROGERS E
2	CHIANG J
2	MCCONNELL J
2	OLKEN H
2	FONTES M
2	PARHANKANGAS A

² All authors count, thus in the case of co-authorship all authors enter the list.

Table 5. Raw journal publication counts

Rank	Journal	1957-2006 N=215	1957-1985 N=75	1986-1995 N=42	1996-2006 N=98
1	J TAX	32	21	2	9
2	RES POLICY	11	0	1	10
3	R D MANAGE	7	0	1	6
4	FORTUNE	6	0	3	3
5	J FINAN	6	3	1	2
6	TECHNOVATION	6	0	0	6
7	BETRIEBSWIRTSCH FORSCH PRAX	5	1	0	4
8	J BUS VENTURING	5	0	1	4
9	J FINAN ECON	5	2	1	2
10	CALIF MANAGE REV	4	4	0	0
11	J BUS	4	0	0	4
12	J CORP TAX	4	1	3	0
13	ECON HIST REV	3	3	0	0
14	FORBES	3	0	0	3
15	HARVARD BUS REV	3	3	0	0
16	LONG RANGE PLANN	3	1	1	1
17	TAXES	3	1	2	0

Table 6. Most cited first authors

1957-2006		1957-1985		1986-1995		1996-2006	
Citation count	First author	Citation count	First author	Citation count	First author	Citation count	First author
34	ROBERTS E	7	JACOBS	11	HITE G	32	ROBERTS E
27	SCHIPPER K	6	BITTKER B	11	MILES J	17	COOPER A
26	HITE G	6	COHEN	11	SCHIPPER K	15	SHANE S
26	MILES J	5	BOUDREAUX K	5	GALAI D	15	SMILOR R
21	COOPER A	5	FAMA E	5	JENSEN M	13	MILES J
17	SMILOR R	5	GREGORY	4	ALEXANDER G	13	TEECE D
15	SHANE S	5	MANDELKER G	4	KUDLA R	12	BARNEY J
15	TEECE D	4	BROMBERG	4	LINN S	12	HITE G
14	JENSEN M	4	HELVERING	4	ROSENFELD J	12	KRISHNASWAMI S
12	BARNEY J	4	KUMMER D	3	ALIC J	12	SCHIPPER K
12	CUSATIS P	4	LOSS L	3	ASQUITH P	11	COHEN W
12	EISENHARDT K	4	PALMER	3	BITTKER B	11	DALEY L
12	KRISHNASWAMI S	4	SCHIPPER K	3	BROWN S	11	EISENHARDT K
12	RADOSEVICH R	4	SHARPE W	3	JAIN P	11	ETZKOWITZ H
11	COHEN W	3	BROWN S	3	KAPLAN S	11	MUSTAR P
11	DALEY L	3	DODD P	3	NELSON R	11	RADOSEVICH R
11	ETZKOWITZ H	3	GALAI D	2	ARROW K	11	SIEGEL D
11	GALAI D	3	HITE G	2	COHEN	10	ALDRICH H
11	MUSTAR P	3	JENSEN M	2	COOPER A	10	CARAYANNIS E
11	NELSON R	3	LYONS	2	COPELAND T	10	CUSATIS P
11	PENROSE E	3	MYERS S	2	CUSATIS P	10	PENROSE E
11	SIEGEL D	3	OWERS J	2	DAVID P	10	SAXENIAN A
10	ALDRICH H	3	SCHIEF	2	DENNIS D	9	CLARYSSE B
10	BITTKER B	3	TREBILCOCK C	2	DODD P	9	DAHLSTRAND A
10	CARAYANNIS E	3	WELLES J	2	EADES K	9	DESAI H
10	PORTER M	2	ALBERTS W	2	FAMA E	9	GRANT R
10	SAXENIAN A	2	AMOROSO V	2	FRUHAN W	9	JONESEVANS D
9	BROWN S	2	BAIN J	2	GRINBLATT M	9	WOO C

