
Volume 41, Issue 8, October 2012 ISSN 0048-7333
ELSEVIER
RESEARCH POLICY
Policy, management and economic studies of science, technology and innovation
Available online at www.sciencedirect.com
SciVerse ScienceDirect

Research Policy 41 (2012) 1283–1295

Contents lists available at SciVerse ScienceDirect

Research Policy

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

Technology push and demand pull perspectives in innovation studies: Current findings and future research directions

Giada Di Stefano[a,1], Alfonso Gambardella[b,*], Gianmario Verona[b,2]

[a] HEC Paris, Department of Strategy and Business Policy, 1, rue de la Libération, 78351 Jouy-en-Josas, France
[b] Bocconi University, Department of Management and Technology, Via Roentgen 1, 20136 Milan, Italy

ARTICLE INFO

Article history:
Received 7 October 2010
Received in revised form 21 February 2012
Accepted 9 March 2012
Available online 13 April 2012

Keywords:
Technology push
Demand pull, Innovation
Bibliometrics
Co-citation analysis

ABSTRACT

This study updates the debate on the sources of innovation. Using techniques like factor analysis, multidimensional scaling, and pathfinder analysis, we examine the most influential articles that have dealt with the topic. Our analysis provides three main findings. The first more precisely highlights the role of demand as a source of innovation. The second illustrates how competences enable firms to match technology with demand and capitalize on technology and demand as sources of innovation. The third unveils a distinction between external and internal sources of innovations. The sources of innovation can be purely external or internally generated competences that enable the firm to integrate external knowledge within its boundaries. Our work contributes to the classic debate by providing a more granular understanding of how technology and demand interact. In discussing our findings, we link our framework to strategy, innovation and entrepreneurship studies that expressly call for a better understanding of technology and demand factors in value creation and capture.

1. Introduction

For years, scholars investigating the economics of technical change conducted their pioneering research by juxtaposing the forces that were to shape two alternative perspectives (e.g., Schmookler, 1966; Meyers and Marquis, 1969; von Hippel, 1976; Mowery and Rosenberg, 1979; Rosenberg, 1982). On the one hand, those who referred to the so-called technology-push perspective pinpointed the key role that science and technology play in developing technological innovations and adapting to the changing characteristics of the industry structure. On the other hand, scholars embracing a demand-pull approach identified a broader set of market features, including characteristics of the end market (particularly, the users) and the economy as a whole, that affects the performance of innovation.

The juxtaposition of these two approaches to innovation fostered a fruitful debate that reached its apex in the Seventies. Those years have witnessed a confirmation of the role of science and technology in generating innovation and a growing skepticism regarding a pure demand-pull perspective. In particular, the latter raised a number of theoretical and empirical concerns. For instance, given the interrelated nature of the curves of demand and supply, Mowery and Rosenberg (1979) claimed that is technically complicated to distinguish a demand-pull situation from a technology-push one. Relatedly, Dosi (1982, p. 150) remarked that research in the demand-pull tradition failed "to produce sufficient evidence that 'needs expressed through market signaling' are the prime movers of innovative activity". Along with this chorus of critiques, but approaching the issue from a disciplinary angle, Stigler and Becker (1977) claimed that *de gustibus non est disputandum*: namely, when the discussion goes so far as to examine differences in tastes among people, economists should leave the floor to those who study and explain tastes – namely, psychologists, anthropologists and phrenologists.

The debate therefore reached a sort of deadlock in the Eighties. At that time it seemed clear that while most technical innovations were driven by science and technology, the role of demand and more broadly of market and social forces was complementary in that respect. For instance, when it is a matter of selecting a specific technological trajectory, "the role of economic, institutional and social factors must be considered in greater detail. A first crucial role (. . .) is the selection operated at each level, from research to production-related technological efforts, among the possible "paths", on the ground of some rather obvious and broad criteria such as feasibility, marketability and profitability" (Dosi, 1982, p. 155). Similarly, Kline and Rosenberg (1986) advocated a shift from linear models of technology and demand to a more interactive model between these two potential sources of innovation.

* Corresponding author. Tel.: +39 02 5836 3706; fax: +39 02 5836 3790.
E-mail addresses: di-stefano@hec.fr (G. Di Stefano), alfonso.gambardella@unibocconi.it (A. Gambardella), gianmario.verona@unibocconi.it (G. Verona).
[1] Tel.: +33 1 3967 9615; fax: +33 1 3967 7084.
[2] Tel.: +39 02 5836 6522; fax: +39 02 5836 2530.

0048-7333/$ – see front matter
doi:10.1016/j.respol.2012.03.021

Overall, science and technology seemed to be "the" source for the vast majority of technological innovations and demand was the best companion to drive innovation in the right economic and institutional directions.

Despite the growing consensus about this mutual dependence with an emphasis on technology as the ultimate source of innovation, the way the selection process and, more broadly, the interaction might have occurred was primarily described *conceptually* and was discussed mostly at a *macro* level. Instead, due to the increasing importance of technology within organizations (Arora and Gambardella, 1994; Chesbrough, 2003; von Hippel, 2005) and the impressive growth of fields focusing on the economics and management of technology (Fagerberg et al., 2012; Martin et al., 2012), in this paper we aim to review the influential articles published on the sources of innovation in recent years. The question that motivated our research is to see whether these more recent studies have enriched our understanding of technology and demand as sources of innovation and have explained more specifically how the two can be leveraged in order to commercialize successful innovations.

Our review follows mainstream methodologies of bibliometric analysis (e.g., Acedo et al., 2006; Nerur et al., 2008; Di Stefano et al., 2010). In addition to better clarifying the role of demand as a source of innovation, our findings show that a clearer balance between the two approaches has apparently now been reached from both an *empirical* and a more *micro* standpoint. Indeed, in addition to confirming the dual nature of innovation sources (technology push and demand pull), our findings highlight that scholars have paid particular attention to studying and demonstrating how firm competences enable firms to match the two sources and thus deliver the right innovations to the market. In this respect, researchers seem to have focused their attention on different approaches to knowledge integration: those who start with a clear focus on the external environment and try to absorb knowledge within firm boundaries and those who start from internal sources and focus on integrating external knowledge. While in the former case, external sources remain the ultimate source of innovation, in the latter case internally generated competences seem to be the sources of innovation.

