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Searching for 'invisible colleges' in the Entrepreneurship literature

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Abstract

The explosion of entrepreneurship scholarship aroused the need to measure scientific production (namely through bibliometric and scientometric approaches) in the field and to understand the scientific structure of this same field. Underlying the scientific structure of a field is the network of informal communicational linkages established between the most influential scholars within that area. These groups of mutually interacting and prolific scientists that exchange knowledge through communication channels are named "invisible colleges".

In spite of the (increasing) academic interest on entrepreneurship subjects and area, invisible colleges, per se, have not been thoroughly investigated. Thus, in the present study we performed a two staged analysis to discover if there are invisible colleges in the field of entrepreneurship. First, we conduct a bibliometric analysis on three "seed" journals of the field: Entrepreneurship Theory and Practice (ETP); Journal of Business Venturing (JBV) and Small Business Economics (SBE). Resorting to the citation bibliometric technique we identify the most cited authors, studies and journals of each "seed" journal and characterize their intellectual scientific structure. Second, we executed a comprehensive analysis on the most influential authors, based on their professional affiliation and educational training, in order to map the informal links between the most cited authors.

Empirical evidence confirms the existence of two invisible colleges in entrepreneurship research: one, directed to broad entrepreneurship issues and associated with ETP and JBV, and the other, economic-oriented and related with JBV. Specifically, results show that ETP and JBV have similar intellectual bases, associated with the research area targeting specially to entrepreneurship, while SBE differs from the other two journals and gives emphasis to more economic-oriented research. We further uncover that the most influential authors in the field are highly connected with each other.

Keywords: Invisible College; Entrepreneurship; Bibliometrics

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Introduction

Academic research on entrepreneurship has increased over the last few decades, accompanying society's interest on the subject (Landström, 2005). In fact, entrepreneurship research and teaching has been one of the most prominent social sciences in recent years, with jobs with a focus on entrepreneurship and faculty expertise in entrepreneurship continuing to increase (Finkle, 2007).

The explosion of entrepreneurship scholarship aroused the need to measure scientific production (namely through bibliometric and scientometric approaches) in entrepreneurship and understand the scientific structure of the field, so that several studies have been devoted to that issue (Cornelius et al., 2006, Grégoire et., 2006, Schildt et al., 2006). Underlying the scientific structure of a field is the network of informal communicational linkages established between the most influential scholars within that area. These groups of mutually interacting and prolific scientists that exchange knowledge through communication channels were named "invisible colleges" (Crane, 1972) and are the aim of our study. In spite of the academic interest on entrepreneurship, we found that invisible colleges, per se, have not been thoroughly investigated (exception maid to the work of Reader and Watkins in 2006).

Thus, the purpose of the present study is to fill this gap in entrepreneurship research literature and assess for the existence of invisible colleges within the entrepreneurship field, following the research framework proposed by Zuccala (2006). According to the methodology, invisible colleges are generated by the intersection of three key elements: social actors (influential authors); subject specialty (research areas) and information use environment (professional affiliation), underpinned by the exchange of (formal and informal) communication.

In a first stage, we undertake a bibliometric/ scientometric approach, more specifically, we perform a (co)citation analysis, based on data collected from three "seed" journals in entrepreneurship research: Entrepreneurship Theory and Practice (ETP); Journal of Business Venturing (JBV) and Small Business Economics (SBE). We gather evidence about the most cited authors, studies (articles or books) and journals for each of the "seed" journals, which allow us to characterize the intellectual bases of entrepreneurship, comparing the results for each of the selected journal.

In a second stage, we confirm the existence of linkages between the most influential (i.e. most cited) authors, though a comprehensive study of their affiliations, educational training and research areas. Examining the social ties (or links) that connect influential authors from entrepreneurship field is fundamental to comprehend the multi-faceted nature of the invisible colleges, since these are based on (formal and informal) exchange of scientific knowledge.

The combination of evidence from the first and second stages of the work give us empirical support to conclude about the existence of invisible colleges.

Synthesizing, the present study seeks to investigate three research issues: 1) identify the most cited authors, studies (article or book), and journals, in each of the entrepreneurship journals selected; 2) explore the linkages between the most cited authors through an analysis of their educational background, research area and profession affiliation and 3) infer the presence of invisible colleges in the entrepreneurship scientific field.

The study is structured as follows. In Chapter 1 we review the literature related to bibliometric and scientometric methods, illustrating with examples, their main applications in entrepreneurship and other scientific areas. Moreover, the concept of invisible college is defined along with Zuccala's approach to the theme. Chapter 2 is devoted to the description of data and methodological considerations. Next, in Chapter 3, we analyse the most cited authors, studies and journals of each "seed" journal and perform a comprehensive study on the linkages between the most cited authors. Finally, we draw the main conclusions, pointing the limitations of the study and suggesting paths for future research.

Chapter 1. Searching for Invisible Colleges in entrepreneurship scientific research: a literature review

1.1. Initial considerations

The present chapter is dedicated to reviewing fundamental concepts related to the aim of our work: to discover if there are "invisible colleges" in the field of entrepreneurship. Given that the operationalisation of the concept involves citation analysis, i.e., bibliometric exercises, the definitions of Bibliometrics and Scientometrics and their main applications are explained (Section 1.2.). Further (Section 1.3.) we discuss the concept of "Invisible Colleges" applied to the discipline of entrepreneurship. The theoretical support of the study and its expected scientific contribution are also enlightened.

1.2. Bibliometrics and Scientometrics: concept and main applications

The term Bibliometrics gained notoriety with Pritchard, in 1969,[1] when he suggested replacing the term "statistical bibliography" with the term of "bibliometrics", describing it as the "the application of the mathematics and statistical methods to books and other media of communication" (Pritchard, 1969: 349). Fairthorne (1969: 319) complemented the concept, explaining it as the "quantitative treatment of the properties of recorded discourse and behaviour appertaining to it".

In the same year, Nalimov and Mulchenko (1969: 12) introduced the term Scientometrics (Granovsky, 2001), defining it as a "quantitative method of investigating the development of science as an information process". The concept acquires credibility with the launching, in 1978, of the international journal *Scientometrics*, by Tibor Braun (Hood and Wilson, 2001). Hood and Wilson (2001) refereed that, with a great deal of bibliometric work being published in the journal Scientometrics, in many cases one cannot differentiate what is bibliometric from what is scientometric. Broadus (1987) has a similar point of view, emphasising that there is a large overlap between bibliometrics and scientometrics' study area. Braun et al. (1985: 5) stress that "in later practice, the limits between these two fields have been interpreted rather vaguely and the two terms have been used almost as synonyms". Despite the similarity of the

[1] Fonseca (1973) points out that Paul Otlet was the first author to use the word "bibliométrie", that is, the French equivalent of the term bibliometrics, in 1934.

methods of bibliometrics and scientometrics, for Braun et al. (1985: 5-6) they should be differentiated according to the subject and the purpose of their topic, proposing the following definitions:

> Bibliometrics considers books, periodicals, etc. as formal and tangible documents, its major purpose being the quantitative analysis of library collections and services with a view to improve scientific documentation, information and communication activities.
>
> Scientometrics analyses the quantitative aspects of the generation, propagation and utilization of scientific information, in order to contribute to a better understanding of the mechanism of scientific research as a social activity.

According with Tague-Stutcliffe (1992: 1):

> Bibliometrics is the study of the quantitative aspects of the production, dissemination and the use of recorded information, [whereas] Scientometrics is the study of the quantitative aspects of science as a discipline or economic activity.

Summarizing, bibliometrics includes the measurement of literature, documents and other media of communication, while scientometrics denotes the study of scientific productivity and utility (Rajan, 1985).

Historically, bibliometrics emerged from the statistical studies of bibliographies (Egghe and Rosseau, 1990). Its origins can be traced back to the nineteen century to works such as "*Histoire des sciences et des savants depuis deux siècles"* by Alphonse de Candolle (1873) (in van Raan, 2004) or *"English Men of Science: Their Nature and Nurture"* by Francis Galton (1874) (in Godin, 2007).

Opinions differ when one tries to establish which academic contribution should be consider the pioneer of bibliometrics' field, with several authors claiming this credit (Hood and Wilson, 2001). For example, according to Sengupta (1992), Campbell (1896) conducted the first bibliometric study by using statistical tools to research subject dispersion in publications. To Godin (2006), the psychologist James Cattell is responsible for the first methodical collection of statistics on science, due primarily to the biographical information published periodically, since 1906, in the directory *American Men of Science*.[2]

Precursor results obtained by Cole and Eales (1917) and Hulme (1923), based on number of published papers, as well as Lotka (1926), Bradford (1934) and Zipf (1949) pioneer's research, regarding distribution of publications over authors and journals, remained relatively

[2] For a more extensive discussion, see Hood and Wilson (2001).

unnoticed until the sixties, when became fundamental to fulfil the lack of information concerning the evaluation of productivity and effectiveness of scientific study (Braun et al., 1985).

With the emergence of the first citation index (Science Citation Index), a database developed by the Institute of Scientific Information (presently Thomson Reuters), founded by Eugene Garfield in 1960, the use of bibliometric tools expanded (Archambault and Gagné, 2004). The fundamental work of Garfield combined with the growing availability of databases containing publication and citation information lead to the development of the fields of bibliometrics and scientometrics (Willet, 2007). In the eighties, as Glänzel (2003: 9) points, the advance of computer science and information technology allowed bibliometrics to "evolve into a distinct scientific discipline with a specific research profile, several subfields and the corresponding scientific communication structures".

Bibliometric data can be applied in monitoring the development of a specific science field, making use of journals and scientific areas analysis (e.g. Ratnatunga and Romano, 1997; Phelan et al., 2002; Silva and Teixeira, 2008; Silva and Teixeira, 2009; Cruz and Teixeira, forthcoming) or individuals (e.g. Garfield, 1985); studying the intellectual development of a scientific field (e.g. Schildt et al., 2006; Cornelius et al., 2006; Culnan, 1987) and exploring the linkages between researchers (Reader and Watkins, 2006; McMillan and Casey, 2007). Beyond these applications, bibliometric methods are also crucial for research performance assessment (e.g. van Raan, 2003), serving as an instrument of science policy and research management (Glänzel, 2003), for decision-makers like the government, managers and institutional administrators, such as universities (e.g. Garfield and Weeljams-Dorof, 1992; Moed, 2006), enabling them to evaluate research productivity for purposes of resource allocation and promoting decisions (Laband and Piette, 1994).

Tables 1-4 summarise and highlight several articles, according to their scientific area, and of the main application areas of bibliometrics, namely: journal analysis, categorization of themes, intellectual structure and invisible colleges. Is not meant to be a comprehensive list rather a selection of the scientific areas based on its contiguity, in terms of knowledge, to our field of research – entrepreneurship – and on the similarity of employed methodology (as it is the case of the scientific area of Industrial Relations & Labor).

Regarding the application of bibliometric analysis (Table 1), in the field of economics, Laband and Piette (1994) updated the work of Liebowitz and Palmer (1984) and uncovered possible transformations in the economics journal market, between 1970 and 1990. The authors justify that update with the utility provided by the Liebowitz-Palmer rankings to the evaluation of scholarly productivity by universities and colleges. To achieve their goal, Laband and Piette resort to, among others tools that are detailed in Table 1, a widely used bibliometric indicator – the citation analysis (Kostoff, 2002).[3] Citation-based indicators are viewed as forms of measurement of the impact or international visibility of scientific research (Narin, 1976; Garfield, 1979), based on the assumption that bibliometric instruments accurately reflect the scientific activity (Rinia et al., 1998).

In the scientific area of management, Phelan et al. (2002) conducted a bibliometric study of the *Strategic Management Journal*, to explore internal changes in content of the publication, over the time. The main reason underlying the study is its usefulness as a guide to the readers, potential authors and to the journal itself, as it could unfold unexplored research opportunities. Using a wider set of journals within the discipline of marketing, Baumgartner and Pieters (2003) investigated the influence of marketing and marketing-related journals over time, with the purpose of contribute to the ranking of universities and journals, decision-making of editorial policies, unveil trends of the discipline and enlighten both authors and readers. A similar study was performed by Van Campenhout et al. (2008) to field of accounting. The results, though not entirely similar, corroborate one of the previous findings: the assessment of journals overall influence should be complemented with the study of sub-area influences.

In the field of entrepreneurship, Gamboa (2008) conducted a review of the articles published by nine selected journals (from the areas of entrepreneurship, international business and management) over two five-year frames, 1986-1990 and 2000-2004 in order to discover what was the role of international entrepreneurship research in major entrepreneurship, international business, and management journals. Complementary, Romano and Ratnatunga (1996) elaborated a citation analysis to assess the impact of small enterprise journals and articles during the period of 1986-1992, with the motivation of providing an objective evaluation of the scholarly research and the relative importance of publications.

[3] For a more detailed review on the subject of "citation analysis" see Smith (1981).

Table 1: Bibliometric studies – Journal analysis

Application Areas	Scientific Areas	Authors (Date)	Main Research Items	Main Results
Journal Analysis	- Economics	Laband and Pieters (1994)	Objectives: - Update paper by Liebowitz and Palmer (1984 - Research possible changes in the economics journal market, during 1970-1990 Bibliometric Indicators : - Number of citations - Number of citations per article - Number of articles - Distribution of citations, via Lorenz-curve analysis	- Steady decrease in concentration of citations among the top economics journals between 1965-1990 - Market share has been taken by new entrants, but inequality in distribution of citations remained stable from 1970 to 1990 - Decline in the influence of "second-tier" general-interest journals in contrast with the increasing influence of specialty journals
	- Management	Phelan et al. (2002)	Objectives: - Examine internal changes in content of the *Strategic Management Journal*, over time Bibliometric Indicators: - Number of citations - Number of citations per article - Number of articles	- Increase in the length of articles, number of references per article and number of authors - Publication lag has increased - More intrajournal citations - Proportion of North American authors remains constant but there are signs of greater international collaboration - Increase in empirical papers
	- Marketing	Baumgartner and Pieters (2003)	Objectives: - Explore the overall and sub-area influence of marketing journals at three points in time: 1996-97, 1981-82 and 1966-67 Bibliometric Indicators: - Number of citations - Number of citations per article - Number of articles - Index of structural influence - Journal impact factor	- Influence share of general business and managerially oriented journals has declined in contrast with the increase in the influence of specialized marketing journals - Select set of journals concentrate influence in marketing and their position remained stable over the studied period - *Journal of Marketing* is considered the most influential marketing journal
	- Accounting	Van Campenhout et al. (2008)	Objectives: - Compare the overall and sub-area journal influence in accounting Bibliometric Indicators: - Number of citations - Number of articles - Index of structural influence	- Substantial differences exist between overall and sub-areas journal influences - For some sub-areas in accounting, specialized journals are not the ones with the highest influence
	- Entrepreneurship	Gamboa and Brouthers (2008)	Objectives: - Discover role of international entrepreneurship research in major entrepreneurship, international business and management journals - Assess possible differences in the type of international entrepreneurship articles published in the three type of journals Bibliometric Indicators: - Number of articles - Number and percentage of international studies	- Substantial increase in international entrepreneurship content in the top entrepreneurship journals by contrast to a much more modest increase in the top international business journals and management journals - Entrepreneurship journals tend to favour replication studies while international business and management journals prefer nonreplications
		Romano and Ratnatunga (1996)	Objectives: - Assess the impact of small enterprise journals and articles during the 1986-1992 period Bibliometric Indicators: - Number of citations - Number of articles - Average number of citations per article - Average citation rate per published article - Self citedness - Uncitedness - Citation frequency - Journal impact factor	- Increasing level of impact in more recent years of the source journal articles as group on contemporary small enterprise research - Substantial number of articles were never cited - Self-citation problem was seen to be of limited impact - Entrepreneurship Theory and Practice and Journal of Business Venturing were the more influential journals during the studied period

Bibliometric analysis of themes and abstracts (*cf.,* Table 2) has recently been used in distinct research areas. Silva and Teixeira (2008) applied bibliometric methods in order to obtain an overall survey on the scientific area of structural change. By studying the references cited in all the articles published, from 1991 to 2007, in this area's "seed journal"[4] they found who were the most widely cited authors and what were the most cited studies. By reviewing the abstracts from the articles published, from 1969 to 2005, on structural change in the Econlit database they were able to identify the areas of rising and declining interest within the major theme. It is important to underline how the classification of the articles - by topics and types of research[5] – opened a whole set of possibilities that broadened the scope of the research. The use of citation analysis combined with the review of abstracts allowed the authors to determine the most influential contributions and to unveil recent trends on structural change.

A similar research, employing abstracts review, was made in the field of evolutionary economics (Silva and Teixeira, 2009). The title, abstract and main-text of each article were thoroughly examined in order to categorize them by sub-fields and methods of research. It is possible to overlook relevant information, while conducting a search by keywords. This constitutes one of the main disadvantages of this kind of bibliometric exercise. In contrast, one of the benefits is the opportunity to cross different information and identify patterns in the evolution of published papers that will help redirect the research on the area of study. Silva and Teixeira (2009) inquired about the "quality" of the published papers. For this purpose, they ranked the journals attached to Econlit and discover that the number of articles published within the evolutionary related research in the top-ranking journals is scarce. The data provided by bibliometric methods, combining the journal ranking with the categorization of both methods of research and sub-fields, resulted in a significant finding: empirical research on evolutionary economics is meagre.