9	CLARYSSE B	2	BENOIT E	2	HERTZEL M	8	AUTIO E
9	DAHLSTRAND A	2	BITTKER	2	JOHN T	8	BURGELMAN R
9	DESAI H	2	BONSALL	2	KLEIN A	8	CHIESA V
9	FAMA E	2	BORDEN	2	LANG L	8	LOCKETT A
9	GRANT R	2	BRADLEY M	2	LELAND H	8	NELSON R
9	JONESEVANS D	2	BRYAN J	2	LICHTENBERG F	8	ZAHRA S
9	ROSENFELD J	2	BULOW J	2	MARAIS L	7	BERGER P
9	WOO C	2	BURNET	2	MODER J	7	BRAY M
8	AUTIO E	2	CAPLIN	2	MODIGLIANI F	7	DIGREGORIO D
8	BURGELMAN R	2	CARLBERG	2	MYERS S	7	FRANKLIN S
8	CHIESA V	2	CHOATE	2	NANDA V	7	GRANOVETTER M
8	COHEN	2	COOPER A	2	PORTER M	7	KLOFSTEN M
8	KUDLA R	2	CORDES	2	RAVENS CRAFT D	7	MOWERY D
8	LOCKETT A	2	CUMMINGS D	2	RUBACK R	7	PARRINO R
8	MOWERY D	2	CURTIS	2	SAPOLSKY H	7	PORTER M
8	SMITH C	2	DANN L	2	SCHNEE J	7	RAJAN R
8	ZAHRA S	2	GIBSON	2	SHLEIFER A	7	STEFFENSEN M
7	BERGER P	2	HAKANSSON N	2	SMILOR R	7	WERNERFELT B
7	BRAY M	2	HALLIBURTON	2	SMITH C	6	BIRLEY S
7	DIGREGORIO D	2	HALPERN P	2	TEECE D	6	CHESBROUGH H
7	DODD P	2	HANAN M	2	WILLIAMSON O	6	JENSEN M
7	FRANKLIN S	2	HATSCHEK R			6	OLOFSSON C
7	GRANOVETTER M	2	HOGARTY T			6	RAPPERT B
7	JACOBS	2	HOLLOMAN J			6	SAMSOM K
7	KLOFSTEN M	2	KERR B			6	SCHARFSTEIN D
7	MYERS S	2	KIM E			6	STANKIEWICZ R
7	PARRINO R	2	KUDLA R			6	STOREY D
7	RAJAN R	2	LANGETIEG T			6	VOHORA A
7	STEFFENSEN M	2	MASSEE			6	WRIGHT M
7	WERNERFELT B	2	MELICHER R			6	ZUCKER L
7	WILLIAMSON O	2	MERTENS J			5	AGRAWAL A
6	BIRLEY S	2	MILES J			5	ALLEN J
6	BOUDREAUX K	2	MINTZ			5	BRUDERL J

6	CHESBROUGH H	2	MUELLER D	5	CHRISTENSEN C
6	COPELAND T	2	OLKEN H	5	DOUTRIAUX J
6	DOUTRIAUX J	2	ORLANSKI	5	FONTES M
6	HANNAN M	2	PENNELL	5	GILSON S
6	JOHN T	2	RANK	5	GRAHAM J
6	OLOFSSON C	2	ROBERTS E	5	HANNAN M
6	RAPPERT B	2	SARGENT	5	HENDERSON R
6	SAMSOM K	2	SCHOLES M	5	LEE C
6	SCHARFSTEIN D	2	SEALY	5	LERNER J
6	SHLEIFER A	2	SHAIMAN	5	MEYER M
6	STANKIEWICZ R	2	SIMON	5	MIAN S
6	STOREY D	2	SMITH C	5	NICOLAOU N
6	THOMPSON J	2	SOLO R	5	OAKY R
6	VOHORA A	2	SOMMER	5	PRAHALAD C
6	WRIGHT M	2	SOWARDS H	5	ROSENFELD J
6	ZUCKER L	2	SPANGLER C	5	THOMPSON J
5	AGRAWAL A	2	WESTON F	5	THURSBY J
5	ALEXANDER G	2	WHEAT	5	VIJH A
5	ALLEN J	2	WHITESIDE	5	VONHIPPEL E
5	ARON D	2	WILLENS R	5	WILLIAMSON O
5	ARROW K	2	YOUNG	5	YIN R
5	BRUDERL J			4	AMIT R
5	CHRISTENSEN C			4	ARON D
5	FONTES M			4	BRUSH C
5	GILSON S			4	BURT R
5	GRAHAM J			4	CONNER K
5	GREGORY			4	COPELAND T
5	HENDERSON R			4	DASGUPTA P
5	KLEIN A			4	DEGROOF J
5	LEE C			4	DENIS D
5	LERNER J			4	DIMAGGIO P
5	LINN S			4	DITTMAR A
5	MANDELKER G			4	DORFMAN N