The rest of the paper is organized as follows. We explain in detail our methodological approach (Section 2); we then present our findings with respect to the three analyses we ran (Sections 3–5); finally, we conclude with a discussion section in which we call for: studies on the microfoundations of innovation, research linking innovation and entrepreneurship, and the pluralism of methodologies for the understanding the topic under investigation.

2. Overview of the method

Co-citation analysis is a bibliometric method used to examine relationships between articles or authors contributing to the development of a research field, based on the assumption that two often co-cited documents are related to each other and address the same broad research questions without necessarily sharing the same opinion (White and Griffith, 1981). The more often they are cited together, the stronger the relationship and the more likely they are to belong to the same research front, sometimes referred to as an "invisible college" (Crane, 1972). In this paper, we focus on the most influential contributions dealing with the sources of innovation and use co-citation analysis to show the "invisible colleges" within the research domain (Crane, 1972; de Solla Price, 1963), pointing out the structure of the field and the relationships binding its components together. As suggested by Di Stefano et al. (2010, p. 1199), although this analysis does have its limitations, "if compared to alternative techniques (such as key informants' judgments), citations are less prone to systematic biases in providing an objective assessment of the influence of publications or authors (Baumgartner and Pieters, 2003)".

Following the methodological prescriptions (e.g., McCain, 1990), we run co-citation analysis by performing the following six steps: (1) selection of the unit of analysis; (2) retrieval of co-citation frequencies; (3) compilation of raw co-citation matrix; (4) conversion of the raw co-citation matrix into a correlation matrix; (5) carrying out multivariate analysis of correlation matrix; and, finally, (6) interpretation and validation. In order to identify the most influential contributions on the topic (McCain, 1990), we looked at the most frequently cited studies, based on the common assumption that citation counts are a valid measure of their importance and influence (Garfield, 1979; Ramos-Rodríguez and Ruíz-Navarro, 2004). Data were collected from the Social Science Citation Index (SSCI) of Thomson-ISI Web of Science database, with specific reference to all articles in the business and management categories. Our analysis is solely based on articles. It omits books, book chapters, and working papers, which cannot be extracted from the database. Our analysis covers the full time span available in this database (from 1956 to 2010).[3]

In order to search for topical papers, we crossed three subsets of words thus ensuring that the retrieved articles refer to at least one of the words in each subset. The first subset defined the boundary of our search domain and included contributions whose title, abstract, and keywords[4] included words with the prefix "innovat" (such as innovation and innovative). The second subset looked at sources of innovation in the technology domain, with the words "technolog" or "scien". Science and technology have indeed independent as well as interactive effects on firm innovation performance, thus creating the need to examine the role that both of them play in innovation (Makri et al., 2010). The third subset investigated sources of innovation in the demand domain, with the words "demand", "consumer(s), "user(s)", "custom" (to allow for customer(s), customization, etc.), "preference(s)", "commercialization" or "complementary assets".[5] By screening the Thomson-ISI SSCI database according to these defined criteria, we obtained a set of 1555 contributions, published from 1976 to 2010. Previous studies used subjective criteria to determine the most influential papers from such a rank ordering, selecting for example the top *n* cited papers or papers with a minimum of *n* citations (e.g., McMillan, 2008; Ponzi, 2002). Consistent with this approach, we selected the top 100 papers from the comprehensive list (Ramos-Rodríguez and Ruíz-Navarro, 2004). In point of fact, despite representing less than 10% of the retrieved papers, this set of contributions accounts for 47% of the total number of citations gathered by the more comprehensive set of 1555 papers. This is consistent with our aim of identifying the underlying foundations of research in this domain (e.g., McCain, 1990). The resulting set of contributions, published between 1991 and 2006, includes the most influential papers on the sources of innovation and is shown in Table 1.[6]

[3] We excluded journals published in the area of Information Systems, as they were outside the scope of our research. Results of a robustness check including journals belonging to Information Systems show the emergence of an additional stand-alone cluster of contributions in that area, interested in the adoption of information systems.

[4] It has to be noted, however, that the coverage of abstracts in the Social Science Citation Index commenced from January 1992. This implies that papers published before that date are searched based only on title and keywords.

[5] In order to account for the influence of the themes of "Open Innovation" (e.g., Chesbrough, 2003) and "Open Source" (e.g., von Hippel and von Krogh, 2003), we also performed an additional analysis by adding the keyword "open" to the list of keywords related to demand. However, since this stream of literature is relatively new, the results did not substantially change with only by two additional contributions, focusing on openness to networks of suppliers rather than demand. Consequently, we did not include the keyword "open" in our search, consistent with the aim of identifying the most cited, established and hence relevant papers for our focus.

[6] As robustness checks, we replicated all the multivariate analyses on panels of papers defined in alternative ways (e.g., using weighted citation scores or Herfindal indexes rather than un-weighted citation scores; looking at only top journals or

Table 1
The set of articles.