Following the same line of thinking, Cruz and Teixeira (forthcoming) applied all the bibliometric tools previously mentioned to the field of regional studies, more specifically "clusters". Combining the citation analysis, based on the references cited on the "seed journal",[6] with the abstracts' review of all the articles related to the subject, published in the Econlit and Business Source Complete databases, the classification of papers according to main topic or sub-field and type or method, and the journals' ranking, permitted a quantitative survey of the cluster-related

[4] The "seed journal" was "Structural Change and Economics Dynamics".
[5] The types of research were categorized in six different classes: formal; appreciative; formal and empirical; appreciative and empirical; empirical and surveys (see Silva and Teixeira, 2008).
[6] The "seed journal" was the "Regional Studies".

Table 2: Bibliometric studies – Themes categorizations

Application Areas	Scientific Areas	Authors (Date)	Main Research Items	Main Results
Themes categorization	- Structural Change	Silva and Teixeira (2008)	Objectives: - Provide a comprehensive survey of the economic literature on structural change Bibliometric Indicators: - Number of citations; Number of articles - Co-authoring; Abstracts analysis; Keyword analysis	- Technological issues increased there relevance during the studied period - Recent trends reflect a rising interest towards empirical work, despite the increased relevance of formal work in the nineties
	- Evolutionary Economics	Silva and Teixeira (2009)	Objectives: - Explore main research paths and contributions in the field of evolutionary economics Bibliometric Indicators: - Number of citations; Number of articles; Abstracts analysis; Keyword analysis	- Evolutionary contributions don't converge to an integrated approach - Arising of two extreme strands: "History of Economic Though and Methodology" and "Games" - Increase of formal approaches in contrast with the stagnation of empirical work
	- Regional studies	Cruz and Teixeira (Forthcoming)	Objectives: - Provide evidence that empirically complements the qualitative surveys of cluster-related literature Bibliometric Indicators: - Number of citations; Number of articles; Co-authoring - Abstracts analysis	- Share of "Appreciative+Empirical" and "Formal+Empirical" articles published in the top ranked cluster-related journals are above the average - Evidence of positive correlation between the "quality" of the journals and formal related research
	- Entrepreneurship	Van Praag and Versloot (2008)	Objectives: - Assess the contribution of entrepreneurs to the economy comparatively to non-entrepreneurs Bibliometric Indicators. - Keyword analysis - Title, abstract and full-text analysis	- Entrepreneurs have a higher, but more volatile, contribution to employment generation. They pay lower wages, but, their employees appear to be more satisfied - Entrepreneurs contribute equally importantly to innovation but trough different aspects - Entrepreneurs do not have higher productivity levels than their counterparts. They contribute more than their counterparts to growth of value added and productivity - Despite having lower and riskier incomes, entrepreneurs are more satisfied
		Watkins and Reader (2004)	Objectives: - Identify current trends in entrepreneurship research, in 2000 and 2001 Bibliometric Indicators: - Textual analysis (keyword and abstract analysis); Co-occurrence matrix	- Identification of twenty two clusters - Incidence of work in areas very attended in the past or in vogue in the present, such as, respectively, Entrepreneurial Psychology and Social Entrepreneurs or Networking among Female Entrepreneurs was lower than expected
		Ratnatunga and Romano (1997)	Objectives: - Analyze, with a quantitative and qualitative approach, the articles in contemporary small enterprise research Bibliometric Indicators: - Number of citations; Number of articles - Articles full-text analysis	- Increase percentage of most cited articles, published by the source journals - Substantial percentage of articles (more than 50%) are well based in observational and contemplative theory - Diversity of topic areas empirical support that there is no coherent structure to research in the field

literature, that gave a more accurate and complete insight of the evolution of regional literature and paths to follow in this scientific area.

Another example of a bibliometric analysis of contents, this time applied to entrepreneurship, is the review of 57 studies performed by Van Praag and Versloot (2008) with the purpose of measuring the contribution of entrepreneurs to the economy in comparison to non-entrepreneurs, in terms of employment generation and dynamics, innovation, productivity and growth and individuals' utility levels. The authors conducted a thoroughly research of title, abstract and full-text, in order to discover if recent empirical evidence could substantiate the common notion that entrepreneurs are beneficial to the economy.

Watkins and Reader (2004) employed an original approach to identify the current trends in the entrepreneurship field, in 2000 and 2001. The authors resort to a textual analysis and the ARPENT corpus as a data source, which allowed them to obtain a better understanding of the major themes in the literature. The data results from a collection of abstracts from 13 entrepreneurship niche journals included in the ARPENT corpus. By doing so, the authors expect to overcome some limitations such as the delay associated to the use of citation tools; the biased towards journals of North American origin and limited coverage related to the use of the Social Sciences Citation Index. Watkins and Reader (2004) conclude that the textual analysis software provides clusters by sets of keywords that seem to meet the expectations of entrepreneurship researchers, with the advantages of having more data available and clusters' generation consume less time.

Ratnatunga and Romano (1997) complemented their 1996 study with a qualitative categorization of the topic, methodology and objectives of the most cited articles, to identify the intellectual origins and directions of entrepreneurship research.

With respect to researching the intellectual structures (Table 3), in the sub-field of innovation, Cottrill et al. (1989) investigate the structure of the discipline, through a co-citation analysis, exploring the interrelationships between the interdisciplinary specialties of the diffusion of innovations and technology transfer. Samples were drowned from Social Sciences Citation Index, concerning the 1966-1972 period of study. The authors discover five major clusters, closely related. Nerur et al. (2008) also used a co-citations analysis to study the evolution of the intellectual structure of the strategic management field. The authors aim at discovering the sub-fields (and the relationships between them) that constitute the intellectual structure of the

discipline, identifying the influential authors in the field and graphically mapping the results. In field of management information systems, Culnan (1987) updated a previous work, dated from 1986, and assessed the intellectual development of the scientific area, through a co-citation analysis. The study provided evidence of the discipline's progress toward a cumulative research tradition.

In entrepreneurship research, an, Cornelius et al. (2006) performed a bibliometric analysis of cited articles, at three points in time, 1986-1990, 1993-1997 and 2000-2004, in order to examine the intellectual structure of the field and assess its the stage of maturation. The data is provide by the Social Sciences Citation Index, through a research of academic articles that include the word "entrep*" in the title, key words, or abstract between 1986 and February, 2005. The idea is to determine the research front of the field, perceiving the most influential scholars and discovering the linkages between them and other authors. By evaluating the research output of key authors and the research themes over time, the authors find evidence to support the idea that entrepreneurship is evolving into a mature field.

Similar to the previous work purpose, Grégoire et al. (2006) studied the intellectual bases of entrepreneurship to understand the extent and nature of conceptual convergence in entrepreneurship research. In the study, they analyze the co-citation networks provided by the articles published between 1981 and 2004 in the Frontiers of Entrepreneurship series and complemented it with an analysis by period (1981-1986, 1987-1992, 1993-1998 and 1999-2004). The emergence of consistent networks of co-citation provide evidence to support the argument that there has been convergence in entrepreneurship research over the last twenty five years, although the overall levels of convergence observed were relatively low.

Schildt et al. (2006) conducted a bibliometric study and analyzed co-citations patterns of entrepreneurship-related articles, published during the period of 2000 to 2004. The data collection was initially based in a research of articles with words beginning with "entrep*" in their abstract, title, or keywords from the Social Sciences Citation Index published during the studied period and then, the study was narrowed to thirty journals that contain entrepreneurship-related articles. By mapping the structure of entrepreneurship literature, the authors seek to obtain some evidence regarding the research directions of the subject, clarifying the state of entrepreneurship field as a discipline and fulfilling a literature gap.

Table 3: Bibliometric studies – Research Intellectual Structures

Application Areas	Scientific Areas	Authors (Date)	Main Research Items	Main Results
Research Intellectual Structures	- Innovation	Cottrill et al. (1989)	Objectives: - Explore the interrelationships between the specialties of the diffusion of innovations and technology transfer, in the 1966-1972 period Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster and factor analysis; Multidimensional scaling	- Clusters of authors obtained are similar to those identified in major reviews of the innovation literature - Little cross-referencing between the diffusion of innovations and the technology transfer authors - Technology transfer research tradition is less integrated than the diffusion of innovations tradition
	- Strategic Management	Nerur et al. (2008)	Objectives: - Trace the evolution of the intellectual structure of the strategic management field during the period 1980–2000 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Multidimensional scaling; Factor analysis; Pathfinder analysis	- Multidisciplinary origins of strategy - Large number of significant inter-correlation between factors suggests that the field did not become fragmented - Theories of the firm have become central to strategy research, which suggests a greater theoretical orientation
	- Management Information Systems	Culnan (1987)	Objectives: - Document the intellectual structure of Management Information Systems, from 1980 to 1985 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis	- Identification of five clusters: foundations; psychological approaches to MIS design and use; MIS management; organizational approaches to MIS design and use; and curriculum
	- Entrepreneurship	Cornelius et al. (2006)	Objectives: - Analyze the development of entrepreneurship with respect to the research front and knowledge base, during the periods of 1986-1990, 1993-1997 and 2000-2004 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster analysis	- Entrepreneurship research has been increasing self-reflective - The number and influence of outsiders has decreased steadily over time while the reliance on insiders is greater - Theoretical issues are more pervasive - Research interests have evolve, despite their consistency - Researchers have increasingly specialized thematically
		Grégoire et al. (2006)	Objectives: - Assess conceptual convergence of entrepreneurship field, through network co-citation analysis Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster analysis	- Evidence of convergence in entrepreneurship research over the last twenty five years - Levels of convergence comparatively low - Entrepreneurship research bases on the contributes of other disciplines, but evidence indicates that the field relies increasingly on its own literature
		Schildt et al. (2006)	Objectives: - Analyze co-citation patterns of entrepreneurship-related articles published, from 2000 to 2004 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Jaccard index; Cluster algorithm	- Evidence of fragmentation in entrepreneurship research - Research findings appear to be noncumulative - Research mostly centred on the United States, but other countries contribute significantly - Signs of isolation among the entrepreneurship scholars
		Etemad and Lee (2003)	Objectives: - Define the knowledge network associated with the field of international entrepreneurship, during the period of 1992 to 2000 Bibliometric Indicators: - Number of citations; Number of publications; Bolean search progression of key words; Co-authoring; Authors' affiliations analysis	- Scholarly articles, followed by book reviews dominate the document types - Upward movement over time in both the number of articles and their associated citations - Mild upward trend in both size of scholarly teams and theirs co-authorship, during the period of 1992-1998 - Authors affiliated with institutions located in the U. S. dominate the distribution, but other country affiliations are also reported - Scholarly articles and books constitute the most important sources upon which research relay

Twenty five major research trends were identified; being presented the ten most cited groups of study and subsequently explored their interrelatedness, through a co-citation network.[7]

Etemad and Lee (2003) studied the knowledge network of the sub-field of international entrepreneurship, during the period of 1992 to 2000, through a Boolean progression of key words that focussed on Social Sciences Citation Index's available database. By using a bibliometric methodology, namely citation analysis, they expected to reveal the antecedents of an emerging field and discover the unique characteristics of its knowledge network. The results obtained confirm Etemad and Lee's (2003) initial hypothesis: scholars of international entrepreneurship depend highly on the disciplines of international business and entrepreneurship to support their scientific research.

Bibliometric methodology is also employed in the investigation of possible (formal and informal) linkages between researchers, which have been identified as Invisible Colleges. The following section explains, in detail, the concept of Invisible Colleges and provides examples of their application in entrepreneurship and other scientific areas.

1.3. The concept of "invisible colleges" and the scope for its application in the scientific area of entrepreneurship

The term "invisible colleges" was introduced in 1645 by Robert Boyle (Wallace, 2007), when the Royal Society of London was founded, as a form of describing the fact that its members, although lacking a formal institution or college, were geographically close and shared common scientific interests (Lievrouw, 1989; Zuccala, 2006). Price (1961; 1963) recover the terminology and applied it to the existence of informal communication network between scholars from several institutions, often geographically separated from one another. The invisible college was defined as a hierarchical and elitist group of scholars, supported by an expectable inequality and a highly connection (Price, 1971).

Crane (1972) undertook, influenced by Price's work, a comprehensive examination of the invisible college phenomenon (Wallace, 2007). Focussing on communication among

[7] The ten most cited groups identified were: Entrepreneurial Networks and Resource Accumulation; Corporate Entrepreneurship and Venturing; Conceptualizations of Entrepreneurial Processes; Value Creation from Corporate Entrepreneurship; Alertness, Opportunity Creation, and Creative Destruction; Psychological Characteristics of Entrepreneurs, Qualitative Research Methods; Entrepreneurial Firm Survival and Growth; Societal Consequences of Entrepreneurship and Born-Global Firms (Schildt et al., 2006).

scientists, the author expanded the scope of the concept of informal communication, including informal discussions, relationships between teachers and students, during a thesis preparation, and a scientist's work influence on another. The study consisted in an analysis of the growth of communication relations between sociologists and mathematicians, sustained by the collection of survey data on co-authorship patterns and exchange of preprints (Zuccala, 2006). Despite Crane's major scientific contribution, Lievrouw (1989) points some limitations to the work, particularly with respect to the definition of invisible college and the lack of real information about informal communication. According to Lievrouw (1989), several other studies (e.g. Crawford, 1971; Mullins, 1968; Lingwood, 1969; Chubin, 1976) reveal the same difficulty with the definition of the concept and its operationalization. This problem is common in the social studies of science, reflecting the use of products of science (for instance, published documents) to capture social processes of science, which have a communicative nature. To Lievrouw (1989: 622), it is a paradox that "the term invisible college describes an informal communication process, yet researchers look for it in formal social structures and documents" and explains an invisible college as "a set of informal communication relations among scientists or other scholars who share a specific common interest or goal".

Zuccala (2006: 155) emphasis the need to understand the multi-faceted nature of the invisible college, proposing the following definition:

> An invisible college is a set of interacting scholars or scientists who share similar research interests concerning a subject specialty, who often produce publications relevant to this subject and who communicate both formally and informally with one another to work towards important goals in the subject, even though they may belong to geographically distant research affiliates.

The novelty in the definition, as Zuccala (2006) points, is its openness to the possibility of combining different types of analysis – bibliometric, sociometric and qualitative – in the study of invisible colleges, benefiting from their unique contributions.

Bibliometric methodology, nevertheless, remains a fundamental tool to researchers by providing a concrete representation of the relationships among the products of science and enabling documents mapping, generated by communication acts (Lievrouw, 1989).

Co-citation analysis[8] has developed into the principal bibliometric technique used to explore the intellectual structure of scientific communication, leaning on citations and co-citations

[8] See Small (1973) to a better understanding of the concept "co-citation analysis".

(Lievrouw, 1989; Bayer et al., 1990; Gmür, 2003). According to Bellardo (1980: 231) co-citation analysis is founded on the premise that "the greater the number of times that a pair of documents are cited together, the more likely it is that they are related in content". A co-citation occurs when two references or authors are mentioned in the same bibliography and serves as a measurement for the closeness of content (Small, 1973; Garfield, 1978; Gmür, 2003).

Although there has been some criticism regarding the use of citation and co-citation analysis, as the utilization of citation links is considered an inadequate representation of communication among researchers (Lievrouw, 1989), their credibility as indicators of scientific communication was vouch for by authors such as Small (1978) and Garfield (1979) and they constitute the grounding for the identification of invisible colleges (Gmür, 2003).

Thus, the research of invisible colleges is one of the main applications of bibliometrics (*cf.,* Table 4).

In the field of economics, namely Industrial Relations and Labour, Casey and McMillan (2008) and McMillan and Casey (2007) assessed the intellectual bases of the area over a reasonable span of years (1974-2006) based on the analysis of one single journal, respectively, Industrial & Labor Relations Review and British Journal of Industrial Relations.

These studies, according to the authors, aim at identifying the invisible colleges of the respective journals, through a co-citation analysis. The invisible colleges are defined as research networks that refer to each other in their documents without being linked by formal organizational ties. However, the empirical application performed by the authors seems to be rather distant of their theoretical concept of invisible colleges, since co-citation analysis is based on formal links. In fact, both the studies defined invisible colleges as social processes, based on informal links, but, empirically, invisible colleges are treated as structures of scholarship, measured by formal elements such as published documents.

Also within economics, but regarding the sub-field of Technology and Innovation, Verspagen and Werker (2004) analysed the structure of collaboration and interaction between researchers, applying a survey methodology that allowed them to map the intellectual relations between active contributors in the discipline and identified possible social networks, i.e., invisible colleges.