5	MCQUEEN D	4	FOMBRUN C
5	MEYER M	4	FRANKEWITSCH T
5	MIAN S	4	GARVIN D
5	NICOLAOU N	4	GERTNER R
5	OKEY R	4	GLASER B
5	PRAHALAD C	4	GOMPERS P
5	ROGERS E	4	HAIR J
5	ROSENBERG N	4	HARMON B
5	ROTHWELL R	4	ITO K
5	SCHOLES M	4	JOHN T
5	SLOVIN M	4	KAZANJIAN R
5	THURSBY J	4	KENNEY M
5	VIJH A	4	KLEPPER S
5	VONHIPPEL E	4	LAMBERT R
5	YIN R	4	LIEBESKIND J
		4	LINDHOLM A
		4	LOWE J
		4	MASON C
		4	MCQUEEN D
		4	MILES M
		4	NDONZUAU F
		4	PIRNAY F
		4	ROGERS E
		4	ROSENBERG N
		4	ROTHWELL R
		4	SCHUMPETER J
		4	SHLEIFER A
		4	SLOVIN M
		4	SMITH C
		4	STINCHCOMBE A
		4	TUSHMAN M
		4	VENKATARAMAN S
		4	WRUCK E

Table 7. Most cited journals

1957-2006		1957-1985		1986-1995		1996-2006	
Citation count	Journal	Citation count	Journal	Citation count	Journal	Citation count	Journal
267	J FINANC ECON	50	J FINANC ECON	61	J FINANC ECON	156	J FINANC ECON
170	J FINANC	13	TAX L REV	40	J FINANC	131	RES POLICY
136	RES POLICY	10	HARVARD L REV	9	TAX NOTES	129	STRATEGIC MANAGE J
135	STRATEGIC MANAGE J	9	J FINANC	7	AM ECON REV	121	J FINANC
121	J BUS VENTURING	9	TAXES	6	ACAD MANAGE J	117	J BUS VENTURING
85	ADMIN SCI QUART	8	BUS LAW	6	STANFORD LAW REV	85	ADMIN SCI QUART
58	ACAD MANAGE REV	7	VA L REV	6	STRATEGIC MANAGE J	56	ACAD MANAGE REV
57	R&D MANAGE	5	BUS HIST	5	RES POLICY	54	R&D MANAGE
49	ACAD MANAGE J	5	ECON HIST REV	4	ENTREPRENEURSHIP REG	47	TECHNOVATION
47	TECHNOVATION	5	J APPL PSYCHOL	4	J BUS VENTURING	43	ACAD MANAGE J
45	MANAGE SCI	4	BC IND COM L REV	4	J LAW ECON	43	ORGAN SCI
43	ORGAN SCI	4	CORPORATE LAW PRACT	4	YALE LAW J	42	MANAGE SCI
40	J TECHNOL TRANSFER	4	LAW FEDERAL INCOME T	3	AM J PUBLIC HEALTH	39	J TECHNOL TRANSFER
28	AM ECON REV	4	SECURITIES REGULATIO	3	ENTREP REGION DEV	27	SMALL BUS ECON
27	SMALL BUS ECON	4	TC	3	FINANC MANAGE	25	J MANAGE
25	J MANAGE	3	HOW LJ	3	HARVARD L REV	20	IND CORP CHANGE
21	J FINANC QUANT ANAL	3	J FINANCIAL QUANTITA	3	J PUBLIC ECON	19	AM ECON REV
20	AM SOCIOL REV	3	J TAX	3	PHOTOGRAMM ENG REM S	19	AM SOCIOL REV
20	IND CORP CHANGE	3	NYU 12TH I FED TAX	3	REV ECON STUD	19	INT J TECHNOL MANAGE
20	INT J TECHNOL MANAGE	3	R&D MANAGE	3	TECHNOL SOC	19	J FINANC QUANT ANAL
19	REG STUD	3	YALE LAW J	2	ACAD MANAGE REV	17	REG STUD
18	ENTREP REGION DEV	2	ACCOUNT REV	2	ADV FINANCIAL PLANNI	15	AM J SOCIOL
17	J BUS	2	AM ECON REV	2	AM J EPIDEMIOLOG	15	ENTREP REGION DEV
16	FINANC MANAGE	2	CAN J PSYCHIAT NURS	2	BELL J ECON	14	HARVARD BUS REV
16	HARVARD BUS REV	2	CASE W RES L REV	2	CALIF MANAGE REV	14	J BUS
16	HARVARD L REV	2	HOUSTON L REV	2	ECONOMICA	14	J MARKETING
15	AM J SOCIOL	2	J BUS	2	FLA ST U L REV	14	SCI PUBL POLICY