	Article	Citations		Article	Citations
1	Teece et al. (1997)	2729	51	Garud and Karnoe (2003)	104
2	von Hippel (1994)	561	52	Danneels and Kleinschmidt (2001)	103
3	Kogut and Zander (1996)	504	53	Christensen et al. (2000)	103
4	Fisher (1997)	411	54	Narver et al. (2004)	102
5	Christensen and Bower (1996)	366	55	Gans and Stern (2003)	101
6	Yli-Renko et al. (2001)	309	56	Zaltman (1997)	99
7	Gatignon and Xuereb (1997)	303	57	Burke (2002)	99
8	Attewell (1992)	272	58	Frambach and Schillewaert (2002)	96
9	Klein and Sorra (1996)	269	59	Magretta and Dell (1998)	96
10	Stuart (2000)	240	60	Garud and Kumaraswamy (1995)	95
11	Rothwell (1992)	220	61	Atuahene-Gima (2005)	93
12	Kemp et al. (1998)	209	62	Shane (1993)	92
13	Sorensen and Stuart (2000)	206	63	Treacy and Wiersema (1993)	92
14	Tyre and Orlikowski (1994)	203	64	Murray (2002)	92
15	Klevorick et al. (1995)	199	65	Demarest (1997)	92
16	Rothaermel and Deeds (2004)	198	66	Elberse and Eliashberg (2003)	91
17	von Hippel and von Krogh (2003)	196	67	Lee (1996)	91
18	Henard and Szymanski (2001)	196	68	Im and Workman (2004)	90
19	Helfat (1997)	194	69	Bruner and Kumar (2005)	89
20	Lakhani and von Hippel (2003)	182	70	Ettlie and Reza (1992)	88
21	Christensen and Rosenbloom (1995)	178	71	MacCormack et al. (2001)	87
22	Tripsas (1997)	177	72	Pittaway et al. (2004)	87
23	Furman et al. (2002)	172	73	Franke and von Hippel (2003)	86
24	Danneels (2002)	172	74	Iansiti and MacCormack (1997)	85
25	Bierly and Chakrabarti (1996)	171	75	Meuter et al. (2005)	84
26	Malerba (2002)	170	76	Adner and Levinthal (2001)	84
27	Langlois and Robertson (1992)	168	77	Hagedoorn and Duysters (2002)	84
28	Dabholkar and Bagozzi (2002)	159	78	Luo and Bhattacharya (2006)	83
29	Mick and Fournier (1998)	157	79	Torkzadeh and Doll (1999)	83
30	Gallouj and Weinstein (1997)	155	80	Kraut et al. (1998)	83
31	Conner and Rumelt (1991)	150	81	Cantwell and Mudambi (2005)	82
32	Etzkowitz et al. (2000)	149	82	von Hippel (2001)	82
33	Chandy and Tellis (2000)	144	83	Arnold and Reynolds (2003)	81
34	Hobday (1998)	141	84	Nambisan (2002)	80
35	Lynn et al. (1996)	140	85	Zahra and Nielsen (2002)	80
36	Veryzer (1998)	137	86	Kim and Kogut (1996)	78
37	Rothaermel (2001)	135	87	Song and Parry (1996)	78
38	Hobday (2000)	127	88	Morrison et al. (2000)	77
39	Garud and Rappa (1994)	123	89	O'Connor (1998)	77
40	Gatignon et al. (2002)	121	90	Venkatraman and Henderson (1998)	77
41	Lumpkin and Dess (2001)	121	91	Hauser et al. (2006)	77
42	Bass et al. (1994)	121	92	Moreau et al. (2001)	76
43	Arora and Gambardella (1994)	119	93	Srinivasan et al. (2002)	76
44	Handfield et al. (1999)	117	94	Afuah (2000)	74
45	Deeds and Hill (1996)	116	95	Prahalad and Hamel (1994)	74
46	Franke and Shah (2003)	111	96	Dutta et al. (1999)	74
47	Geels (2004)	109	97	Leonard-Barton and Rayport (1997)	73
48	Zhou et al. (2005)	109	98	Stewart et al. (1999)	72
49	Glynn (1996)	108	99	Harhoff et al. (2003)	71
50	Hill and Rothaermel (2003)	108	100	Bhave (1994)	70

After selecting the unit of analysis, we retrieved the co-citation frequencies for each pair of articles in our panel, and compiled them into a raw co-citation matrix. The co-citation matrix is a square matrix: the rows and columns represent the articles included in the set and the cells represent the number of times each pair of documents was cited together.[7] We then converted the raw co-citation matrix into a matrix of Pearson's correlation coefficients. Correlation represents a measure of similarity between two works: the higher the positive correlation, the higher the perceived similarity between the two (White and McCain, 1998). Correlation coefficients are preferable to co-citation frequencies since the data can be standardized and the number of zeros reduced, thus providing a better basis for statistical analyses (Rowlands, 1999). The correlation matrix provided the input for the multivariate techniques used to analyze the data and interpret the findings. Consistent with previous literature, our study adopts three multivariate techniques to assess the structure of the research field, namely Factor Analysis, Cluster Analysis, and Multidimensional Scaling (McCain, 1990). Following Nerur et al. (2008), we also relied on Pathfinder analysis (Schvaneveldt, 1990) to detect the network structure linking our panel of influential papers, and to consider their positions within the network.

3. Updating the debate on technology and demand as sources of innovation

We started our empirical investigation by mapping and describing the selected innovation studies. We first used factor analysis to cluster the core contributions. Factor analysis is employed to classify papers into related sets, called factors, based on the varying

only Business or Management journals; changing the keywords used for the analysis). Despite differences in the construction of panels, the analytical results for multivariate analyses were very consistent across all panels.

[7] We consider the cells of the main diagonal (i.e., the number of times an author was cited together with him/herself) as missing values, as suggested by White and McCain (1998).

degrees of relatedness (McCain, 1990). By seeing how the papers in our panel group together, factor analysis allowed us to identify a number of research fronts that have emerged in recent contributions on the sources of innovation opportunities.[8]

We used principal component analysis as the extraction method,[9] varimax rotation of the extracted factors to interpret the results,[10] and Kaiser's criterion along with a scree test to determine the number of extracted factors.[11] Factor loadings represent the correlation between a given article and the factor, i.e., the degree to which the article belongs to that set. We included all factor loadings, although loadings of 0.7 or higher are considered the most reliable in interpreting the factor (McCain, 1990). Negative loadings signal divergence of the negatively loaded papers with respect to the factor, either in subject or in their position with respect to the same subject (Acedo et al., 2006). Loadings of the same article on more than one factor indicate the tendency of that article to bridge different perspectives. We indicate secondary loadings that exceed 0.4, consistent with prior research (McCain, 1990), with superscripts indicating which of the factors show these loadings. The analysis resulted in five factors explaining 78.0% of the variance.[12] Results are shown in Table 2.[13]

To interpret the five factors, we examined the papers in each group looking for common themes, approaches, and topics. The final interpretation resulted from a process of codification performed independently by the authors. Given that the data is nominal in form with no natural ordering, we computed the Cohen's Kappa (Cohen, 1960) to check for inter-rater agreement. The high value ($k = 0.964$) indicates high agreement among coders. Our consensus-based interpretation is as follows. The five areas identified by the factors include: Technology and Competences for Innovation (Factor 1); New Product Development and Market Learning (Factor 2); Demand and User Innovation (Factor 3); Systems of Innovation (Factor 4); and Technology Diffusion and Adoption (Factor 5).