Table 4: Bibliometric studies – Research Invisible Colleges

Application Areas	Scientific Areas	Authors (Date)	Main Research Items	Main Results
Research Invisible Colleges	- Industrial Relations & Labor	Casey and McMillan (2008)	Objectives: - Compare Industrial & Labor Relations Review intellectual bases across three periods: 1974-1984, 1985-1995 and 1996-2006 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation network analysis	- The most cited journals were economic-oriented during the studied period - Emergence of the field of human resource and management in recent years
		McMillan and Casey (2007)	Objectives: - Uncover British Journal of Industrial Relations for two time periods, 1986-1995 and 1996-2005 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation network analysis	- Evidence suggests that economics literature remains important, but sociological and management literature has dominated in recent years - Regarding authors, Millward's initial influence has been replaced by Kelly and Wood - Possible signs of internationalization
	- Management	McMillan (2008)	Objectives: - Examine R&D Management, in four time periods, 1986-1990, 1991-1995, 1996-2000 and 2001-2005 Bibliometric Indicators: - Number of citations; Number of articles; co-citation network analysis	- During the two first periods R&D Management focus on more traditional technology and innovation management sources, contrasting with the last two periods, in which R&D Management was based on journals more detached of the traditional sources - Cohen and Levinthal's absorptive capacity model dominates the final two periods and possibly constitutes an emerging base
	- Economics of Technology and Innovation	Verspagen and Werker (2004)	Objectives: - Identify the role of "intellectual leaders" in connecting the research network - Study the structure of the field in terms of sub-communities Bibliometric Indicators: - Survey analysis	- The network of scholars in the field may be characterized as a scale-free network - The field does not seem to evolve in a mode of competition between paradigmatic approaches to the object of study
	- Entrepreneurship	Reader and Watkins (2006)	Objectives: - Identify groups of entrepreneurship authors whose work falls into similar areas and explore the themes that characterize entrepreneurship field - Investigate the social and collaborative structure of entrepreneurship research Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster analysis; Correlation matrix; Factor analysis; Questionnaire survey	- Findings reveal nine clusters of authors whose work falls into similar areas - Little evidence of international sharing of ideas - Strong evidence that closely related authors share both formal and informal communication links

In the field of management, McMillan (2008) presents a co-citation analysis of *R&D Management*, for four time periods, 1986-1990, 1991-1995, 1996-2000 and 2001-2005, with the purpose of assessing possible changes in its intellectual base, identified by the author, albeit in a simplistic way, as 'invisible colleges'. The motivation behind the work is the opportunity to fulfil a literature gap, conducting a comprehensive analysis of the journal, and providing some directions to future research.

In entrepreneurship scientific area, Reader and Watkins (2006) explored the existence of invisible colleges, by complementing a co-citation analysis of the field's scientific structure with a questionnaire survey. The authors resort to a comprehensive database, created by the Southampton Business School, which includes full coverage of the major niche journals in entrepreneurship, conference proceedings and other major, but not so specific, journals as those on the Social Sciences Citation Index. The key authors were defined through a process of cross-referencing that reduced a list of 4405 documents initially generated by a keyword search of the word "Entrepreneur$" within the database. Using the author co-citation and factor analysis, the authors try to identify, respectively, groups of entrepreneurship scholars whose work falls into similar areas and the themes that characterize and define the field. The survey allowed them to explore the social and collaborative nature of entrepreneurship research between the leading co-cited authors, unveiled in the first stage of the work. Therefore, the subfields identified in the author co-citation analysis of informal communication links between closely related authors and then validated by the survey represent to Reader and Watkins (2006) the "invisible colleges".

In spite of all the research devoted to assess the intellectual structure of the entrepreneurship field, namely the presence and nature of the scholar communities that comprise the field, there is steel very little literature specifically focussed on the subject of invisible colleges. The multi-faceted constitution of this phenomenon, particularly the issue structure versus social process, requires, as Lievrouw (1990) recommended, distinct approaches to the subject in order to provide new insights on the discipline.

Therefore, the aim of this work is to explore the existence of invisible colleges in the field of entrepreneurship, undertaking a citation analysis of the articles published in three "seed journals" within the entrepreneurship area – Entrepreneurship Theory and Practice; Journal

Business Venturing and Small Business Economics. For that purpose we resort to the methodology proposed by Zuccalla (2006) in order to operationalise the (widely debatable) concept of 'invisible college'. We argue that although this theory underlying the concept is well developed and relatively consensual the empirical application or the operationalisation of such a concept lags well behind the theoretical achievements. Moreover, in our view, one need an objective framework structure which enables, in a more rigorous manner to approach the 'measurement' and 'assessment' of invisible colleges. To the best of our knowledge such operationalisation of the Invisible College concept has never been applied in entrepreneurship literature.

According to Zuccala's (2006) previous mentioned definition of Invisible Colleges and its research framework, the invisible college is a consequence of the interrelationship (through formal and informal communication) between three key elements: the subject specialty, the social actors and Information Use Environment. The first informs the invisible college of its disciplinary rules and research problems, the second refers to the scientific scholars who understand and agree upon the rules and interact one another to solve problems and the third and last element, represents the scientific workspace, i.e., the "set of elements that affect the flow and use of information messages into, within, and out of any definable entity" (Taylor, 1986: 3). The social actors, i.e., the most influential authors resort to the invisible college to support their search of information and sharing patterns (informal communication) and reinforce the invisible college through bibliometric artifacts (formal communication). Therefore, Zuccala (2006: 8) concludes that the invisible college is an organizational structure produced by "the space that intersects the Information Use Environment, the subject specialty and the social actors" (*cf.,* Figure 1).

Thus, similarly to previous studies (e.g. McMillan, 2008; Casey and McMillan, 2008; McMillan and Casey, 2007), the present work applies a bibliometric analysis in order to obtain empirical evidence that allows to asses the development of the field's intellectual bases. However, unlike these studies that are constrained to a narrow definition of invisible colleges and do not provide any insights regarding scholars interrelatedness through informal channels, we complement the study of the most cited authors, articles/books and journals, with an analysis of the linkages between the most influential (i.e., most cited) authors, based on their educational training affiliation, professional affiliation and research area.

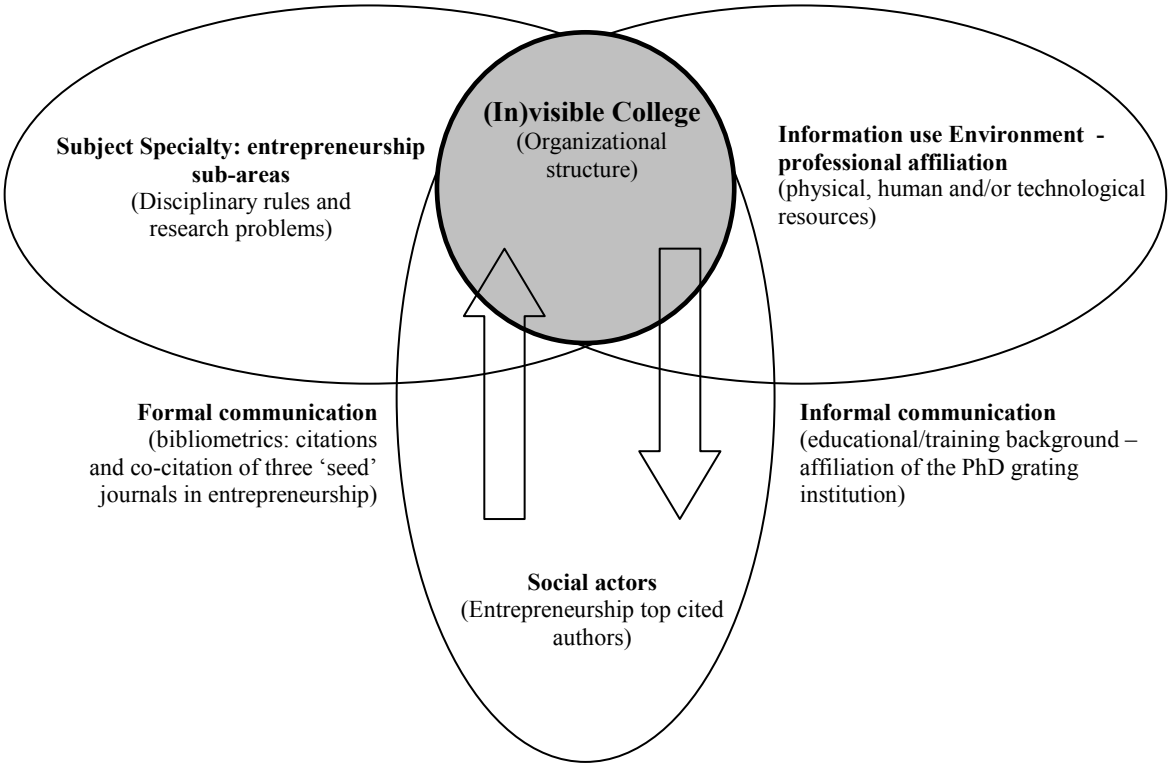


Figure 1: Conceptual model for analysing the structure of an invisible college in entrepreneurship

Source: Adpated from Zuccala (2006: 156)

The use of three "seed" journals, in stead of resorting to one single journal analysis (e.g. McMillan, 2008), allows us to infer whether, within the entrepreneurship field, there are distinct invisible colleges according to the "seed" journal considered. By circumscribing the study to three niche journals in the field but including all articles available until February of 2009, we ensure a comprehensive analysis that preserves all relevant information. That is not the case of those analyses that rely on a wider range of data sources, but confine their sample to a process based on the initial search of a specific key word, within the chosen database – a limitation present in several studies previously mentioned (e.g. Cornelius et al.,2006; Schildt et al., 2006; Reader and Watkins, 2006). In fact, obtaining data through such a broad process does not insure that the interacting authors share similar research areas, as proposed by Zuccala (2006), which constitutes a handicap in those studies.

The next chapter provides a description of the selected "seed" journals and explains the methodological articulation of the study, namely the data collection issues.

Chapter 2. Searching for the 'invisible colleges' in the Entrepreneurship literature: methodological underpins

2.1. Initial considerations

The purpose of the present study is to unveil possible "invisible colleges" in the entrepreneurship field. This goal can only be achieved after we identify the most cited authors, studies (article or book), and journals, in each of the three entrepreneurship journals selected and explore the linkages between the most cited authors through an analysis of their educational background, research area and profession affiliation. In order to do so, one must study the intellectual bases of three "seed" journals in the field of entrepreneurship, trough a (co)citation analysis. Each of the selected journals has its distinct features and the study of its contribution (Section 2.2), adds to the mapping of the entrepreneurship field. Data collection issues are clarified and a methodological scheme is exhibit (Section 2.3.).

2.2. A brief description of the selected 'seed journals' – Entrepreneurship Theory and Practice, Journal of Business Venturing, Small Business Economics

Our research aims to identify possible invisible colleges within the field of entrepreneurship. In order to do so, we will combine a (co)citation analysis with a study of the relationships between the most influential authors. Underlying this approach is the notion that publications are key elements in the knowledge exchange process and scientists' studies of high quality are referred on another researcher's work (van Raan, 2003). Thus, leading academic journals have played an increasingly important role in the dissemination of scientific results (Ratnatunga and Romano, 1997).

The present study selected three "seed" journals in the field of entrepreneurship: Entrepreneurship Theory and Practice (ETP), Journal of Business Venturing (JBV) and Small Business Economics (SBE). The selection of the journals was based on John Carroll University Classification of entrepreneurship journals (see Table A1).[9] This choice is also supported by Fried's (2003) study of the forum for entrepreneurship research. In an update of MacMillan (1993)'s work, Fried (2003) concludes that the Journal of Business Venturing

[9] Journal of Small Business Management, although included in level I, was discarded due to its low impact factor (0.875 in 2008 and 0.703 in 2007).

(JBV), Entrepreneurship Theory and Practice (ETP) and Small Business Economics (SBE) were the entrepreneurship-focused journals most highly ranked by a set of leading scholars in the field of entrepreneurship. Additionally, ETP and JBV are widely recognized as the strongest journals whose aim is limited to entrepreneurship research (Dean, 2007; Chandler and Lyon, 2001; Shane, 1997; Romano and Ratnatunga, 1996). SBE, though established as an entrepreneurship specialist journal, has a more accentuated disciplinary economics orientation, covering economic research on small and medium size firms (Lee, 2001).

Table 4 exhibits the description, scope, year of the first publication, impact factor for 2008 and 2007 and the current editor for each of the three selected Journals.

ETP began publication as the American Journal of Small Business from 1976 until 1988, year when the journal adopted its current title. According to D. R. Bagby (Baylor University, US) – its present editor – there was only one other English language publication in the area, the *Journal of Small Business Management*, and the field was initially defined as small business because words like entrepreneur and entrepreneurship were used infrequently in those days. ETP is characterized as a scholarly journal, generated at Baylor University, with a bi-monthly publication frequency and a broad scope of topics, that pursuits its ultimate goal of contribute to the development of the field of entrepreneurship.

JBV started its publication in 1985 and is established as a scholarly forum that provides innovative insights about the phenomenon of entrepreneurship. It is jointly sponsored by the Johnson Center for Entrepreneurship and Innovation at the Kelley School of Business, Indiana University – where its present editor, D. Shepherd, holds the position of entrepreneurship professor – and the Batten Institute for Entrepreneurship and Innovation at the Darden School of Business, University of Virginia, and published six issues per year.

SBE was the last of the three journals to begin publication and its first issue goes back to 1989. It was founded and edited by Z. Acs (George Mason University, US) and D. B. Audretsch (Max Planck Institute of Economics, DE), remaining until the present date as their editors-in-chief. SBE is an academic journal with six publications per year and international and national exposure, focussed on entrepreneurship and small business research based on the contributions of a wide set of academic disciplines such as economics, finance, management, psychology, regional studies, sociology and strategy.

Table 5: Description, scope, year first published, impact factor and present editor of ETP, JBV and SBE

Journal	Description	Scope	1st Year published	IF (2008)	IF (2007)	Present Editor (s)
Entrepreneurship Theory and Practice	ETP is a leading scholarly journal in the field of Entrepreneurship studies and the official journal of the United States Association for Small Business and Entrepreneurship.	The journal publishes original conceptual and empirical papers that contribute to the advancement of the field of entrepreneurship. Article topics include, but are not limited to: National and International Studies of Enterprise Creation; Small Business Management; Family-owned Businesses; Minority Issues in Small Business and Entrepreneurship; Research Methods; Venture Financing; Corporate and Non-profit Entrepreneurship.	1976	1.526	1.805	D. Ray Bagby
Journal of Business Venturing	JBV provides a scholarly forum for sharing useful and interesting facts, theories, narratives, and interpretations of entrepreneurship and consequences of entrepreneurship.	The journal aspires to publish ideas that deepen the understanding of, and ultimately impact, the entrepreneurial phenomenon in its myriad forms. Its scope includes Entrepreneurship, Entrepreneurial Finance, Innovation and Regional Development. Articles should be grounded in the practice of entrepreneurs, innovators, and their support systems; and address issues useful to scholars, educators, enablers, and practitioners of the entrepreneurial phenomenon. The journal welcomes pluralism in approach, methods, and disciplines.	1985	2.143	1.875	D. Shepherd
Small Business Economics	SBE provides an invaluable forum for research and scholarship focusing on the role of entrepreneurship and small business.	The journal publishes theoretical, empirical, and conceptual papers and encourages interdisciplinary and cross-disciplinary research from a broad spectrum of disciplines and related fields, including economics, finance, management, psychology, regional studies, sociology and strategy. Its scope includes entrepreneurs' characteristics, new ventures and innovation, firms' life cycles; as well as the role played by institutions and public policies within local, regional, national and international contexts.	1989	1.415	1.168	Z.J. Acs; D.B. Audretsch

Source: Information collected directly from ETP, JBV and SBE *websites.*

ETP, JBV and SBE presented in 2008 journal impact factors of, respectively, 1.526; 2.143 and 1.415 (*cf.,* Table 4), which represents a decrease to ETP and an increase to JBV and SBE, comparing with the values of 2007. The journal impact factor is considered a measure of the journals' prestige or quality and is calculated by the ratio between the number of citations received in a given year from the documents published in a journal in the two preceding years and the number of the cited documents published in the journal in those two prior years (Moed, 2005). Therefore, in 2008, on average, an article of ETP was cited 1.526 times in the two years following the year of publication. A similar reasoning can be applied to both JBV and SBE.

Since their first publication until 2008, the three journals published a total of 2716 articles (see Figure 2).[10] ETP, being the eldest, is the most prolific journal, with a total of 1015 articles published. SBE, in spite of being the youngest journal, follows ETP with 979 articles published against the 722 articles published in JBV. Analysing the period of 1989 to 2008 – common to the three journals – SBE is the most prolific journal, overcoming ETP and JBV production of articles in every year, with the exception of 1993, 2007 and 2008. JBV becomes second on the rank, exceeding ETP, although ETP has been improving its publication numbers since 2005.