15	J MARKETING	2	J IND ECON	2	HARVARD BUS REV	13	FINANC MANAGE
15	Q J ECON	2	JAMA-J AM MED ASSOC	2	IEEE T ENG MANAGE	12	Q J ECON
14	CALIF MANAGE REV	2	KAN L REV	2	IND L REV	11	CALIF MANAGE REV
14	SCI PUBL POLICY	2	Q J ECON	2	INT ECON REV	11	ENTREP THEORY PRACT
13	BUS LAW	2	T SOC ACTUARIES	2	J BROADCAST ELECTRON	11	IEEE T ENG MANAGE
13	IEEE T ENG MANAGE	2	U PA L REV	2	J COMMUN	11	J PROD INNOVAT MANAG
13	RAND J ECON	1	BELL J ECON	2	J FINANC QUANT ANAL	11	RAND J ECON
13	TAX L REV	1	BETRIEBSWIRTSCHAFT	2	MANAGE SCI	9	ECON J
11	ENTREP THEORY PRACT	1	BRIT J MARKETING	2	Q EC COMMENTARY	9	INT J IND ORGAN
11	J PROD INNOVAT MANAG	1	BTA	2	RAND J ECON	8	ECONOMETRICA
10	ECON J	1	BUL REV	2	REG STUD	8	J ACCOUNT ECON
10	INT J IND ORGAN	1	CALIF MANAGE REV	2	REV BUS ECON RES	8	J ECON BEHAV ORGAN

Figure 1. Citation among source documents. Fruchterman-Reingold.