Factor 1 groups the highest number of publications among the ones included in our panel, and, consequently, explains most of the variance (39.3%). This factor is deeply influenced by the Resource-based View and Knowledge-based View in stressing the role of firm-specific inputs in exploiting technological and innovation opportunities. Papers loading on this factor cover a variety of topics in the domain of technology and competences for innovation. Most of the papers in this factor focus on how firms can develop technological innovations thanks to their knowledge (e.g., Bierly and Chakrabarti, 1996; Kogut and Zander, 1996; Yli-Renko et al., 2001) and capabilities (e.g., Teece et al., 1997; Afuah, 2000; Danneels, 2002; Gatignon et al., 2002; Hill and Rothaermel, 2003; Rothaermel and Deeds, 2004), and more generally to sources of technological opportunities (Arora and Gambardella, 1994; Klevorick et al., 1995; Christensen and Bower, 1996; Adner and Levinthal, 2001). Along these lines, a second group of papers takes a closer look at the development of innovation through collaborative agreements, thus emphasizing the role of knowledge and capabilities developed through specific inter-firm alliances and networks (Deeds and Hill, 1996; Lee, 1996; Handfield et al., 1999; Stuart, 2000; Hagedoorn and Duysters, 2002). Not only are competences needed to develop innovations, but they also play an important role in commercializing technologies (Zahra and Nielsen, 2002; Gans and Stern, 2003): this is where complementary assets become crucial (Helfat, 1997; Tripsas, 1997; Rothaermel, 2001). Other topics covered by contributions loading on this factor include issues of technology adaptation and implementation within organizations (Tyre and Orlikowski, 1994; Klein and Sorra, 1996), as well as the construct of entrepreneurship (Lumpkin and Dess, 2001) and entrepreneurial venture creation (Bhave, 1994).

Factor 2 deals with more micro issues related to the specific process of new product development and the role of the market as a source of learning in new product development. Interestingly enough, most of these contributions pertain to marketing studies – and more precisely the branch of marketing devoted to new product development and technological innovations (see, e.g., Hauser et al., 2006). This factor is constituted by a high number of papers and explains 16.9% of the total variance. A portion of this factor consists of papers dealing with the successful development of new products (Song and Parry, 1996; Gatignon and Xuereb, 1997; Danneels and Kleinschmidt, 2001; Henard and Szymanski, 2001) and radical innovations (Lynn et al., 1996; Veryzer, 1998; Chandy and Tellis, 2000). A second group of papers deals with incorporating learning from the market in new product development (O'Connor, 1998; Zhou et al., 2005), with emphasis put on the firm's market orientation (Im and Workman, 2004; Narver et al., 2004) and the specific tools used to learn from the market in the design process (Leonard-Barton and Rayport, 1997). This factor also includes entrepreneurship contributions dealing with the concept of proclivity (Stewart et al., 1999) and the impact of socio-cultural issues (e.g., Shane, 1993) and external actors (like universities and research centers: e.g., Etzkowitz et al., 2000; Murray, 2002) on the development of new products.[14]

Overall, Factors 1 and 2 both show a focus on technology, with more emphasis though on the role of knowledge and competences in helping ventures grasp the benefits of technological and scientific trajectories. In these articles, demand seems to follow the intuition of classic works in this domain: technology seems to be

[8] Both cluster analysis and factor analysis serve the same purpose – namely, to identify sets of correlated variables, and the results obtained were extremely consistent across the two analyses. We chose to present the results of factor rather than the (consistent) ones of cluster analysis, since it has the advantage of allowing the analyzed objects to load on more than one factor, which is not the case in clustering or scaling techniques. This characteristic helps reveal the breadth of the contributions included in the analysis and allowed us to draw a map that also takes into consideration those contributions that serve as a bridge between two or more approaches, i.e., papers displaying secondary loadings (McCain, 1990).

[9] Principal Component Analysis is by far the most common form of factor analysis and it is generally preferred for purposes of data reduction. Other methods (such as unweighted least squares, generalized least squares, maximum likelihood, principal axis factoring, alpha factoring and image factoring) are used less, except for principal axis factoring which is better suited for causal modelling.

[10] In the choice for rotation methods, orthogonal solutions, such as varimax, should be preferred to oblique ones, such as oblimin, when one expects factors to be theoretically independent. We chose varimax because we did not want to make an assumption of theoretical dependence. Also, this choice had no impact on the results, which were consistent regardless of the types of analysis we employed. Moreover, the component correlation matrix displayed with oblimin rotation showed poor correlation among the factors, providing further support for our choice.

[11] Kaiser's criterion for factor extraction is accurate when there are less than 30 variables with communalities after extraction higher than 0.7 or more than 250 variables with communalities after extraction higher than 0.6. Having 100 variables with communalities after extraction all higher than 0.7, the use of the screeplot is hence justified.

[12] The choice of 5 factors was made by looking at the elbow of the screeplot – a choice we justify in footnote 11. It is worth noting, however, that, using Kaiser criterion, 13 factors were extracted, with factors from 6 to 13 explaining between 1% and 3% of the variance and grouping very few papers each. We chose the more parsimonious solution, based on the interpretation of the screeplot (see related footnote), as we believed it provides the optimal trade-off between completeness and efficiency.

[13] We also tried to run factor analysis on two chronologically different sub-samples of our panel, in order to trace the development and main trends of this research field. In particular, we half-split the data into two periods, i.e., 1991–2000 and 2001–2010 (see also Nerur et al., 2008). Results are consistent with the ones shown for the overall factor analysis, given that the citations received by the papers of our panel are mostly concentrated in the last years.

[14] The fact that entrepreneurship contributions are factored with new product development papers can be justified by the fact that in the case of entrepreneurial concerns it is empirically rare to find a distinction between the "macro" technology strategy of the firm and the more "micro" new product development activity.