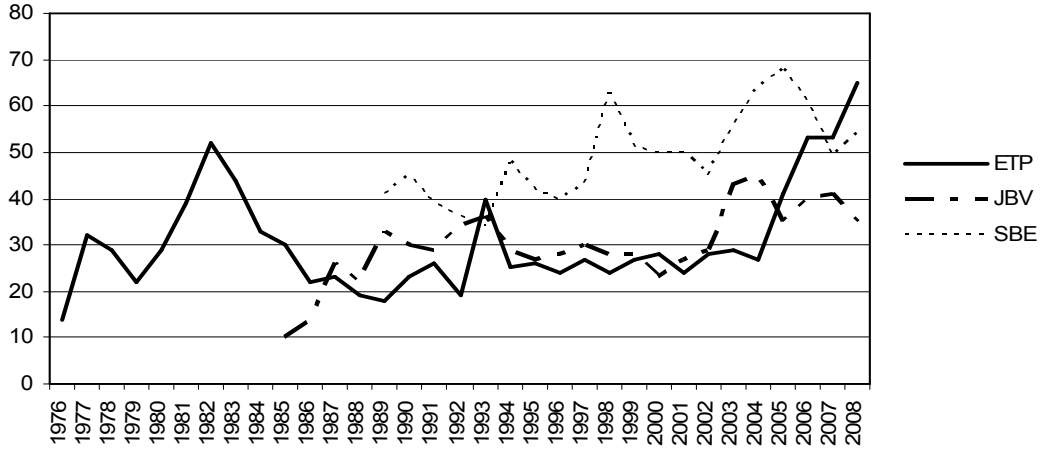


Figure 2: Evolution of the number of articles per year published in ETP, JBV and SBE, 1976-2008
Source: Authors computations based on our sample of articles collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE, (n=2716)[11]

[10] Obituaries, corrections and editorial comments were not included.
[11] The number of articles included in the years 1985 and 1986 for JBV, and 1989, 1990 and 1991 for SBE were collected manually, since they were unavailable in the ISI database.

Table 5 provides a ranking of the 20th most productive (i.e. with the highest number of published articles) authors for each of the journals until 2008, ordered by the total number of articles published in the three journals. The first three leading positions (black cells in Table 5) are different for each of the journals. James Chrisman (Mississippi State University, US) is the most prolific author in the list and simultaneous is the most prolific author of ETP (although he takes the seventh position in JBV and has not published any article in SBE). Ian MacMillan (University of Pennsylvania, US) and Roy Thurik (Erasmus University Rotterdam, NL) are, respectively, the leading contributors to JBV and SBE, although the first did not published any articles in ETP and SBE, and the second occupies a very low rank in ETP and JBV.

Regarding the total number of articles published, as it was mentioned, James Chrisman (Mississippi State University, US) is the author with the highest number of published articles. Following James Chrisman is, respectively, William Gartner (Clemson University, US), Michael Wright (University of Nottingham, UK) and Shaker Zahra (University of Minnesota, US). These three authors belong to a set of sixteen authors common to all the three journals (grey cells in Table 5). In spite of the authors shared by the three journals, SBE presents a very distinct ranking of entrepreneurship authors, with poor (or none) ranking positions for the majority of authors listed in Table 5, with the exception of Michael Wright (University of Nottingham, UK). This results contrast with ETP and JBV clear signs of similarity: seven of the 20th most prolific authors of ETP and JBV are common to both journals and, in parallel, belong to the tenth leading contributors to the total number of published articles. One could point as a possible explanation for the founded differences between ETP and JBV, on the one hand, and SBE, on the other, is the stricter scope (economics) of the latest.

With respect to the affiliation of the most prolific authors, the Indiana University (US) provides the highest number of contributor researchers (five), followed by the University of Durham (UK) and the University of Minnesota (US), with four contributors each. The Mississippi State University (US) and the University of Nottingham (UK) are each affiliated with three authors. Exploring the affiliation according to the "seed" journal, Indiana University (US) and University of Minnesota (US) are the largest providers of prolific authors to ETP and JBV, whereas, to SBE, the most relevant institution is the University of Durham (UK).

Table 6: List of the top 20 most productive authors in ETP, JBV and SBE

		Rank			Number of Articles			
Author	**Affiliation**	ETP	JBV	SBE	ETP	JBV	SBE	**Total**
Chrisman, J.J.	Mississippi State University, US	1	7	-	31	10	0	41
Gartner, W.B.	Clemson University, US	4	3	40	15	16	3	34
Wright, M.	University of Nottingham, UK	3	9	7	16	9	9	34
Zahra, S.A.	University of Minnesota, US	2	5	177	17	13	1	31
Shepherd, D.A.	Indiana University, US	8	2	-	11	17	0	28
Macmillan, I.C.	University of Pennsylvania, US	-	1	-	0	25	0	25
Thurik, A.R.	Erasmus University Rotterdam, NL	128	92	1	2	2	20	24
Mcdougall, P.P.	Indiana University, US	9	10	69	11	9	2	22
Acs, Z.J.	George Mason University, US	-	-	2	0	0	19	19
Sapienza, H.J.	University of Minnesota, US	11	12	178	10	8	1	19
Westhead, P.	University of Durham, UK	33	17	19	6	7	6	19
Birley, S.	Bae Sistems (Retired), UK	26	6	-	7	11	0	18
Chua, J.H.	University of Calgary, CA	6	30	-	13	5	0	18
Audretsch, D.B.	Max Planck Institute of Economics, DE	78	61	4	3	3	11	17
Katz, J.A.	Saint Louis University, US	10	42	70	11	4	2	17
Brush, C.	Babson College, US	16	22	179	9	6	1	16
Kuratko, D.F.	Indiana University, US	5	203	-	15	1	0	16
Covin, J.G.	Indiana University, US	12	31	-	10	5	0	15
Reynolds, P.D.	George Mason University, US	299	32	8	1	5	9	15
Shane, S.	Case Western Reserve University, US	300	4	-	1	14	0	15
Busenitz, L.	University of Oklahoma, US	20	23	-	8	6	0	14
Hisrich, R.	Thunderbird School of Global Management, US	36	13	180	5	8	1	14
Hoy, F.	University of Texas at El Paso, US	13	43	-	10	4	0	14
Cooper, A.C.	Purdue University (Retired), US	79	8	-	3	10	0	13
Winn, J.	University of Denver, US	7	-	-	13	0	0	13
Honig-Haftel, S.	Wichita State University, US (Retired)	129	62	14	2	3	7	12
Storey, D.J.	University of Warwick, UK	-	-	3	0	0	12	12
Wiklund, J.	Syracuse University, US	17	93	181	9	2	1	12
Bruton, G.	Texas Christian University, US	21	63	-	8	3	0	11
Cowling, M.	Institute for Employment Studies, UK	301	-	5	1	0	10	11
Deeds, D.	University of St. Thomas, US	80	14	-	3	8	0	11
Gatewood, E.J.	Wake Forest University, US	22	94	182	8	2	1	11
Reid, G.C.	University of St Andrews, UK	302	-	6	1	0	10	11
Sharma, P.	Family Firm Institute, Inc., US	18	95	-	9	2	0	11
Steier, L.	University of Alberta, CA	23	65	-	8	3	0	11
De Cenzo, D.A.	Coastal Carolina University, US	14	-	-	10	0	0	10
Franklin, C.M. †	University of Southern California, US	15	-	-	10	0	0	10
Oviatt, B.	University of New South Wales, AU	24	96	-	8	2	0	10
Phan, P.H.	Johns Hopkins University, US	-	11	183	0	9	1	10
van Stel, A.	EIM Business and Policy Research, NL	303	205	11	1	1	8	10
Baron, R.A.	Oklahoma State University, US	130	18	-	2	7	0	9
Bird, B.	American University, US	19	-	-	9	0	0	9
Carree, M.	Maastricht University, NL	-	206	12	0	1	8	9

(…)

		Rank			Number of Articles			
Author	**Affiliation**	ETP	JBV	SBE	ETP	JBV	SBE	**Total**
Cressy, R.	University of Birmingham, UK	-	-	10	-	-	9	9
Kellermanns, F.W.	Mississippi State University, US	25	207	-	8	1	-	9
Wagner, J.	University of Lueneburg, DE	-	-	9	-	-	9	9
Abetti, P.A.	Rensselaer Polytechnic Institute, US	-	15	-	-	8	-	8
Autio, E.	Imperial College London, UK	-	208	15	-	1	7	8
Fitzroy, F.R.	University of St Andrews, UK	-	-	13	-	-	8	8
Kaufmann, P.J.	Boston University, US	305	19	-	1	7	-	8
Venkataraman, S.	University of Virginia, US	-	16	-	-	8	-	8
Dant, R.P.	University of Oklahoma, US	-	20	-	-	7	-	7
Henrekson, M.	Research Institute of Industrial Economics, SE	-	-	16	-	-	7	7
Johnson, P.	Durham University, UK	308	-	20	1	-	6	7
Karlsson, C.	Jönköping University, SE	-	-	17	-	-	7	7
Levesque, M.	University of Waterloo, CA	-	21	-	-	7	-	7
Watson, R.	University of Durham, UK	-	-	18	-	-	7	7

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE[12].

Note: Since the affiliation of the authors could be changed in the future, the validity of data concerning current affiliation is only guaranteed until August of 2009.

Extending the analysis to the country where the institutions affiliated with the leading contributors are located, United States of America clearly stands out as the major provider of the most prolific authors, with a total of thirty four leading authors, followed by the United Kingdom with twelve contributors. This result, however, differs according to the "seed" journal. While United States is responsible for about 84% and 81% of the most prolific authors to, respectively, ETP and JBV, its contribution to SBE is around 15%. In fact, the United Kingdom is the country that represents a larger proportion of prolific authors in SBE and the journal receives contributions from a wider group of countries such as The Netherlands, Sweden and Germany.

2.3. Data gathering considerations

The purpose of the data collection phase was to compile and sort the citations obtained from the source journals selected: ETP, JBV and SBE. JBV and SBE are indexed to the Social Sciences Citation Index (SSCI), managed by the Institute for Scientific Information (ISI)'s

[12] The years 1985-1986 for JBV and 1989-1991 for SBE were not included, since they were not available on ISI database.

Web of Science Service.[13] Thus, we started by exporting all the cited references included in SSCI of each of the articles published by JBV and SBE, from, respectively, 1987 and 1992 until February of 2009.[14] The procedure of data gathering for ETP journal was distinct, since SSCI did not provide any data prior to 2003. Thus, all the cited references of each article published between 1976 and February of 2009, were collected manually and typed in order to be processed.

The citation database of each journal consisted of the relevant details of every cited reference: name of the author(s) of the cited reference, title of the cited reference, published source (i.e., title of the journal or book) and the year of publication. Citations extracted from SSCI, however, refer only the first author of the cited reference (authors who do not obtain first authorship are not represented), which bias the results and constitutes a database limitation for JBV and SBE. As previously mentioned, we did not consider as "articles" obituaries, corrections and editorial comments. Therefore, references/citations included in editorials, research notes, corrections, comments, replies and rejoinders were excluded.

The data files of each journal were transferred to Microsoft Office Excel 2003 which enabled the harmonization and validation of the references/citations. Due to differences of format and text codification (for instance, in the names of the authors,[15] titles of the cited paper, titles of journals or books and edition's year), between journals and within the journal itself, excel's functions were used to standardize the citations' sample. In relation to data distribution, a total of 2,598 articles were published in ETP (40%), JBV (27%) and SBE (33%), during the studied period[16] which originated a total of 91,172 citations. Thus, the average number of citations provided per article was 35. Analysing separately for each of the journals, JBV has the highest average of citations – 40 – followed by SBE with 34 and, finally, ETP with an average of 30 citations.

[13] Social Sciences Citation Index (SSCI) is an interdisciplinary citation index, developed by the Institute for Scientific Information (ISI) and made available through the Web of Science service, that provides access to bibliographic and citation information from 2474 social sciences journals across more than 50 disciplines. Journals included in SSCI database are previously submitted to an objective evaluation process.
[14] Cited references contained in articles from 1985 and 1986 for JBV and 1989, 1990 and 1991 for SBE were not included in the study due to its unavailability in ISI database.
[15] Authors' first name presented with two letters (e.g. Chrisman, J.J.) was restricted to one (e.g. Chrisman, J.).
[16] From 1976 (ETP), 1987 (JBV) and 1992 (SBE) to February of 2009.

Table 7: Distribution of articles and citations per journals and year from 1992 to 2008

	Entrepreneurship Theory and Practice					Journal of Business Venturing					Small Business Economics				
	Number of Articles	%	Number of Citations	%	Average of citations per article	Number of Articles	%	Number of Citations	%	Average of citations per article	Number of Articles	%	Number of Citations	%	Average of citations per article
1992	18	4%	780	3%	43	34	6%	1001	4%	29	36	4%	816	3%	23
1993	25	5%	960	4%	38	36	6%	1276	5%	35	34	4%	779	3%	23
1994	27	6%	1154	4%	43	29	5%	1238	4%	43	48	6%	1201	4%	25
1995	15	3%	510	2%	34	27	5%	1118	4%	41	42	5%	1199	4%	29
1996	13	3%	558	2%	43	28	5%	1424	5%	51	40	5%	1106	4%	28
1997	14	3%	778	3%	56	30	5%	1381	5%	46	43	5%	1309	4%	30
1998	29	6%	1282	5%	44	28	5%	1286	5%	46	63	7%	2081	7%	33
1999	36	8%	1943	8%	54	28	5%	1276	5%	46	51	6%	1769	6%	35
2000	25	5%	1074	4%	43	23	4%	1208	4%	53	50	6%	1635	5%	33
2001	22	5%	1074	4%	49	27	5%	1611	6%	60	50	6%	1634	5%	33
2002	27	6%	1542	6%	57	29	5%	1659	6%	57	45	5%	1577	5%	35
2003	22	5%	1256	5%	57	43	8%	2071	7%	48	56	7%	2180	7%	39
2004	21	4%	1073	4%	51	45	8%	2339	8%	52	64	7%	2373	8%	37
2005	38	8%	2643	10%	70	35	6%	2150	8%	61	68	8%	2596	9%	38
2006	18	4%	1022	4%	57	40	7%	2365	8%	59	61	7%	2756	9%	45
2007	66	14%	4122	16%	62	41	7%	2205	8%	54	49	6%	2563	8%	52
2008	63	13%	3883	15%	62	35	6%	2248	8%	64	54	6%	2643	9%	49
Total	**479**	**100%**	**25654**	**100%**	**54**	**558**	**100%**	**27856**	**100%**	**50**	**854**	**100%**	**30217**	**100%**	**35**

Since the studied period differs according to the selected journal, Table 6 provides some insights regarding data distribution during the common period to all three journals: 1992 to 2008. ETP contributes with the minor proportion of articles and citations, obtaining an average of 54 citations per article. Analysing the evolution per year, ETP revels an increase on the average since 2005. SBE, on the contrary, is the major publisher of articles that provided the larger proportion of citations, having the lowest average of citations per article.

After the consolidation of the citation databases, we were able to construct three distinct but complementary rankings, for each of the "seed" journals: the twentieth most cited authors; the tenth most cited studies and the twentieth most cited journals. The rankings allowed us to answer the first research question of the study, identifying the most cited authors, studies (article or book), and journals, in each of the entrepreneurship journals select. With the identification of the key authors we could then explore if there were similarities among the leading authors previously obtained and answer the second research question, through an analysis that implied gathering personal data on the authors' educational background, research area and profession affiliation (*cf.,* Figure 3).

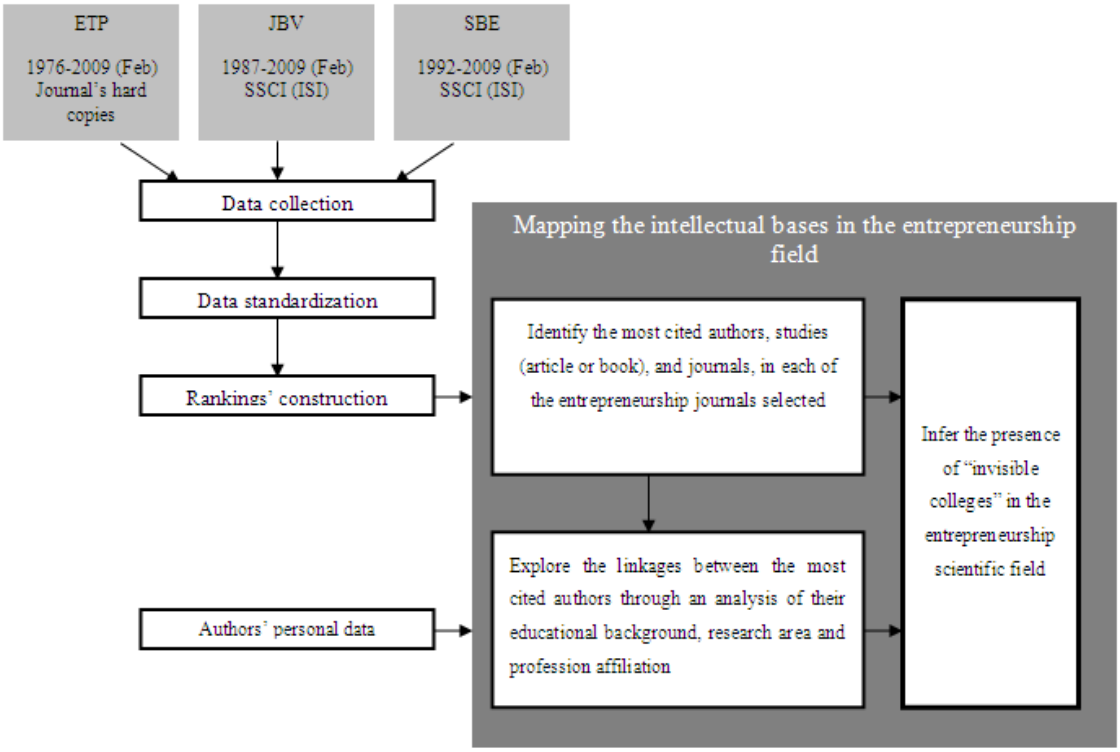


Figure 3: Methodological scheme

The mapping of the intellectual bases of the three “seed” journals combined with the analysis of the relationships between the most cited authors provides the fundamental tools to infer about the presence of invisible colleges in the entrepreneurship scientific field, answering the last research question and achieving the main purpose of the present study.