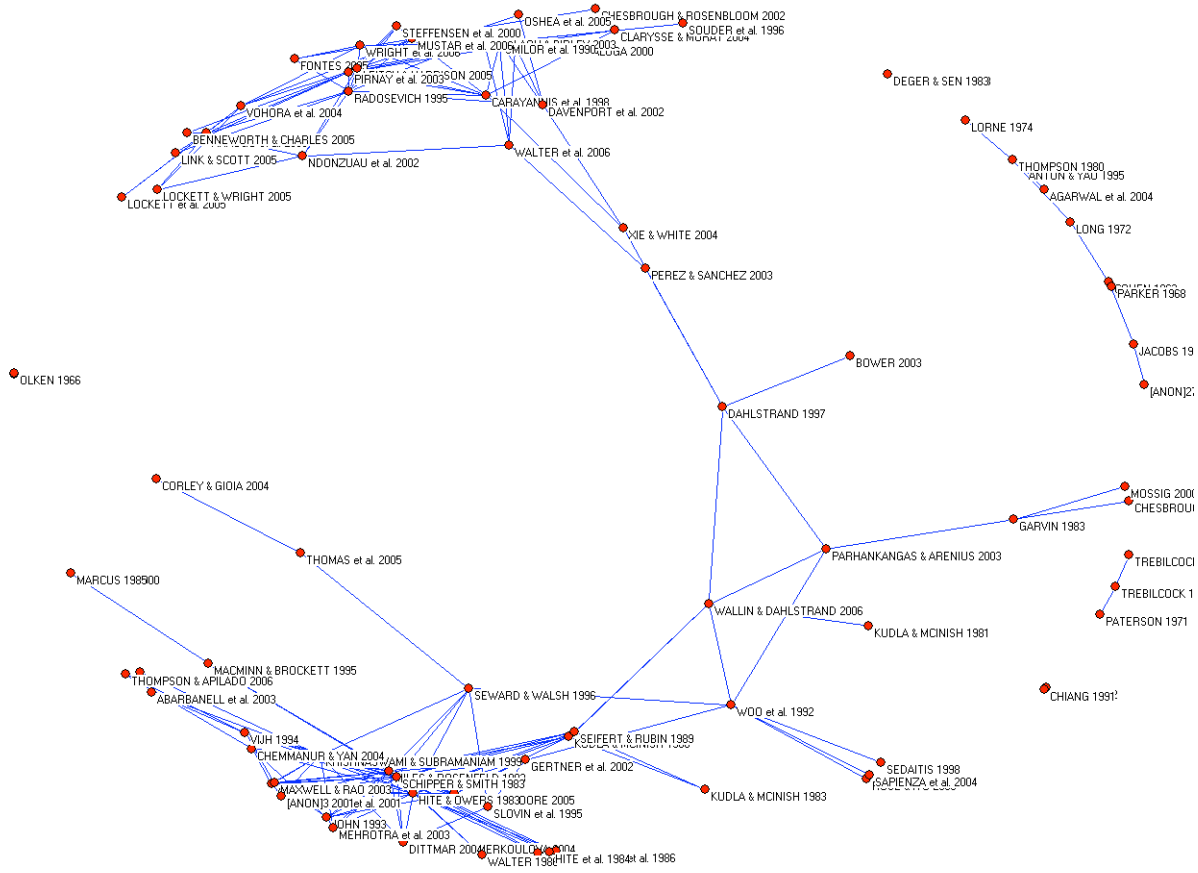


Figure 2. Co-occurrence of keyword network. (min 2). Summed up values. Fruchterman-Reingold.

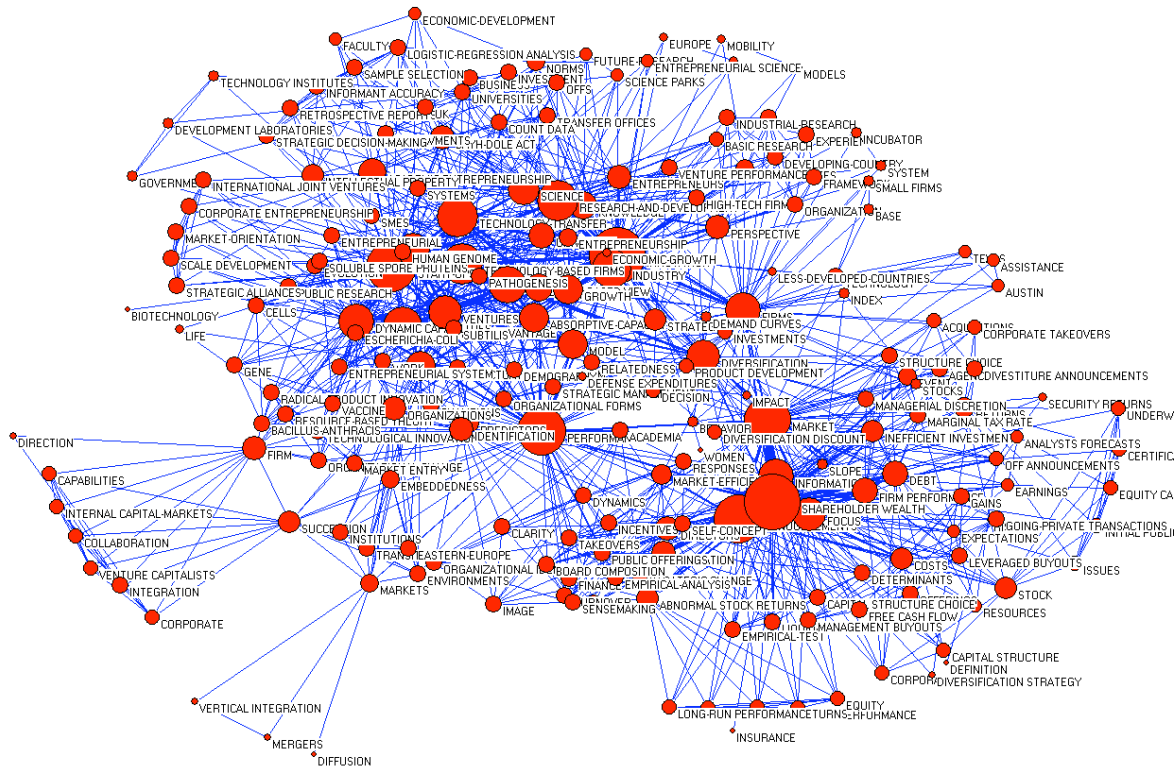


Figure 3. Co-occurrence of keyword network (min 3). Summed up values. Fruchterman-Reingold.