Table 2
Factor analysis.[a]

	F1		F1	F2	F3	F4	F5
Kim and Kogut (1996)	0.98	Zaltman (1997)	−0.34				
Yli-Renko et al. (2001)	0.98	Hobday (1998)	0.33				
Kogut and Zander (1996)	0.98	Hobday (2000)	0.31				
Helfat (1997)	0.98	Song and Parry (1996)		0.96			
Sorensen and Stuart (2000)	0.97	Im and Workman (2004)		0.95			
Bierly and Chakrabarti (1996)	0.97	Henard and Szymanski (2001)		0.94			
Ettlie and Reza (1992)	0.97	Danneels and Kleinschmidt (2001)		0.94			
Rothaermel and Deeds (2004)	0.96	Zhou et al. (2005)		0.93			
Zahra and Nielsen (2002)	0.95	Narver et al. (2004)		0.93			
Cantwell and Mudambi (2005)	0.95	Srinivasan et al. (2002)		0.92			
Danneels (2002)	0.95	Chandy and Tellis (2000)		0.90			
Hagedoorn and Duysters (2002)	0.95	Gatignon and Xuereb (1997)		0.89			
Klevorick et al. (1995)	0.95	Hauser et al. (2006)		0.89			
Venkatraman and Henderson (1998)	0.95	Atuahene-Gima (2005)[1]		0.86			
Afuah (2000)	0.94	Veryzer (1998)		0.81			
Rothaermel (2001)	0.94	O'Connor (1998)		0.80			
Tripsas (1997)	0.94	Moreau et al. (2001)		0.72			
Stuart (2000)	0.94	Leonard-Barton and Rayport (1997)		0.71			
Handfield et al. (1999)	0.93	Lynn et al. (1996)[4]		0.67			
Demarest (1997)	0.93	Elberse and Eliashberg (2003)		0.54			
Hill and Rothaermel (2003)	0.93	Murray (2002)[-5]		−0.54			
Prahalad and Hamel (1994)	0.92	Bass et al. (1994)		0.52			
Deeds and Hill (1996)	0.92	Stewart et al. (1999)		0.41			
Gans and Stern (2003)	0.90	Etzkowitz et al. (2000)		−0.30			
Pittaway et al. (2004)	0.88	Shane (1993)		0.26			
Furman et al. (2002)	0.88	Nambisan (2002)			0.92		
Torkzadeh and Doll (1999)	0.86	von Hippel (2001)			0.92		
Treacy and Wiersema (1993)	0.86	Morrison et al. (2000)			0.90		
Fisher (1997)	0.84	Franke and Shah (2003)			0.89		
Magretta and Dell (1998)	0.84	Harhoff et al. (2003)			0.88		
Christensen and Rosenbloom (1995)	0.83	Franke and von Hippel (2003)			0.85		
Dutta et al. (1999)[2]	0.83	Lakhani and von Hippel (2003)			0.80		
Teece et al. (1997)	0.82	von Hippel and von Krogh (2003)			0.79		
Lumpkin and Dess (2001)[2]	0.80	Iansiti and MacCormack (1997)			0.73		
Christensen and Bower (1996)[2]	0.80	von Hippel (1994)[1]			0.67		
Glynn (1996)[2]	0.79	Langlois and Robertson (1992)[1]			0.49		
Tyre and Orlikowski (1994)[5]	0.75	Christensen et al. (2000)			0.47		
Rothwell (1992)	0.74	Geels (2004)				0.83	
Gatignon et al. (2002)[2]	0.73	Garud and Karnoe (2003)				0.82	
Arora and Gambardella (1994)[3]	0.70	Kemp et al. (1998)				0.81	
Adner and Levinthal (2001)	0.69	Malerba (2002)[1]				0.69	
Garud and Rappa (1994)[4]	0.66	Burke (2002)				−0.60	
Klein and Sorra (1996)	0.65	Meuter et al. (2005)				−0.57	
Luo and Bhattacharya (2006)[5]	0.57	Dabholkar and Bagozzi (2002)[1]				−0.56	
Conner and Rumelt (1991)[3]	0.56	Mick and Fournier (1998)[5]				−0.55	
Garud and Kumaraswamy (1995)	0.56	Bruner and Kumar (2005)				−0.54	
MacCormack et al. (2001)[3]	0.56	Arnold and Reynolds (2003)				−0.43	
Lee (1996)	0.53	Attewell (1992)[1]					0.64
Gallouj and Weinstein (1997)	0.46	Kraut et al. (1998)					0.59
Bhave (1994)[3,5]	0.45	Frambach and Schillewaert (2002)					0.37
% Variance explained	39.3	% Variance explained	39.3	16.9	11.0	6.3	4.4

[a] *Extraction method*: Principal component analysis. *Rotation method*: Varimax with Kaiser normalization. Rotation converged in 7 iterations. Superscripts next to papers represent secondary loadings ≥±0.4 (i.e., [1] represents a secondary loading on Factor 1).

the core source of innovation, while demand enables the innovation to adapt to market needs in order to favor its adoption and diffusion. Specifically, these papers provide details on how organizational competences (Factor 1) and marketing practices (Factor 2) support this process. It is worth noting that both factors start envisioning a proactive role of firms and managers: in many cases they indeed go beyond a mere reactive role of technology (e.g., Christensen and Bower, 1996; Teece et al., 1997) and marketing strategists (e.g., Chandy and Tellis, 2000; Narver et al., 2004); in so doing, they envision the role of internal competences as sources of innovation.

Factor 3 shifts attention to a more holistic role of demand and users as a source of innovation. It specifies more carefully how users can become the ultimate drivers of innovation and attempts to reveal the mechanisms firms can adopt to absorb knowledge from the market and, more precisely, from the users. This factor, which explains 11% of the total variance within our panel of contributions, deals specifically with the role of users (e.g., Franke and Shah, 2003; Harhoff et al., 2003; von Hippel, 1994) and with the tools that can be used to absorb their knowledge to stimulate the development of innovations (e.g., Nambisan, 2002; von Hippel, 2001) and the collective mechanisms of collaboration related to open-source innovation (Lakhani and von Hippel, 2003; von Hippel and von Krogh, 2003).

Factor 4 explains 6.3% of the variance and is divided into two sub-groups, depending on the sign of the factor loading. The first group consists of papers displaying a positive factor loading – subsequently referred to as Factor 4a. These contributions adopt a system perspective to innovation with a strong focus on science, and discuss the presence and nature of sectoral systems of innovation (Geels, 2004; Malerba, 2002) and of technological regimes (Kemp et al., 1998). The second group consists of papers displaying a negative factor loading – subsequently referred to as Factor 4b. These papers also present a system perspective but instead of centering on the role of science they center on the role of customers. Indeed these papers envision a service or technology interface (Burke, 2002; Dabholkar and Bagozzi, 2002) and study the different actors and technologies supporting the process of customer understanding of new technologies (Meuter et al., 2005) and their acceptance (Bruner and Kumar, 2005; Mick and Fournier, 1998).

Finally, Factor 5 consists of only three papers, but explains 4.4% of the total variance. The papers loading on this factor deal with issues of technology diffusion (Attewell, 1992) and adoption (Frambach and Schillewaert, 2002).