Chapter 3. Searching for the 'invisible colleges' in the Entrepreneurship literature: empirical results

3.1. Initial considerations

The present chapter answers the three research questions posed in the study. The most cited authors, studies and journals are identified and the intellectual bases of each "seed" journal are explored on several levels (Section 3.2.). The linkages between the key scholars are analysed resorting to their educational background, research area and professional affiliation. The study is further developed with the inclusion of data concerning key scholars' last affiliations (Section 3.3.). The evidence gathered from the applied analysis provides grounds to infer the presence of invisible colleges, answering the last research question and accomplished the main purpose of this study.

3.2. Who are the most cited authors, studies and journals in the last decades?

The most cited author in ETP since its first publication until February, 2009, is Michael Wright (University of Nottingham, UK). The author ranks on the 71st and 77th positions in, respectively, JBV and SBE. The most cited author in JBV, from 1987 until February, 2009, [17] is Arnold Cooper (Purdue University, US), which takes the 3rd and 37th positions, respectively, in ETP and SBE's ranking. Zoltan Acs is the most cited author in SBE, during the period of 1992 to February of 2009, [18] raking in 96th in ETP and 126th in SBE.

Table 8 exhibit the 20th most cited authors per journal, ordered by descending number of citations. The three Top 20 most cited authors' rankings only have in common one author: Howard Aldrich (University of North Carolina, US). Similarities regarding top cited authors are notoriously higher between ETP and JBS than with SBE. ETP and JBV have nine top cited authors only common to them both, whereas JBV and SBE only share exclusively two authors and ETP and SBE have no top author common just to the two journals (*cf.* Table 8).

[17] Cited references contained in articles from the initial publication's years of 1985 and 1986 for JBV were not included in the study due to its unavailability in ISI database.
[18] Cited references contained in articles from the initial publication's years of 1989 to 1991 for SBE were not included in the study due to its unavailability in ISI database.

Table 8: Ranking of the Top 20 most cited authors in ETP, JBV and SBE (name and number of citations)

Entrepreneurship Theory and Practice (ETP)		Journal of Business Venturing (JBV)		Small Business Economics (SBE)	
Name	**#**	**Name**	**#**	**Name**	**#**
Wright, M.	178	Cooper, A.	307	Acs, Z.	509
Zahra, S.	168	Aldrich, H.	241	Audretsch, D.	508
Cooper, A.	144	MacMillan, I.	213	Storey, D.	276
MacMillan, I.	138	Gartner, W.	209	Reynolds, P.	258
Brush, C.	122	Miller, D.	183	Evans, D.	248
Bygrave, W.	121	Porter, M.	183	Schumpeter, J.	173
Chrisman, J.	118	Zahra, S.	182	Porter, M.	130
Covin, J.	118	Shane, S.	180	Blanchflower, D.	126
Aldrich, H.	117	Vesper, K.	143	Geroski, P.	123
Hitt, M.	115	Hambrick, D.	141	Dunne, T.	116
Miller, D.	113	Covin, J.	135	Jovanovic, B.	116
Gartner, W.	112	Bygrave, W.	130	Cressy, R.	112
Westhead, P.	111	Birley, S.	129	Bates, T.	107
Sexton, D.	107	Eisenhardt, K.	128	Wagner, J.	100
Reynolds, P.	103	Schumpeter, J.	124	Baumol, W.	99
Sapienza, H.	103	Van de Ven, A.	121	Aldrich, H.	98
Hisrich, R.	100	Williamson, O.	120	Berger, A.	97
Birley, S.	90	Brockhaus, R.	118	Caves, R.	96
Dess, G.	87	Kanter, R.	116	Cohen, W.	94
Hambrick, D.	86	Timmons, J.	115	Davis, S.	93
				Scherer, F.	93

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE.

Common to all three journals
Only common to JBV and SBE
Only common to ETP and JBV
Only common to ETP and SBE

According to Zuccala's (2006) methodology adopted in this study (see Section1.3.), there are three principal elements to take in consideration in the definition of invisible college: influential scholars (i.e. top cited authors); subject specialty (i.e. research areas) and information use environment (i.e. affiliation environment, such as institution and country). Following this method, we assigned a main research area to each of the most cited authors and analysed, for each "seed journal", and for all journals combined, the geographical distribution of the authors' current affiliation (Figure 4).[19]

The designation of the core research areas is based on a comprehensive survey of the research themes on entrepreneurship, provided by Santos and Teixeira (forthcoming), which allowed us

[19] Due to methodological convenience top cited authors' affiliation (employer institution) and research area are exhibited in Table 12 (Section 3.3.).

to establish five distinct research areas within the entrepreneurship field.[20] Furthermore, the analysis of the academic publications and areas of interest of the most cited authors of each journal revealed that it was necessary to include two additional research areas (Labor and Industrial Organization), economic-oriented, outside the entrepreneurship field (Table 9).[21]

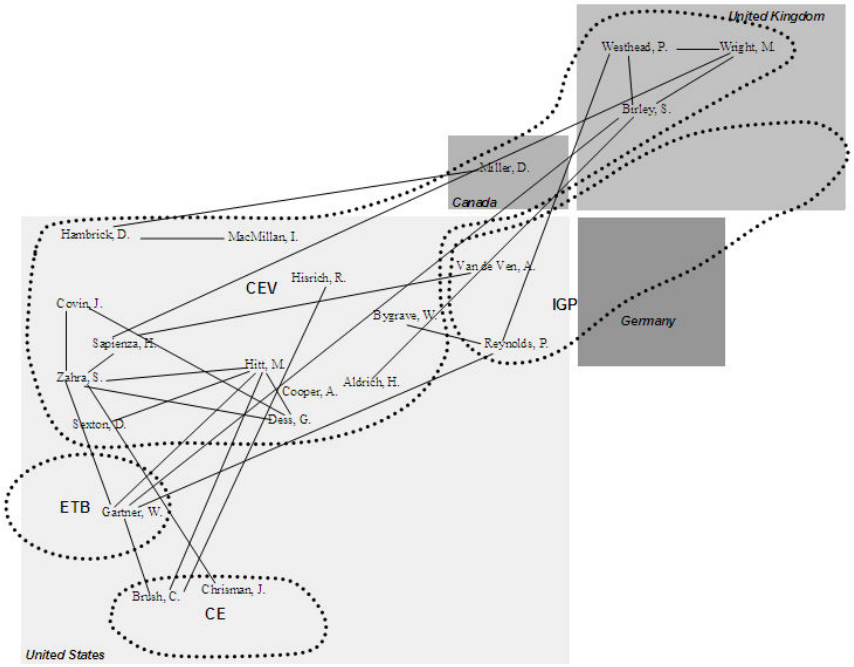
Table 9: Areas of scientific research associated with top cited authors

Research Areas	Abbreviaton
Entrepreneurship Theory Building	ETB
Characteristics of the Entrepreneur	CE
Corporate and Entrepreneurship Venturing	CEV
Entrepreneurship Education	EE
Innovation, Growth and Policy	IGP
Labor	L
Industrial Organization	IO

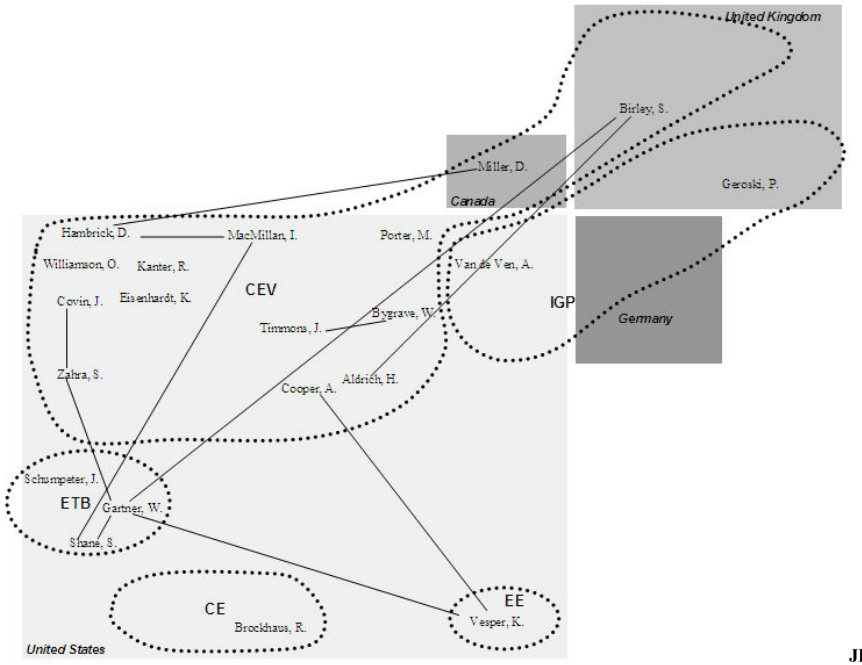
Analysing for all the "seed" journals, United States is the most prominent country, attracting around 79% of the most cited authors. United Kingdom comes in second, with 15%. Germany and Canada are less prominent, affiliating, respectively, two and one of the influential authors in entrepreneurship research. Regarding the research areas, CEV has the higher proportion of most cited authors (47%), followed by IGP (17%) and IO (13%). The other research areas have less influence. While this pattern is observed in the UK, in US, CEV remains the research area with more top cited scholars (46%), but it is followed by IO (14%). IGP represents 11%, along with CE and ETP. Overall, US is the only country with influential scholars in all the seven research areas.

[20] Santos and Teixeira (forthcoming) identified eleven major topics on entrepreneurship literature: Entrepreneurship theory building; Entrepreneurial psychological issues; Demographic traits; Entrepreneurial context; Corporate entrepreneurship; Venture capital; Entrepreneurship education; Policy; Innovation; Growth and Regional. Due to the wide scope of academic interests reflected on the influential authors' publications, we aggregated these topics into five, so that we could assign only one major research area to each of the authors – a requirement (and limitation) of the mapping constructions in this study (e.g. Figure 4 and 5).

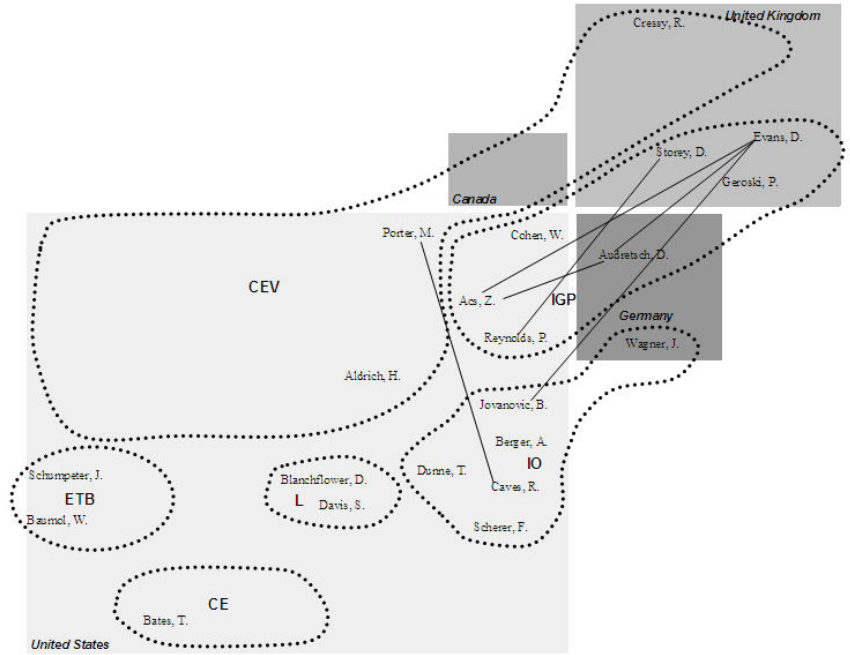
[21] Colours assigned to each scientific research are used in Section 3.3.



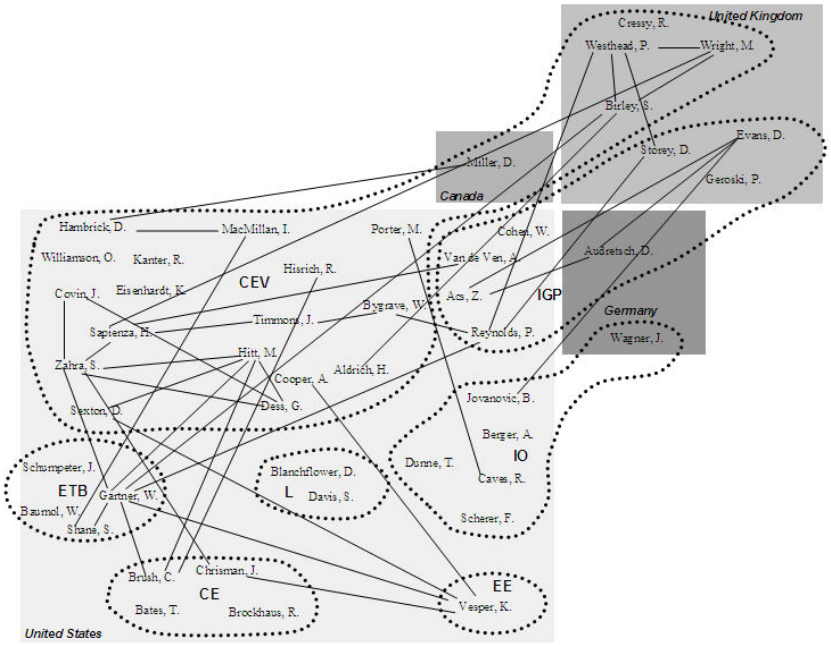
ETP



JBV



SBE



ALL

Figure 4: Mapping the international scientific linkages of the most influential authors in entrepreneurship by 'seed journal'

Legend: ETB - Entrepreneurship Theory Building; **CE** – Characteristics of the Entrepreneur; **CEV** - Corporate and Entrepreneurship Venturing; **EE** - Entrepreneurship Education; **IGP** – Innovation, Growth and Policy; **L** – Labor; **IO** – Industrial Organization.

By examining the map composed by all the "seed" journals (Figure 4), we observe that the most cited authors from entrepreneurship specific areas collaborate with key authors from other research areas, particularly CVE, where different authors relate to other scholars, from five distinct areas. The economic-oriented areas are the exception to this scenario, containing highly cited authors rather isolated from each other, with scarce or no collaboration ties.

Comparing the mapping for the most cited authors for each of the selected journals, we observed that both ETP and JBV present similar intellectual structures, with respect to the research areas, EE being the exception – there are no key authors in this area, in ETP. For both journals, CVE is the subject specialty involving the highest number of influential authors and the economic-oriented subject specialties of IO and L do not appeared in the set. The main difference between the two journals seems to lie on the areas of CE and EE. CE appears to be a more influential research area in ETP comparatively to JBV, namely trough the contributions of Candida Brush and James Chrisman (respectively, 5th and 7th in the top 20 most cited authors of ETP), that impel the collaboration between researchers of distinct subject specialities. In JBV, this area has only a single influential author – Robert Brockhaus – with no visible collaborations. The inverse situation occurs with EE: whereas excluded in the ETP mapping, it has a significant role in JBV, due to the work of Karl Vesper (9th in the top 20 most cited authors of JBV). Nevertheless, influential authors such as Gartner, Zahra, Covin, Hambrick, MacMillan, Aldrich and Birley and their collaborations remain common to both journals. Top cited authors' geographical distribution is also very similar: both journals have no influential authors located in Germany, maintaining US, Canada and UK (although UK concentrates a higher number of key scholars in ETP compared to JBV). The results obtained support the assessment of existing similarities in the intellectual structure and linkages among influential authors for ETP and JBV, which suggests that they could be part of the same invisible college.

SBE's mapping is substantially different from the other two "seed" journals. The core area that gathers the higher number of most cited authors is Innovation, Growth and Policy, IGP (with seven authors), followed by Industrial Organization, IO (with six authors). CEV, previously the most appealing research area for ETP and JBV, is now relegated to the third position, with only three key authors. SBE is the only journal to contemplate the economic-oriented areas of IO and L and, contrarily to ETP and JBV, collaborations between influential

authors of distinct subject specialties are almost inexistent. Instead, the mapping of SBE unveils a highly concentration of collaborations between the most cited authors within the main research area – IGP. Additionally, the top five most cited authors of SBE belong to this subject specialty. The geographic distribution of the most cited authors is also distinct: American domain is counterbalanced by the UK and Germany. The two European countries embrace more than half of the total key authors' affiliations in the core area of IGP and three of these key scholars are among the top five most cited authors in SBE. Canada is absent in SBE. The findings seem to indicate that the "seed" journal SBE represents a rather distinct invisible college within the entrepreneurship field.