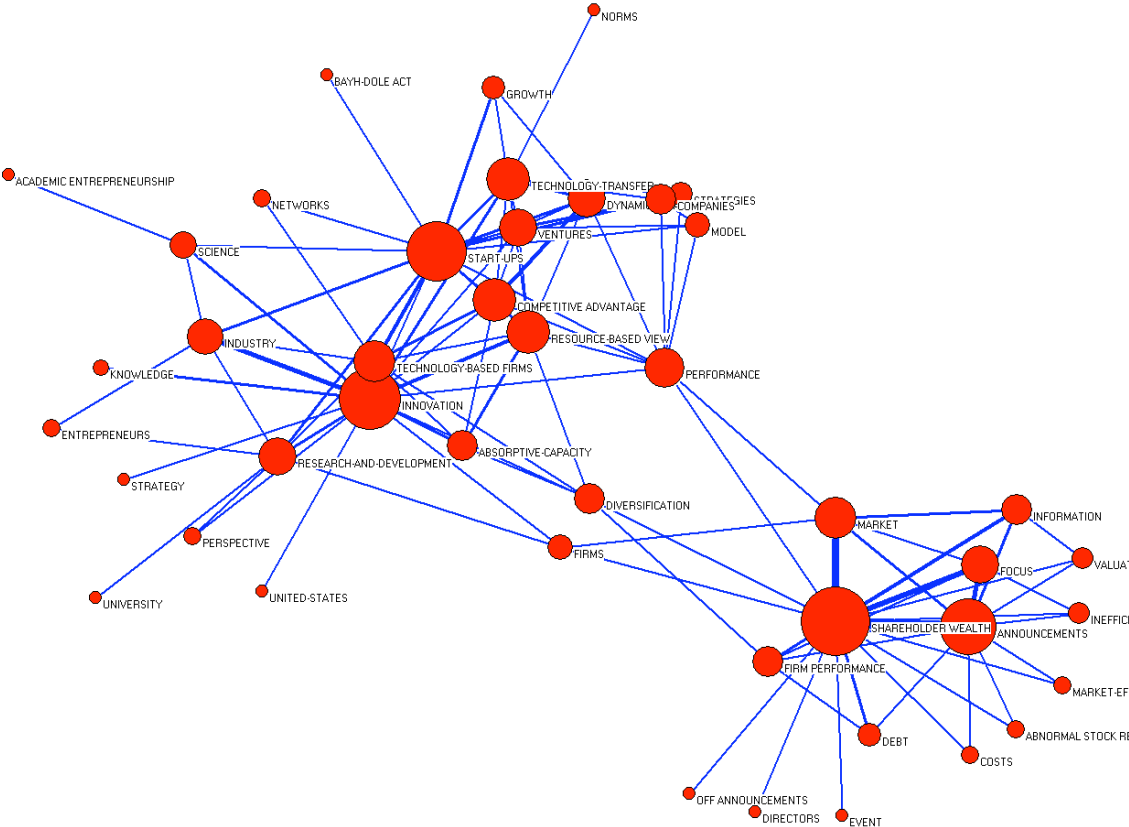


Figure 4. Author co-citation network (min 5 co-citations) 1957-2006. Fruchterman-Reingold.