4. Firm competences as a source of innovation

In this section, we use multidimensional scaling (MDS) to interpret the core links between the different contributions (Kruskal and Wish, 1978). More specifically, on the one hand the MDS graph is used as a robustness check of factor analysis, and on the other hand, it serves to better interpret the relationships between the different factors – and consequently the different papers. Using Pearson's correlation coefficients, MDS generates a bi-dimensional map, where the position of each paper depends on its relationship to the others perceived by the community of authors that cite these works (McCain, 1990). The closer the papers appear on the map, the higher their conceptual similarity. The greater the proximity among papers within a group, the higher the internal consistency of their conceptual domain. The Kruskal's Stress test result of 0.21, coupled with the high R-squared (RSQ) value of 0.53, indicates an acceptable level of fit for co-citation data (see McCain, 1990).

First of all, the MDS map shown in Fig. 1 is consistent with the results of factor analysis. Indeed, the analyzed contributions tend to graphically cluster in five main groups, resembling the five factors and occupying very specific positions on the map – we have highlighted the factors in the map to help the reader compare MDS with factor analysis. More importantly, the graph makes it easier to interpret the two core venues of development of these factors. Contributions loading on Factor 1 (Technology and Competences for Innovation) and Factor 2 (New Product Development and Market Learning) cluster at the top of the map, respectively on the upper right-hand side and upper left-hand side. Papers loading on Factor 3 (Demand and User Innovation) are placed at the bottom of the map. Factor 4 is visually split into the two sub-groups of papers previously identified, with papers positively loading on Factor 4a placed on the right-hand side of the map and papers negatively loading on Factor 4b placed on the left-hand side of the map. Finally, Factor 5 (Technology Diffusion and Adoption) is placed in the middle of the map. The specific positions of the five factors were used to interpret the axes of the map.

As we move from the right- to the left-hand side of the map, the x-axis juxtaposes the two alternative sources of innovation opportunities: technology and demand. As shown in Fig. 1, this juxtaposition is illustrated by the fact that Factor 1 (with its emphasis on technology) and Factor 4a (with its emphasis on sectoral systems of innovation) is placed on the right of the map, whereas Factors 2 (with its emphasis on marketing and market learning) and 4b (system innovation centered on user interface for information technology and for service) are placed on the left. Factor 3 papers also point to the left-hand direction with respect to the axis.[15]

This neat separation in the graph substantiates the classic debate between technology and demand as sources of innovation. In this respect, the fact that most of the contributions are placed on the right-end side of the graph demonstrates that the vast majority of articles embrace an idea of technology as the source of innovation. Papers loading on Factors 1 and 4a see demand in its complementary role – i.e., in the role of matching the market needs that can make technological innovations successful in the marketplace. On the opposite, in Factors 2 and 4b demand is seen as a potential source of innovation, with technology helping firms to ideate as well as to develop the innovation.

Moving top-down on the map, the y-axis juxtaposes papers focusing on internal sources of innovation – and specifically firm competences – to papers focusing on external sources of innovation. This is illustrated by the fact that Factor 1, dealing with competences required to the development of technological innovation, and Factor 2, dealing with successful new product development, have an upward orientation, while the Factor that explicitly proposes user innovation is oriented downward (Factor 3).[16]

In this respect, it is quite striking to note how, except for Factor 3, all of the factors tend to cluster in the upper part of the map. Contributions clustered at the bottom of the map adopt a purely external perspective, and with their emphasis on open innovation and user communities push the boundaries of innovation beyond those of the firm. Papers on the upper part of the map tend to rely on the idea of internal competences as a crucial crossroads to assimilate and combine external knowledge within firm boundaries. This confirms the importance of the Resource-based and Knowledge-based Views in the case of innovation (see also Martin, 2012).

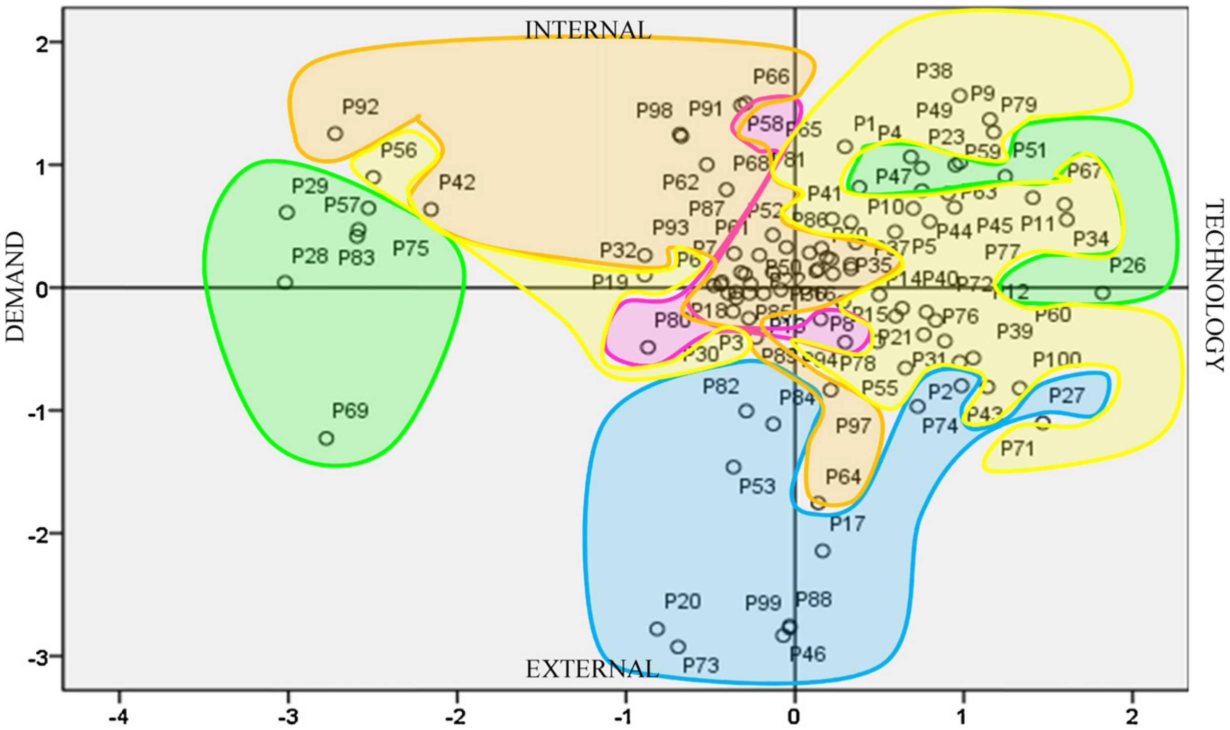
5. Central nodes in co-citation networks