The differences exposed by the above evidence could not be discovered if the present study had been based on one single source of data, which emphasizes the importance of using three "seed" journals to assess the existence of invisible colleges. Table 10 presents, for each of the selected journals, the top 10 most cited studies, ranking them by their number of citations. The most cited study in ETP (90 citations) and JBV (80 citations) is the book *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*, a seminal contribution by Joseph Schumpeter to the conceptualization of entrepreneurial processes (Schildt et al., 2006). Schumpeter's book is also the only cited study common to all the three journals and ranks as the 3rd most cited study in SBE. The most cited study in SBE (cited 92 times) is David Storey's book *Understanding the small business sector*, where the author synthesizes the research on small business and draws conclusions from a policy perspective (Landström, 2005).

Again, we can identify several similarities among ETP and JBV regarding top cited studies. ETP and JBV's rankings have in common seven highly cited studies, contrasting emphatically with SBE's ranking, which, besides Schumpeter's book, only has in common with JBV Michael Porter's book *Competitive advantage: Creating and sustaining superior performance.* The differences between ETP, JBV and SBE extend to the main subjects of the most cited studies. While in ETP and JBV's studies prevail themes related with corporate entrepreneurship and venture capital, SBE's themes revolve around innovation combined with industrial issues. The evidence gathered and illustrated in Table 10 further corroborates the distinct intellectual structure underlying ETP and JBV, on the one hand, and SBE, on the other.

Table 10: Ranking of the Top 10 most cited studies in ETP, JBV and SBE

	Author(s)	Date	Title	Source	Number of citations
ETP	Schumpeter, J.	1934	The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle	-	90
	Gartner, W.	1988	"Who is an entrepreneur?" is the wrong question	American Journal of Small Business	63
	Shane, S.;Venkataraman, S.	2000	The promise of entrepreneurship as a field of research	Academy of Management Review	59
	Barney, J.	1991	Firm resources and sustained competitive advantage	Journal of Management	57
	Gartner, W.	1985	A conceptual framework for describing the phenomenon of new venture creation	Academy of Management Review	57
	McClelland, D.	1961	The achieving society	-	55
	Porter, M.	1980	Competitive strategy: Techniques for analyzing industries and competitors	-	55
	Stinchcombe, A.	1965	Social structure and organizations	-	52
	Low, M.;MacMillan, I.	1988	Entrepreneurship: Past research and future challenges	Journal of Management	49
	Covin, J.;Slevin, D.	1991	A conceptual model of entrepreneurship as firm behavior	Entrepreneurship Theory and Practice	45
	Vesper, K.	1980	New venture strategies	-	45
JBV	Schumpeter, J.	1934	The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle	-	80
	Porter, M.	1980	Competitive strategy: Techniques for analyzing industries and competitors	-	79
	Vesper, K.	1980	New venture strategies	-	66
	Stinchcombe, A.	1965	Social structure and organizations	-	61
	Low, M.;MacMillan, I.	1988	Entrepreneurship: Past research and future challenges	Journal of Management	59
	Gartner, W.	1985	A conceptual framework for describing the phenomenon of new venture creation	Academy of Management Review	56
	Jensen, M.;Meckling, W.	1976	Theory of the firm: Managerial behavior, agency costs and Ownership structure	Journal of Financial Economics	53
	McClelland, D.	1961	The achieving society	-	52
	MacMillan, I.;Siegel, R.;Subbanarasimha, P.	1985	Criteria used by venture capitalists to evaluate new venture proposals	Journal of Business Venturing	47
	Porter, M.	1985	Competitive advantage: Creating and sustaining superior performance	-	47
SBE	Storey, D.	1994	Understanding the small business sector	-	92
	Jovanovic, B.	1982	Selection and the evolution of industry	Econometrica	91
	Schumpeter, J.	1934	The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle	-	89
	Audretsch, D.	1995	Innovation and Industry Evolution		85
	Acs, Z.;Audretsch, D.	1990	Innovation and small firms		77
	Evans, D.;Jovanovic, B.	1989	An estimated model of entrepreneurial choice under liquidity constraints	Journal of Political Economy	75
	Porter, M.	1985	Competitive advantage: Creating and sustaining superior performance	-	66
	Schumpeter, J.	1942	Capitalism, socialism, and democracy	-	53
	Stiglitz, J.;Weiss, A.	1981	Credit rationing in markets with imperfect information	American Economic Review	52
	Acs, Z.;Audretsch, D.	1988	Innovation in large and small firms: An empirical analysis	American Economic Review	49
	Dunne,T.; Roberts, M.;Samuelson, L.	1989	The growth and failure of U.S. manufacturing plants	Quarterly Journal of Economics	49

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index of the ISI Web of Science, for JBV and SBE

Common to all three journals
Only common to JBV and TE
Only common to ETP and JBV
Only common to ETP and SBE

The most cited journals in ETP, JBV and SBE are identified and ranked in Table 11. The most cited journal in ETP is ETP itself. The same occurs with JBV and SBE. The results do not surprise and, to some extend, they were expected since it has been established by several authors that a journal will cite itself more often than other citing journals (Ratnatunga and Romano, 1997). Considering the total number of citations from the three journals, JBV is the most influential journal, receiving the highest number of citations (a total of 5468 citations). ETP ranks as the second most cited journal with 3329 citations, followed by Strategic Management Journal (3206 citations). SBE appears in 6th, being cited by the "seed" journals 1841 times. The evidence obtained is in line with previous studies that established ETP and JBV as the journals with the greatest impact on the development of the field of entrepreneurship (e.g. Dean, 2007; Chandler and Lyon, 2001; Shane, 1997; Romano and Ratnatunga, 1996).

The three journals have in common eight cited journals but their distribution and citation pattern differs from ETP and JBV to SBE. While in ETP and JBV six of the eight cited journals in common rank among the ten most cited journals, in SBE top ten only includes three cited journals from the eight shared by all the "seed" journals. Citation pattern also confirms the differences between SBE and the other two journals. In ETP and JBV management-oriented journals domain the top positions in the raking, whereas SBE gives preference to journals economic-oriented. The Academy of Management Review and the Journal of Finance are illustrative of the distinction between ETP/JBV and SBE. If the "seed" journals' rankings only contemplated the ten most cited studies, the gap between ETP/JBV and SBE would be even more visible: the selected journals would have only two most cited journals in common, but ETP and JBV would steel remain with nine journals in common.[22] The similarities between ETP and JBV are notorious: from twenty most cited journals, sixteen are common to the two journals, and eight are exclusively common to the both.

The analysis of the most cited authors, studies and journals finds evidence that attest the multidisciplinary nature of the entrepreneurship field. The citations gathered arise from a wide of disciplines across the social sciences such as economics, management, marketing, finance, sociology and psychology.

[22] This difference could be explained by the fact that Frontiers of Entrepreneurship Research was not considered a journal when gathering data from ETP.

Table 11: Ranking of the Top 20 most cited journals in ETP, JBV and SBE

Entrepreneurship Theory and Practice		Journal of Business Venturing		Small Business Economics	
Cited Journal	**#**	**Cited Journal**	**#**	**Cited Journal**	**#**
Entrepreneurship Theory and Practice	2053	Journal of Business Venturing	2825	Small Business Economics	1662
Journal of Business Venturing	2047	Strategic Management Journal	1573	American Economic Review	762
Strategic Management Journal	1253	Entrepreneurship Theory and Practice	974	Journal of Business Venturing	596
Academy of Management Review	1134	Academy of Management Journal	933	Journal of Political Economy	564
Academy of Management Journal	971	Academy of Management Review	878	Journal of Finance	387
Administrative Science Quarterly	674	Administrative Science Quarterly	809	Strategic Management Journal	380
Journal of Small Business Management	660	Frontiers of Entrepreneurship Research	639	Review of Economics and Statistics	377
Family Business Review	516	Harvard Business Review	473	Quarterly Journal of Economics	361
Journal of Management	500	Management Science	428	Journal of Industrial Economics	331
Harvard Business Review	494	Journal of Small Business Management	418	Regional Studies	315
Management Science	300	Journal of Management	388	Entrepreneurship Theory and Practice	302
Organization Science	280	Organization Science	268	The Economic Journal	297
Journal of Financial Economics	235	Journal of Financial Economics	248	International Journal of Industrial Organization	292
Journal of Management Studies	231	Journal of Finance	246	Research Policy	278
Journal of Finance	230	American Economic Review	231	Econometrica	276
Journal of International Business Studies	222	Journal of International Business Studies	206	Journal of Small Business Management	237
Entrepreneurship & Regional Development	191	American Journal of Sociology	203	Journal of Financial Economics	234
American Journal of Sociology	189	Family Business Review	192	Administrative Science Quarterly	213
Small Business Economics	179	Journal of Marketing	191	Journal of Economic Literature	208
California Management Review	171	Research Policy	184	Academy of Management Review	205

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE.

Common to all three journals
Only common to ETP and JBV
Only common to JBV and SBE
Only common to ETP and SBE

Several authors (e.g. Grégoire et al., 2006; Cornelius et al., 2006) report in their work the diversity of entrepreneurship research, pointed that this field attracts authors with different backgrounds and different methodological traditions.

When comparing the most prolific authors with the most cited authors, we observe that nineteen scholars fall into both categories, confirming that a high productive author tends to emerge as a highly influential author and, ultimately, vouching for the field's maturity. This conclusion is also congruent with Cornelius et al. (2006) results of an increasing internal orientation in entrepreneurship research. The fact that authors with research areas outside the entrepreneurship's mainstream research (such as IO and L) are among the most cited authors appears to be a contradiction to the previous conclusion, since, as Cornelius et al. (2006) stress, entrepreneurship research has been increasingly self-reflective and the influence of outsiders (researchers that not cite but are being cited by entrepreneurship researchers) has been decreasing over the time. However, a closer look into the results reveals that the majority of outsiders comes from Small Business Economics, a more recent and economic-oriented journal than ETP and JBV, which underpins another finding of Cornelius et al. (2006): entrepreneurship scholars have increasingly specialized thematically, indicating that autonomous research groupings will develop.

The evidence obtained by the study of the most cited authors, studies and journals, performed on the selected journals, characterizes the intellectual bases of the field of entrepreneurship and suggests that similarities between ETP and JBV could indicate the presence of an invisible college and, at the same, SBE's distinct intellectual structure may denote a dissimilar invisible college. Nevertheless, to assess the phenomenon of the invisible colleges, one should include both formal and informal communication (Zuccala, 2006) and the previous analysis does not provide any insights regarding authors' connectivity through informal channels.

In order to validate the previous findings and follow the methodological approach proposed in Figure 1 (See Section 1.3.), in the next section, we complement the co-citation analysis with the study of the correlations between the most cited authors, regarding their educational training, professional affiliation and research area. The analysis will allows us to assess the linkages between the most influential authors, revealing potential social informal connections among key authors.

3.3. Are there any similarities/correlations between the most cited authors regarding their educational training and professional affiliation, and research area?

In the previous section, we identified, trough a (co)citation analysis, 47 highly cited authors in the field of entrepreneurship. But co-citation techniques, though assessing the intellectual structure of a research field, do not capture all the insights related with the phenomenon of the invisible college (Zuccala, 2006). As Reader and Watkins (2006) point, are the highly cited authors strictly part of a set of ideas constructed in the minds of the citers; or is there an effective net of social interactions between the influential scholars? In order to answer this question, we complement the (co)citation analysis, exploring the possible collaborations between highly cited authors, based on the study of their affiliation, educational background and main research area.

Table 12 exhibits personal data on the 47 most cited authors (employer institution, research area and granting school),[23] ranking them by the total number of citations obtained from the three selected journals. Among the most cited authors David Audretsch is the scholar with the highest number of citations received from all the "seed" journals, although he is not part of ETP and JBV's rankings. Regarding key authors current affiliation – represented in the column "employer institution" – we observed that a total of 40 institutions employ the 47 most cited authors.[24] Harvard University (US) employs the highest number of most cited authors (5), followed by Babson College (US) and University of Minnesota (US), with three authors each and George Mason University (US) and New York University (US), both with two. The remaining 32 institutions employ only one influential author each. With respect to the organizations' geographical distribution, US stands as the country where more institutions are located (29), followed by the UK (7) and then, Germany and Canada, with two institutions each. By combining the number of citations presented in Table 12, with the correspondent research area, for each cited author, we confirm the previous results regarding research areas. CVE is the main research area for twenty two influential authors, IGP attracts eight scholars, followed by IO, with six scholars.

[23] Validity regarding data on the current Professional affiliation of the authors is only guaranteed until August of 2009. Due to the absence of information, it was no possible to identify the granting school of one author and the graduation year of four authors.

[24] Note that three authors (Miller, Hambrick and Sexton) are affiliated with two institutions each.

Table 12: Information on the affiliation, educational background and research area of the 47 most cited authors

	Author	Number of Citations			Employer institution	Secondary unit	Research Area	Granting School (Ph.D.)	Year
		ETP	JBV	SBE					
1	Audretsch, D.	48	39	508	Max Planck Institute of Economics, DE	Entrepreneurship, Growth and Public Policy Group	IGP	University of Wisconsin-Madison, US	1980
2	Acs, Z.	32	37	509	George Mason University, US	School of Public Policy	IGP	Graduate Faculty, The New School, US	1980
3	Cooper, A.	144	307	73	Purdue University (Retired), US	Krannert School of Management (Retired)	CEV	Harvard University, US	1962
4	Aldrich, H.	117	241	98	University of North Carolina, US	Kenan-Flagler Business School	CEV	University of Michigan, US	1969
5	Reynolds, P.	103	94	258	George Mason University, US	School of Public Policy	IGP	Stanford University, US	1969
6	Gartner, W.	112	209	77	Clemson University, US	Arthur M. Spiro Institute for Entrepreneurial Leadership	ETB	University of Washington, US	1982
7	Zahra, S.	168	182	38	University of Minnesota, US	Carlson School of Management	CEV	University of Mississippi, US	1982
8	Porter, M.	55	183	130	Harvard University, US	Harvard Business School	CEV	Harvard University, US	1973
9	MacMillan, I.	138	213	14	University of Pennsylvania, US	Wharton School of Business	CEV	University of South Africa, ZA	1975
10	Storey, D.	49	36	276	University of Warwick, UK	Warwick Business School	IGP	Newcastle University, UK	1978
11	Schumpeter, J. †	49	124	173	Harvard University, US	-	EBT	University of Vienna, AT	1906
12	Miller, D.	113	183	42	University of Montréal and University of Alberta, CA	Ecole des Hautes Etudes Commerciales and Family Enterprise and Strategy	CEV	McGill University, CA	1976
13	Shane, S.	78	180	78	Case Western Reserve University, US	Weatherhead School of Management	EBT	University of Pennsylvania, US	1992
14	Evans, D.	13	48	248	Law and Economics Consulting Group (LECG) Europe, UK	-	IGP	University of Chicago, US	1983
15	Bygrave, W.	121	130	33	Babson College, US	-	CEV	-	-
16	Birley, S.	90	129	54	Bae Sistems (Retired), UK	-	CEV	*N/a*	*N/a*
17	Covin, J.	118	135	17	Indiana University, US	Kelley School of Business	CEV	University of Pittsburgh, US	1985
18	Wright, M.	178	47	35	University of Nottingham, UK	Nottingham University Business School	CEV	University of Nottingham, UK	*N/a*
19	Brush, C.	122	86	36	Babson College, US	-	CE	-	-
20	Westhead, P.	111	47	85	University of Durham, UK	Durham Business School	CEV	University College of Wales, UK	1988
21	Hambrick, D.	86	141	12	Pennsylvania State University and Columbia University, US	Smeal College of Business and Graduate School of Business	CEV	Pennsylvania State University, US	1979
22	Williamson, O.	35	120	79	University of California, Berkeley, US	Walter A. Haas School of Business	CEV	Carnegie Mellon University, US	1963
23	Vesper, K.	64	143	15	University of Washington, US	University of Washington Business School	EE	Stanford University, US	1969
24	Eisenhardt, K.	63	128	26	Stanford University, US	Department of Industrial Engineering and Engineering Management	CEV	Stanford University, US	1982
25	Hisrich, R.	100	87	28	Thunderbird School of Global Management, US	Walker Center for Global Entrepreneurship	CEV	University of Cincinnati, US	1971

(…)