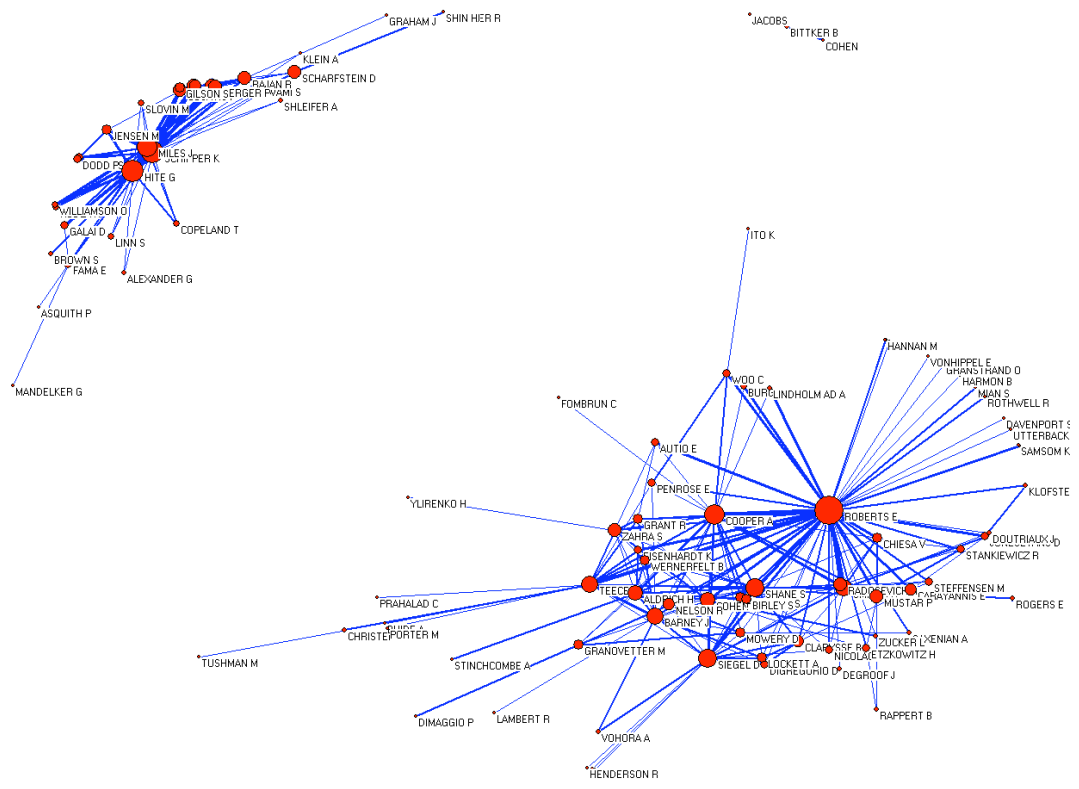
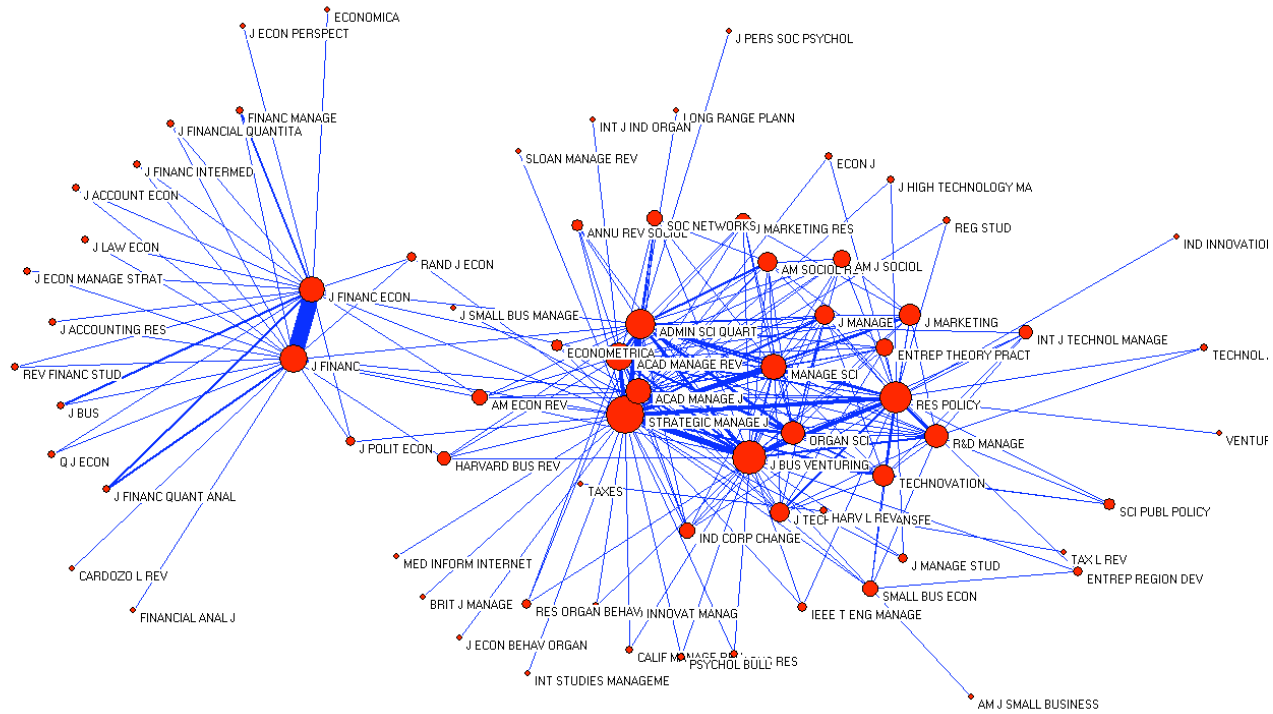


Figure 5. Journal co-citation network. Kamada-Kawai.



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