In order to unveil the knowledge brokers of the scholarly communities behind the five factors, we now turn to Pathfinder analysis to examine the network linking these contributions. This analysis is particularly suitable to identifying clusters of articles that span boundaries, bridging otherwise disconnected communities of research and influencing different disciplinary domains (Marion and McCain, 2001; White, 2003; Nerur et al., 2008). Pathfinder analysis generates a network structure that highlights the strongest relationships between units of analysis (Schvaneveldt, 1990). The Pathfinder network is derived from proximities between pairs of entities, where co-citations represent proximities and papers are the entities. The Pathfinder network shown in Fig. 2 is derived from the co-citations between papers: the papers analyzed are "nodes" linked together on the basis of co-citations patterns (Dearholt and Schvaneveldt, 1990; Nerur et al., 2008). Since co-citations are symmetrical for every pair of papers (i.e., the number of times paper A is cited together with paper B is equal to the number of times paper B is cited together with paper A), the links in our network are undirected. Note that the proximity between papers is shown by the existence of a link between them and not by spatial proximity as in the MDS map.

The network is first of all characterized by one boundary-spanning paper – i.e., a contribution that bridges different communities of research and exerts its influence across different disciplinary domains (Burt, 2005; Nerur et al., 2008). This is the case of Teece et al. (1997, marked as 1 in the network). The article provides a conceptual bridge across the three main clusters that would

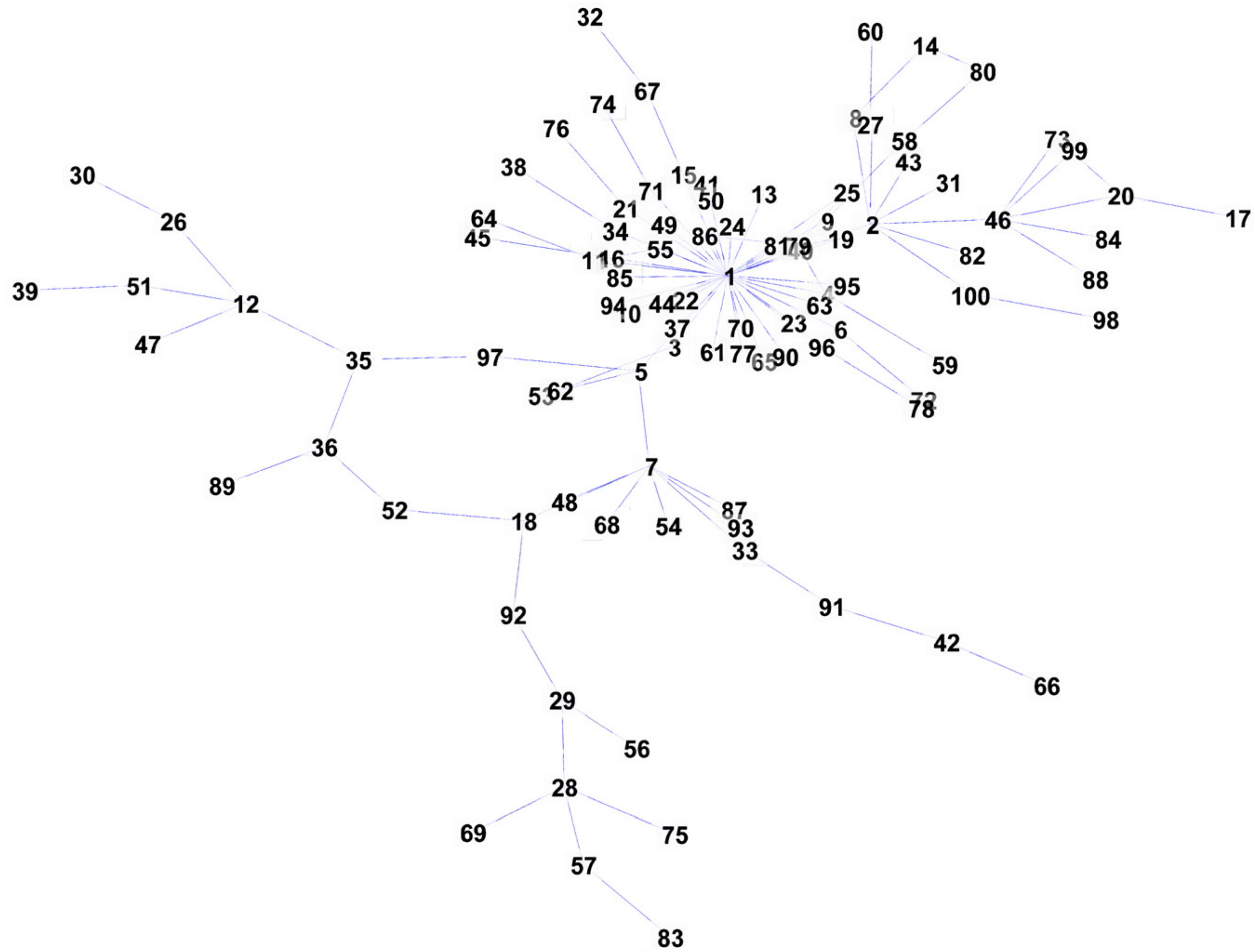
[15] This is confirmed by the fact that the closest paper on the right is by Langlois and Robertson (1992): in this contribution users are only one of the different types of actor that contribute to the modular system of innovation envisioned in the paper.

[16] A closer look at the articles within Factors 1 and 2 confirms our intuition: Articles at the top of the graph propose an idea of technological competence (factor 1) and marketing practice (factor 2) which is more internally driven compared to those at the bottom.