	Author	Number of Citations			Employer institution	Secondary unit	Research Area	Granting School (Ph.D.)	Year
		ETP	JBV	SBE					
26	Sexton, D.	107	96	11	Ohio State University (Retired)/ Ewing Marion Kauffman Foundation, US	-	CEV	Ohio State University, US	1972
27	Van de Ven, A.	81	121	11	University of Minnesota, US	Carlson School of Management	IGP	University of Wisconsin, US	1972
28	Timmons, J. †	75	115	20	Babson College, US	-	CEV	Harvard University, US	1971
29	Sapienza, H.	103	80	27	University of Minnesota, US	Carlson School of Management	CEV	University of Maryland, US	1989
30	Bates, T.	25	76	107	Wayne State University, US	Department of Economics	CE	University of Wisconsin, US	1972
31	Brockhaus, R.	63	118	13	Saint Louis University, US	John Cook School of Business	CE	University of Washington , US	1976
32	Hitt, M.	115	59	9	Texas A&M University, US	Mays Business School	CEV	University of Colorado, US	1974
33	Chrisman, J.	118	47	15	Mississippi State University, US	College of Business and Industry	CE	University of Georgia, US	1986
34	Dess, G.	87	78	14	University of Texas at Dallas, US	School of Management	CEV	University of Washington, US	1980
35	Baumol, W.	20	48	99	New York University, US	Leonard N. Stern School of Business	ETB	University of London, UK	1949
36	Kanter, R.	47	116	3	Harvard University, US	Harvard Business School	CEV	University of Michigan, US	1967
37	Cohen, W.	11	53	94	Duke University, US	Fuqua School of Business	IGP	Yale University, US	1981
38	Blanchflower, D.	5	9	126	Dartmouth College, US	Department of Economics	L	University of London, UK	1985
39	Caves, R.	10	34	96	Harvard University, US	Department of Economics	IO	Harvard University, US	1958
40	Geroski, P. †	3	9	123	University of London, UK	London Business School	IGP	University of Warwick, UK	*N/a*
41	Jovanovic, B.	4	14	116	New York University, US	Department of Economics	IO	University of Chicago, US	1978
42	Cressy, R.	4	12	112	University of Birmingham, UK	Birmingham Business School	CEV	University of Edinburgh, UK	*N/a*
43	Scherer, F.	11	24	93	Harvard University, US	John F. Kennedy School of Government	IO	University of Michigan, US	1954
44	Dunne, T.	0	10	116	Federal Reserve Bank of Cleveland, US	Research Department	IO	Pennsylvania State University, US	1987
45	Berger, A.	9	11	97	University of South Carolina, US	Moore School of Business	IO	University of California, Berkeley, US	1983
46	Wagner, J.	12	4	100	University of Lueneburg, DE	Institute of Economics	IO	University of Hannover, DE	1984
47	Davis, S.	6	6	93	University of Chicago, US	Booth School of Business	L	Brown University, US	1986

Note: Authors are ordered by the total of citation in each journal. The grey cells indicate that the author is part of the Top 20 most cited authors in the designated journal

Legend: ETB - Entrepreneurship Theory Building; **CE** – Characteristics of the Entrepreneur; **CEV** - Corporate and Entrepreneurship Venturing; **EE** - Entrepreneurship Education; **IGP** – Innovation, Growth and Policy; **L** – Labor; **IO** – Industrial Organization**.**

CE, ETB, L and EE are less prominent areas of interest. CVE is the most frequent research area associated with ETP and JBV, while in SBE, IGP domains, as previously investigated. Beyond that, we can also draw further evidence: IGP, in spite of not being the most frequent research area, is the main research area for the two most cited authors – Audretsch and Acs – among the 47. Another point should be stressed: the bottom of top cited authors are exclusively associated with SBE (they are seldom cited by ETP and JBV) and eight of them are related with economic-oriented areas, whereas ETP and JBV do not rank in the top 20 any authors with research areas non-related with entrepreneurship. These findings support the preceding evidence that suggests that the three entrepreneurship "seed" journals embody two (in)visible colleges in the entrepreneurship field: one associated with ETP and JBV and the other associated with SBE.

Educational training is also explored gathering information concerning the institution that granted the PhD degree to the cited authors (if that is the case) and respectively, the graduation year. We identify 31 distinct universities that granted the doctoral degree to 44 of the most cited authors. Harvard University (US) granted 4 PhDs, followed by the Stanford University US), University of Michigan (US) and University of Washington (US), which granted 3 PhDs each. Pennsylvania State University (US), University of Chicago (US), University of Wisconsin (US) and University of London (UK) have two PhDs each among the most cited authors. The remaining 23 universities granted a PhD to only one top cited author. The geographical distribution of the cited authors' granting schools has a similar pattern to the one concerning their affiliation. US concentrates the vast majority of the universities (33), followed by UK (7). The only two differences are the inclusion of New Zealand and Austria, in the granting schools of the most cited authors. Observing the graduation year, we infer that the 44 PhD most cited authors hold their degree for a relatively long time (the PhD degree most recent was granted 17 years ago and belongs to Scott Shane).

According to Zuccala (2006) the Information Use Environment is a key element to identify the invisible colleges, representing a scientific workspace where information related behaviours occur. Based on this concept, we include additional information regarding the academic experience of the most cited authors, so that our analysis captures all the (invisible) links between the key scholars. Thus, to infer if there are social correlations between the highly

cited authors, in addition to PhD's university and current professional affiliation, we gather data concerning other current affiliations, besides the main employer institution, and present visiting academic institutions along with data on previous affiliations[25] and past visiting academic institutions (Table A5 provides, in detail, the information collected with respect to these two items).[26]

Figure 5 illustrates graphically the links between the highly cited authors, based on the academic institutions that received the authors over their professional career. We only considered institutions that had received or are currently employing more than two top cited authors, which give us a total of 24 institutions.[27] The map represents the links between a total of 44 top cited authors, through 24 organizations. Each of the top cited authors is identified by their rank number established in Table 11, as well as, the respective research area colour. Each link is represented by a straight lines and denotes that at least one top cited author worked in the two linked institutions. An overall analysis of the map tells us that all institutions have received at least one top cited author which suggests a substantial degree of correlation between the most cited authors in entrepreneurship research.

The connections between the institutions and number of influential authors associated with them are distinct, according to each institution. Harvard University (US) is the institution that gathers the highest number of top cited authors (9), followed by the University of Pennsylvania (US), with 7 key authors. A total of 12 institutions is attach with 3 top cited authors. The University of Pennsylvania (US) holds the highest number of links (11), which implies that top cited authors connect with others, trough 11 distinct institutions. University of London (UK) comes in second, being connected with 10 institutions. The least interactive institutions, among the top ones, are the University of Michigan (US) and the University of Washington (US), with, respectively, 2 and 3 links.

[25] The past affiliations previous to cited authors' doctoral degree were disregarded.
[26] Due to the absence of information we did not gathered information on current and past affiliations/visiting academic institutions for six cited authors.
[27] A previous attempt was made in order to include institutions with more than one highly cited author but the number of institutions obtained (48) plus the inherent linkages among them did not permit a graphical representation.

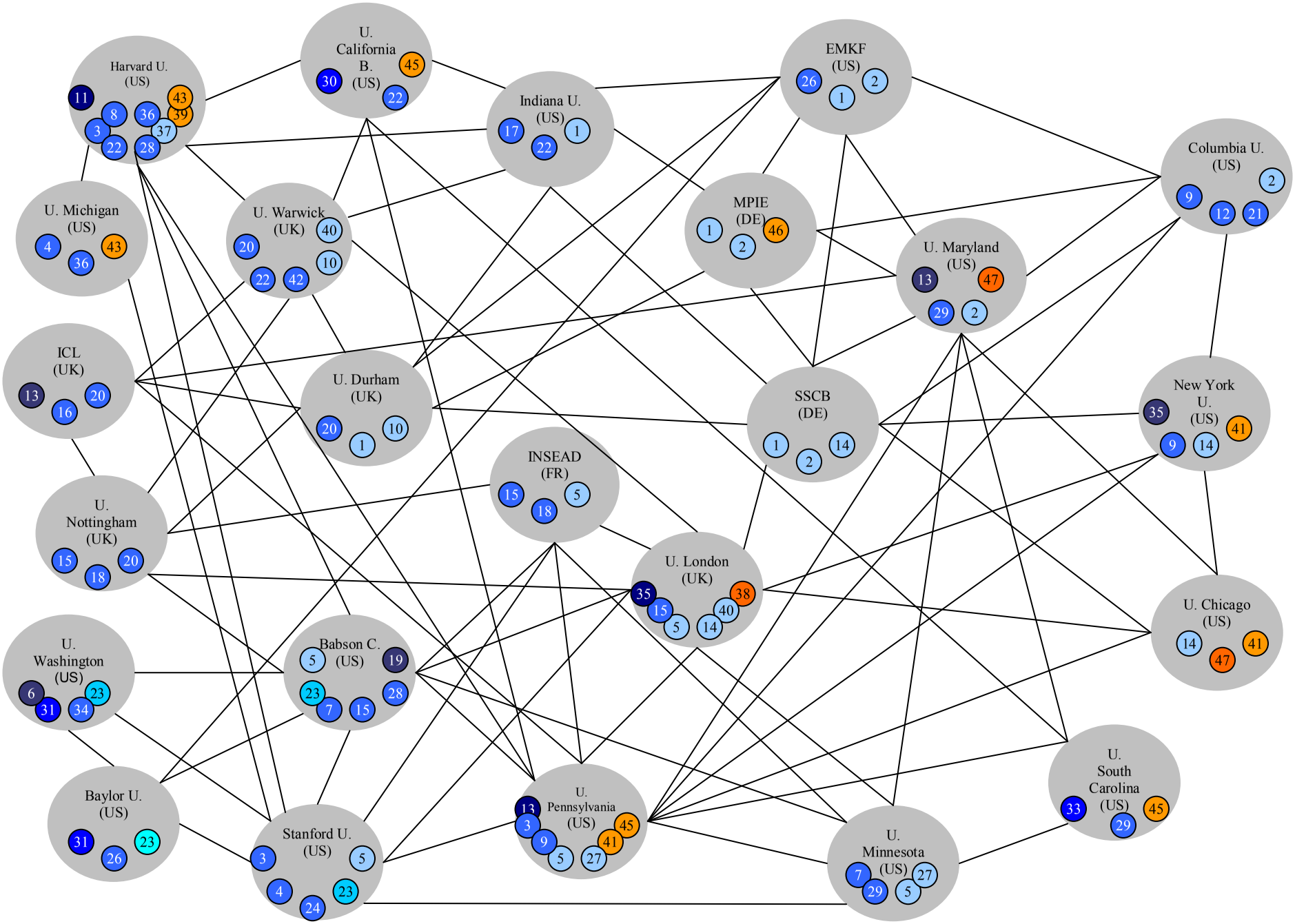


Figure 5: Mapping links among top cited authors in entrepreneurship scientific area

Note: Each link means that at least two top cited authors worked in the two linked organizations

ETB	Entrepreneurship Theory Building	CE	Characteristics of the Entrepreneur	CEV	Corporate and Entrepreneurship Venturing	L	Labor
EE	Entrepreneurship Education	IGP	Innovation, Growth and Policy	IO	Industrial Organization		

One should notice that the number of top cited authors associated with an institution is not, per se, an indicative of the degree of connectivity between influential authors. For instance, the University of Michigan (US) receives 4 top cited authors but only links with 2 other institutions. On the other hand, the Social Science Centre of Berlin (DE) receives only 3 top cited authors, but establishes connections with 9 distinct institutions, which attests for the top cited authors' professional mobility, confirmed when we identify two of the cited authors, Audretsch and Acs, the two most cited authors in our study and renowned academics, with a vast and productive career.

An analysis on the research area of the 44 top cited authors indicates that the degree of collaboration, represented by the links between institutions, agrees with the initial distribution of authors through the research areas, i.e., the majority of the links established belong to top cited authors, whose main research area is CVE, IGP appears in second, followed by IO. The exception to this pattern comes from the research area of EE that, with only one top cited author, connects with 4 other institutions, overcoming the research area of Labor (L) that has two influential authors with no established collaborations outside their current affiliation.

The evidence obtained indicates that top cited authors are highly connected, which is particularly visible to the research areas of CVE and IGP.

3.4. Are there different "invisible colleges" in entrepreneurship research area?

Identifying the most cited authors, studies and journals for the three "seed" journals allowed us to explore the intellectual structure of entrepreneurship research. Evidence supports the multidisciplinary nature of the entrepreneurship field, when results show that highly influential authors in the field of entrepreneurship are working in several subject specialities, including research areas not so entrepreneurship focussed, like economics. These so called "non-entrepreneurship" researchers are highly related with the specific orientation of each of the "seed" journals. The present study empirically corroborates the idea that ETP and JBV are the most influential journals in the entrepreneurship field and SBE is, indeed, economic oriented, embodying economic-oriented researchers among the most cited authors. In fact, the (co) citation analysis confirms several similarities between ETP and JBV regarding the most cited authors, studies and journals and main research area and attests for the distinct intellectual structure of SBE.

To infer the presence of invisible colleges it is crucial to include in the analysis the informal channels of scientific communication. Thus, the second stage of the study consisted in exploring the informal communication links between highly cited authors. By collecting personal data regarding top cited authors' current and past affiliation, educational background and combining it with the research areas assigned, one could infer about the social ties established among the top cited authors. The results reveal that 44 key authors are highly correlated among themselves, through 24 distinct institutions where they developed or are currently developing their work.

The evidence provided by the two stages of the study fulfils the key elements to assess the existence of invisible colleges: social actors (the most cited authors); subject specialty (research areas) and information use environment (professional affiliation of the most cited authors). Formal and informal communication is represented by, respectively, the most cited studies/journals and affiliations' linkages. Thus, it is possible to identify two invisible colleges: one associated with ETP and JBV journals and the other associated with SBE.

The results obtained are summarized in Figure 6. Social actors are represented by the top five most cited authors of each "seed" journal ; the scientific research area that attracts the highest number of most cited authors is the "subject specialty" and the information use environment is defined by the professional affiliation where more highly cited authors currently (until August 2009) work. Formal and informal communication is given, respectively, by the top five studies and journals for each of the three journals and the linkages extracted from information regarding top cited authors' current and past affiliations and PhD granting affiliation. When examining the evidence exhibited in Figure 6, we confirm previous assessment concerning the intellectual proximity of ETP and JBV journals and their distance towards SBE's intellectual bases. The formal channels of communication further enhance, on one hand, the similarities between ETP and JBV and, on the other, the differences regarding SBE: the top five cited studies and top five cited journals are quite similar between ETP and JBV, while the evidence for SBE empirically shows that this journal values economic-related topics. Informal ties also corroborate the findings: ETP and JBV have more affiliations in common than with SBE and the geographical distribution of the affiliations' pattern also differ from ETP/JB (where the US supremacy prevails) to SBE (where UK and Germany have a significant impact).

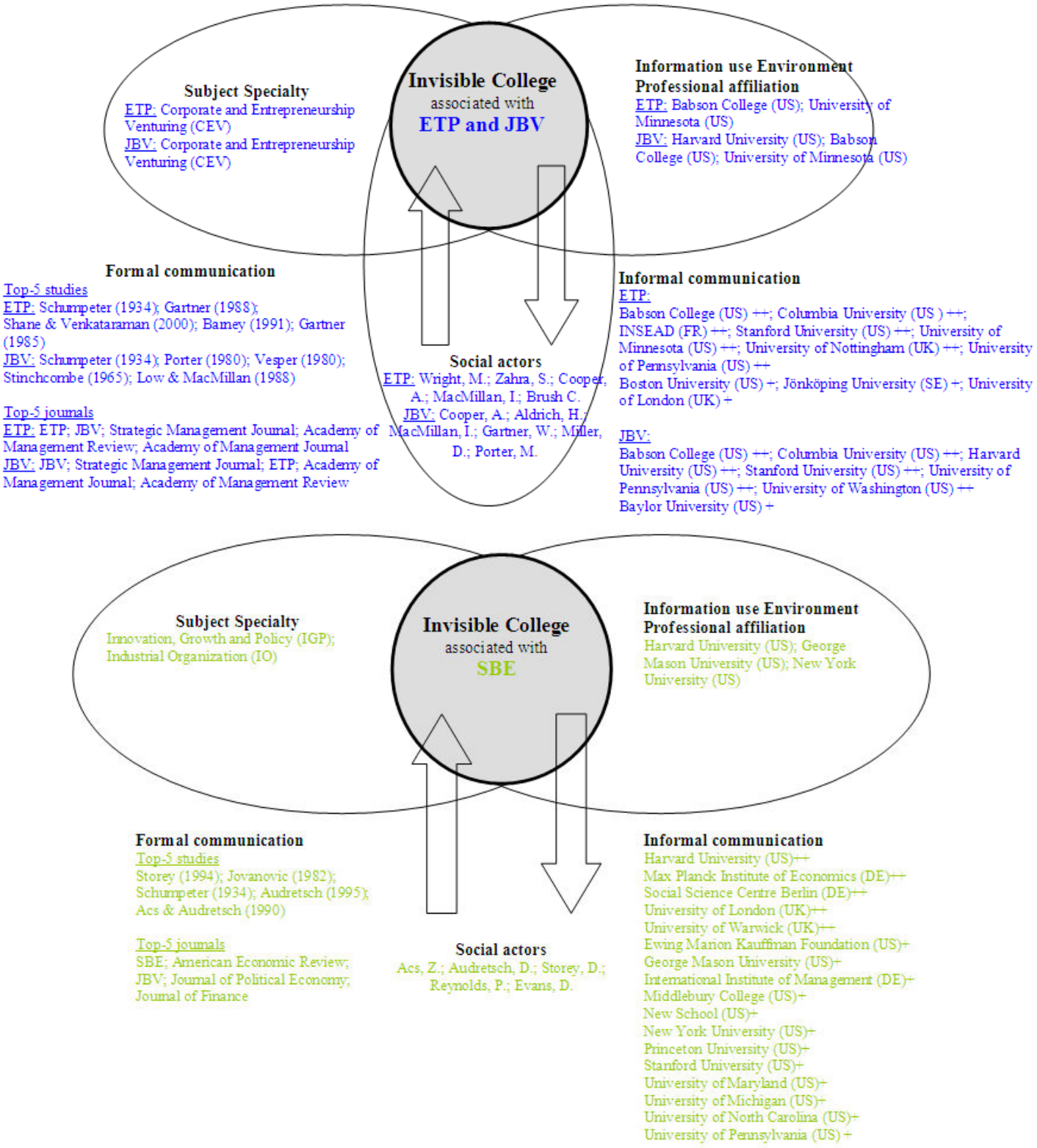


Figure 6: Invisible colleges in entrepreneurship research

Notes: Universities listed in "Informal Communication" have affiliated at least 3 of the most cited authors in the Journal (++) or have affiliated 2 of the most cited authors in the Journal who have more than 3 links with universities that also affiliates most cited authors in the Journal(+)

One should point that the evidence regarding links among the most cited authors reveals a strong interaction among scholars from the two invisible colleges, which means that they are not isolated from each other or even from influential authors of other scientific fields.

In short, based on an analysis on the "seed" journals (ETP, JBV and SBE), we conclude that there are two invisible colleges in the entrepreneurship field. The first invisible college is focussed specifically in entrepreneurship research, as the orientation of ETP and JBV. The similarities between these two journals were a constant in all the stages of the study. The second invisible college is originated by the evolution of the entrepreneurship field into an increasingly specialized thematically discipline, developing autonomous research groupings, such as the one represented by SBE.

Conclusions

The disciplinary rules and research problems of a scientific domain and their acknowledgment by scholars within that domain are rooted by the internal ties that link scientists with similar research interests in the form of what Crane (1972) calls "invisibles colleges" (Reader and Watkins, 2006). In this sense, they are valuable instruments to identify processes of knowledge dissemination and monitor the dynamics of scientific developments.

The aim of this study was to discover if there were invisible colleges within the entrepreneurship field. We selected three "seed journals" – ETP, JBV and SBE – in the field as our database source and based our analysis on Zuccalla's (2006) definition of invisible colleges, regarded as groups of influential researchers with scientific interests in common toward a subject specialty, related with one another, through formal and informal channels. First, we performed a (co)citation analysis to identify the most cited authors, studies and journals of each "seed" journal and explore their intellectual structures. The results indicated strong scientific similitaries between ETP and JBV and a distinct intellectual pattern for SBE. ETP and JBV most cited authors, studies (articles or books) and journals are focussed on entrepreneurship research, per se, while, evidence concerning SBE reveals an economic-oriented research interest towards areas such as innovation, growth and policy or industrial organization.

(Co)citations, nevertheless, are considered by several authors (e.g. Lievrouw, 1989) as structural (formal) data and, therefore, incapable of recognize invisible colleges' multi-faceted nature (formal plus informal). In order to overcome this limitation, in a second stage of the study, we mapped the existing links between the key scholars previously identified, through a comprehensive research on the top cited authors' professional affiliation, educational training and current and past affiliations/visiting academic institutions. The evidence found validated prior results, confirming the existence of a highly connected network of links between the most influential authors in the entrepreneurship field, in ETP and JBV, on the one hand, and in SBE, on the other.

All in all, the evidence gathered justified our assessment that two invisible colleges exist in the field of entrepreneurship: one devoted to entrepreneurship research, per se, and associated to ETP and JBV; the other, economic-oriented, related with SBE' scope of research.

That being said, the limitations of our analysis should be pointed. Only one research area was imputed to each top cited author, which narrows down the academic scope of the researchers. The inclusion of more than one area of research would have insightful to a better understanding of the social network formed by key scholars. Another question relates to the period of analysis: in this study we included the journals' available data from their initial publications until the present time, which provides a static report of entrepreneurship. In our view, to compare his overall analysis with by-period analyses would provide insights regarding the evolution of the field and benefit the investigation. Also, the subjective nature of the key element, "informal communication relations", that underlies the concept of the invisible colleges raises some concern. We resort to data regarding affiliations and educational background, but other methods, such as questionnaires, mailings, conferences' attendance, could have been used.

Future research on the subject could combine bibliometric techniques with ethnographic methods of research so that we could enhance our interpretation of the invisible college phenomenon. Nevertheless, we still believe that the discovery of these two invisible colleges in entrepreneurship research provides a better understanding of the scientific discipline, enlightening researchers, students and public, in general.

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Appendix

Table A 1: John Carroll University Classification of entrepreneurship journals

Level I
1. Journal of Business Venturing.
2. Small Business Economics.
3. Entrepreneurship Theory and Practice.
4. Journal of Small Business Management.
Level II
1. Entrepreneurship, Innovation and Change.
2. Family Business Review.
3. International Journal of Entrepreneurship Development, Education and Training.
4. International Journal of Entrepreneurship.
5. International Journal of Technological Innovation and Entrepreneurship.
6. Journal of Developmental Entrepreneurship.
7. Journal of Enterprising Culture.
8. Journal of Entrepreneurship Education.
9. Journal of Private Enterprise.
10. New England Journal of Entrepreneurship.
11. Small Business and Enterprise Development.
Level III
1. Economic Analysis: A Journal of Enterprise and Participation.
2. Enterprise and Innovation Management Studies.
3. Entrepreneurship Development Review.
4. Journal of Entrepreneurship.
5. Journal of International Business and Entrepreneurship.
6. Journal of Technology Transfer.
7. Small Enterprise Research: The Journal of SEAANZ.
8. Studies in Cultures, Organizations and Societies.

Source: Adapted from http://www.marketingtechie.com/articles/mtart20020307.pdf

Table A 2: Ranking of the Top 10 most cited articles in Entrepreneurship Theory and Practice

Entrepreneurship Theory and Practice				
Author(s)	**Year**	**Article Title**	**Journal**	**Number of times cited**
Gartner, W.	1988	"Who is an entrepreneur?" is the wrong question	American Journal of Small Business	63
Shane, S.;Venkataraman, S.	2000	The promise of entrepreneurship as a field of research	Academy of Management Review	59
Barney, J.	1991	Firm resources and sustained competitive advantage	Journal of Management	57
Gartner, W.	1985	A conceptual framework for describing the phenomenon of new venture creation	Academy of Management Review	57
Low, M.;MacMillan, I.	1988	Entrepreneurship: Past research and future challenges	Journal of Management	49
Covin, J.;Slevin, D.	1991	A conceptual model of entrepreneurship as firm behavior	Entrepreneurship Theory and Practice	45
Lumpkin, G.;Dess, G.	1996	Clarifying the entrepreneurial orientation construct and linking it to performance	Academy of Management Review	44
Jensen, M.;Meckling, W.	1976	Theory of the firm: Managerial behavior, agency costs and Ownership structure	Journal of Financial Economics	43
Busenitz, L.;Barney, J.	1997	Differences between entrepreneurs and managers in large organizations: Biases and heuristics in strategic decision making	Journal of Business Venturing	40
Katz, J.;Gartner, W.	1988	Properties of emerging organizations	Academy of Management Review	39
Miller, D.	1983	The correlates of entrepreneurship in three types of firms	Management Science	39

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE.

Common to all three journals
Only common to JBV and SBE
Only common to ETP and JBV
Only common to ETP and SBE

Table A 3: Ranking of the Top 10 most cited articles in Journal of Business Venturing

Journal of Business Venturing				
Author(s)	**Year**	**Article Title**	**Journal**	**Number of times cited**
Low, M.;MacMillan, I.	1988	Entrepreneurship: Past research and future challenges	Journal of Management	59
Gartner, W.	1985	A conceptual framework for describing the phenomenon of new venture creation	Academy of Management Review	56
Jensen, M.;Meckling, W.	1976	Theory of the firm: Managerial behavior, agency costs and Ownership structure	Journal of Financial Economics	53
MacMillan, I.;Siegel, R.;Subbanarasimha, P.	1985	Criteria used by venture capitalists to evaluate new venture proposals	Journal of Business Venturing	47
Shane, S.;Venkataraman, S.	2000	The promise of entrepreneurship as a field of research	Academy of Management Review	46
Sandberg, W.;Hofer, C.	1987	Improving new venture performance: The role of strategy, industry structure, and the entrepreneur	Journal of Business Venturing	44
Barney, J.	1991	Firm resources and sustained competitive advantage	Journal of Management	39
Cohen, W.;Levinthal, D.	1990	Absorptive capacity: A new perspective on learning and innovation	Administrative Science Quarterly	35
Covin, J.;Slevin, D.	1989	Strategic management of small firms in hostile and benign environments	Strategic Management Journal	35
Venkataraman, S.	1997	The distinctive domain of entrepreneurship research	Advances in Entrepreneurship, Firm Emergence and Growth	35

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE.

Common to all three journals
Only common to JBV and SBE
Only common to ETP and JBV
Only common to ETP and SBE

Table A 4: Ranking of the Top 10 most cited articles in Small Business Economics

Small Business Economics				
Author(s)	**Year**	**Article Title**	**Journal**	**Number of times cited**
Jovanovic, B.	1982	Selection and the evolution of industry	Econometrica	91
Evans, D.;Jovanovic, B.	1989	An estimated model of entrepreneurial choice under liquidity constraints	Journal of Political Economy	75
Stiglitz, J.;Weiss, A.	1981	Credit rationing in markets with imperfect information	American Economic Review	52
Acs, Z.;Audretsch, D.	1988	Innovation in large and small firms: An empirical analysis	American Economic Review	49
Dunne,T.; Roberts, M.;Samuelson, L.	1989	The growth and failure of U.S. manufacturing plants	Quarterly Journal of Economics	49
Evans, D.;Leighton, L.	1989	Some empirical aspects of entrepreneurship	American Economic Review	47
Evans, D.	1987	Tests of alternative theories of firm growth	Journal of Political Economy	45
Audretsch, D.;Feldman, M.	1996	R&D spillovers and the geography of innovation and production	American Economic Review	44
Evans, D.	1987	The relationship between firm growth, size and age: Estimates for 100 manufacturing industries.	Journal of Industrial Economics	43
Lucas, R.	1978	On the size distribution of business firms	Bell Journal of Economics	40

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index of the ISI Web of Science, for JBV and SBE.

Common to all three journals
Only common to JBV and SBE
Only common to ETP and JBV
Only common to ETP and SBE

Table A 5: Information on current and previous affiliations/ visiting academic institutions

	Author	Affiliations/ Visiting Academic Institutions [a]	Previous Affiliations/ Visiting Academic Institutions [b]
1	Audretsch, D.	Indiana University, US	Georgia State University, US
		Ewing Marion Kauffman Foundation, US	Middlebury College, US
		Friedrich-Schiller-University Jena, DE	Social Science Centre Berlin, DE
		ZEW, Centre for Economic Research, DE	University of Durham, UK
		CEPR, Centre for Economic Policy Research, UK	Kiel Institute of World Economics, DE
		EIM Consulting for Small and Medium-Sized Business, NL	Tinbergen Institute, NL
2	Acs, Z.	Max Planck Institute of Economics, DE	University of Maryland, US
		University of Baltimore, US	Social Science Centre Berlin, DE
		Ewing Marion Kauffman Foundation, US	University of Illinois Springfield, US
		-	Manhattan College, US
		-	Columbia University, US
		-	Middlebury College, US
		-	Santa Anna School of Advanced International Studies, IT
		-	Université Aix-Marseille II, FR
		-	University of St Andrews, UK
3	Cooper, A.	Harvard University, US	Stanford University, US
		-	University of Pennsylvania, US
		-	University of Manchester, UK
		-	International Institute for Management Development, CH
4	Aldrich, H.	-	Cornell University, US
		-	Stanford University, US
		-	International Institute of Management, DE
		-	University of Oxford, UK
		-	Centre for Environmental Studies, UK
		-	Universita' Commerciale Luigi Bocconi, IT
		-	Wirtschaftsuniversität Wien, AT
		-	BI Norwegian School of Management, NO
		-	Universita' degli Studi di Trento, IT
		-	University of British Columbia, CA
		-	Keio University, JP
		-	Jönköping University, SE
		-	Universitat Autònoma de Barcelona, ES
5	Reynolds, P.	-	Florida International University, US
		-	University of London, UK
		-	Babson College, US
		-	Marquette University, US
		-	University of Minnesota, US
		-	University of Pennsylvania, US
		-	INSEAD, European Institute of Business Administration, FR
6	Gartner, W.	-	University of Southern California, US
		-	San Francisco State University, US
		-	Georgetown University, US
7	Zahra, S.	-	Babson College, US
		-	Georgia State University, US
8	Porter, M.	-	-
9	MacMillan, I.	-	New York University, US
		-	Columbia University, US
10	Storey, D.	University of Reading, UK	-
		University of Manchester, UK	-
		University of Durham, UK	-
11	Schumpeter, J. †	-	-
12	Miller, D.	-	McGill University, CA
		-	Columbia University, US

(…)

	Author	Affiliations/ Visiting Academic Institutions [a]	Previous Affiliations/ Visiting Academic Institutions [b]
		-	Imperial College London, UK
		-	University of Maryland, US
13	Shane, S.	-	National University of Singapore, SG
		-	Massachusetts Institute of Technology, US
		-	Georgia Institute of Technology, US
		University of London, UK	Fordham University, US
14	Evans, D.	-	Social Science Centre Berlin, DE
		-	New York University, US
		University of London, UK	University of Nottingham, UK
15	Bygrave, W.	-	INSEAD, European Institute of Business Administration, FR
		-	Bryant University, US
		-	Boston University, US
		-	University of Massachusetts Dartmouth, US
16	Birley, S.	-	Imperial College London, UK
17	Covin, J.	-	Georgia Institute of Technology, US
		Erasmus University Rotterdam, NL	EMLYON Business School, FR
18	Wright, M.	INSEAD, European Institute of Business Administration, FR	University of Ghent, BE
		University of Siena, IT	-
19	Brush, C.	Norwegian University of Science and Technology, NO	Boston University, US
		-	Jönköping University, SE
		Bodø University College, NO	
		-	University of Warwick, UK
20	Westhead, P.	-	University of Stirling, UK
		-	University of Nottingham, UK
		-	Imperial College London, UK
21	Hambrick, D.	-	-
		-	Australian National University, AU
		-	Panthéon-Sorbonne University, FR
		-	Northwestern University, US
22	Williamson, O.	-	Saarland University, DE
		-	Indiana University, US
		-	Harvard University, US
		-	University of Kyoto, JP
		-	University of Warwick, UK
		-	Baylor University, US
23	Vesper, K.	-	Babson College, US
		-	University of Calgary, CA
24	Eisenhardt, K.	-	-
25	Hisrich, R.	-	Case Western Reserve University, US
26	Sexton, D.	-	Baylor University, US
27	Van de Ven, A.	-	University of Pennsylvania, US
		-	Kent State University, US
		-	Northeastern University, US
28	Timmons, J. †	-	Boston College, US
		-	Colgate University, US
29	Sapienza, H.	-	University of South Carolina, US

(…)

	Author	Affiliations/ Visiting Academic Institutions [a]	Previous Affiliations/ Visiting Academic Institutions [b]
30	Bates, T.	-	New School, US
		-	University of Vermont, US
		-	University of North Carolina, US
		-	University of California, Berkeley, US
		-	University of California, Los Angeles, US
31	Brockhaus, R.	-	Kansas State University, US
		-	University of Waikato, NZ
		-	Baylor University, US
32	Hitt, M.	-	Arizona State University, US
33	Chrisman, J.	University of Alberta, CA	University of Calgary, CA
		-	Louisiana State University, US
		-	University of South Carolina, US
		-	University of Kentucky, US
34	Dess, G.	-	Chinese University of Hong Kong, CN
		-	BI Norwegian School of Management, NO
		-	Dartmouth College, US
		-	University of Oporto, PT
35	Baumol, W.	Princeton University, US	-
36	Kanter, R.	-	Yale University, US
		-	Brandeis University, US
37	Cohen, W.	-	Carnegie Mellon University, US
		-	Harvard University, US
38	Blanchflower, D.	University of Munich, DE	University of Surrey, UK
		University of Bonn, GE	-
		University of Stirling, UK	-
39	Caves, R.	-	Harvard University, US
40	Geroski, P. †	-	-
41	Jovanovic, B.	-	University of Pennsylvania, US
42	Cressy, R.	-	University of Warwick, UK
		-	University of Hull, UK
43	Scherer, F.	-	Princeton University, US
		-	Swarthmore College, US
		-	Northwestern University, US
		-	International Institute of Management, DE
44	Dunne, T.	-	University of Oklahoma, US
45	Berger, A.	University of Pennsylvania, US	-
		Tilburg University, NL	-
		-	Georgetown University, US
46	Wagner, J.	Max Planck Institute of Economics, DE	-
		IZA Institute for the Study of Labor, DE	-
		ZBW, German National Library of Economics, DE	-
47	Davis, S.	-	Massachusetts Institute of Technology, US
		-	University of Maryland, US

Source: Authors' personal web pages and universities web pages.
Note: Due to the absence of information, we have not identified the current visiting institutions or last affiliation of 6 authors.
[a] Validity guaranteed until August 2009.
[b] Last affiliation(s) pos doctoral program.