Factor 1	
P86	Kim & Kogut, 1996
P6	Yli-Renko *et al.*, 2001
P3	Kogut & Zander, 1996
P19	Helfat, 1997
P13	Sorensen & Stuart, 2000
P25	Bierly & Chakrabarti, 1996
P70	Ettlie & Reza, 1992
P16	Rothaermel & Deeds, 2004
P85	Zahra & Nielsen, 2002
P81	Cantwell & Mudambi, 2005
P24	Danneels, 2002
P77	Hagedoorn & Duysters, 2002
P15	Klevorick *et al.*, 1995
P90	Venkatraman & Henderson, 1998
P94	Afuah, 2000
P37	Rothaermel, 2001
P22	Tripsas, 1997
P10	Stuart, 2000
P44	Handfield *et al.*, 1999
P65	Demarest, 1997
P50	Hill & Rothaermel, 2003
P95	Prahalad & Hamel, 1994
P45	Deeds & Hill, 1996
P55	Gans & Stern, 2003
P72	Pittaway *et al.*, 2004
P23	Furman *et al.*, 2002
P79	Torkzadeh & Doll, 1999
P63	Treacy & Wiersema, 1993
P4	Fisher, 1997
P59	Magretta & Dell, 1998
P21	Christensen & Rosenbloom, 1995
P96	Dutta *et al.*, 1999
P1	Teece *et al.*, 1997
P41	Lumpkin & Dess, 2001
P5	Christensen & Bower, 1996
P49	Glynn, 1996
P14	Tyre & Orlikowski, 1994
P11	Rothwell, 1992
P40	Gatignon *et al.*, 2002
P43	Arora & Gambardella, 1994
P76	Adner & Levinthal, 2001
P39	Garud & Rappa, 1994
P9	Klein & Sorra, 1996
P78	Luo & Bhattacharya, 2006
P31	Conner & Rumelt, 1991
P60	Garud & Kumaraswamy, 1995
P71	Mac Cormack *et al.*, 2001
P67	Lee, 1996
P30	Gallouj & Weinstein, 1997
P100	Bhave, 1994
P56	Zaltman, 1997
P34	Hobday, 1998
P38	Hobday, 2000
Factor 2	
P87	Song & Parry, 1996
P68	Im & Workman, 2004
P18	Henard & Szymanski, 2001
P52	Danneels & Kleinschmidt, 2001
P48	Zhou *et al.*, 2005
P54	Narver *et al.*, 2004
P93	Srinivasan *et al.*, 2002
P33	Chandy & Tellis, 2000
P7	Gatignon & Xuereb, 1997
P91	Hauser *et al.*, 2006
P61	Atuahene-Gima, 2005
P36	Veryzer, 1998
P89	O'Connor, 1998
P92	Moreau *et al.*, 2001
P97	Leonard & Rayport, 1997
P35	Lynn *et al.*, 1996
P66	Elberse & Eliashberg, 2003
P64	Murray, 2002
P42	Bass *et al.*, 1994
P98	Stewart *et al.*, 1999
P32	Etzkowitz *et al.*, 2000
P62	Shane, 1993
Factor 3	
P84	Nambisan, 2002
P82	von Hippel, 2001
P88	Morrison *et al.*, 2000
P46	Franke & Shah, 2003
P99	Harhoff *et al.*, 2003
P73	Franke & von Hippel, 2003
P20	Lakhani & von Hippel, 2003
P17	von Hippel & von Krogh, 2003
P74	Iansiti & Mac Cormack, 1997
P2	von Hippel, 1994
P27	Langlois & Robertson, 1992
P53	Christensen *et al.*, 2000
Factor 4	
P47	Geels, 2004
P51	Garud & Karnoe, 2003
P12	Kemp *et al.*, 1998
P26	Malerba, 2002
P57	Burke, 2002
P75	Meuter *et al.*, 2005
P28	Dabholkar & Bagozzi, 2002
P29	Mick & Fournier, 1998
P69	Bruner & Kumar, 2005
P83	Arnold & Reynolds, 2003
Factor 5	
P8	Attewell, 1992
P80	Kraut *et al.*, 1998
P58	Frambach & Schillewaert, 2002

Fig. 1. Multidimensional scaling.



1	Teece *et al.*, 97	26	Malerba, 02	51	Garud & Karnoe, 03	76	Adner & Levinthal, 01
2	von Hippel, 94	27	Langlois & Robertson, 92	52	Danneels & Kleinschmidt, 01	77	Hagedoorn & Duysters, 02
3	Kogut & Zander, 96	28	Dabholkar & Bagozzi, 02	53	Christensen *et al.*, 00	78	Luo & Bhattacharya, 06
4	Fisher, 97	29	Mick & Fournier, 98	54	Narver *et al.*, 04	79	Torkzadeh & Doll, 99
5	Christensen & Bower, 96	30	Gallouj & Weinstein, 97	55	Gans & Stern, 03	80	Kraut *et al.*, 98
6	Yli-Renko *et al.*, 01	31	Conner & Rumelt, 91	56	Zaltman, 97	81	Cantwell & Mudambi, 05
7	Gatignon & Xuereb, 97	32	Etzkowitz *et al.*, 00	57	Burke, 02	82	von Hippel, 01
8	Attewell, 92	33	Chandy & Tellis, 00	58	Frambach & Schillewaert, 02	83	Arnold & Reynolds, 03
9	Klein & Sorra, 96	34	Hobday, 98	59	Magretta & Dell, 98	84	Nambisan, 02
10	Stuart, 00	35	Lynn *et al.*, 96	60	Garud & Kumaraswamy, 95	85	Zahra & Nielsen, 02
11	Rothwell, 92	36	Veryzer, 98	61	Atuahene-Gima, 05	86	Kim & Kogut, 96
12	Kemp *et al.*, 98	37	Rothaermel, 01	62	Shane, 93	87	Song & Parry, 96
13	Sorensen & Stuart, 00	38	Hobday, 00	63	Treacy & Wiersema, 93	88	Morrison *et al.*, 00
14	Tyre & Orlikowski, 94	39	Garud & Rappa, 94	64	Murray, 02	89	O'Connor, 98
15	Klevorick *et al.*, 95	40	Gatignon *et al.*, 02	65	Demarest, 97	90	Venkatraman & Henderson, 98
16	Rothaermel & Deeds, 04	41	Lumpkin & Dess, 01	66	Elberse & Eliashberg, 03	91	Hauser *et al.*, 06
17	von Hippel & von Krogh, 03	42	Bass *et al.*, 94	67	Lee, 96	92	Moreau *et al.*, 01
18	Henard & Szymanski, 01	43	Arora & Gambardella, 94	68	Im & Workman, 04	93	Srinivasan *et al.*, 02
19	Helfat, 97	44	Handfield *et al.*, 99	69	Bruner & Kumar, 05	94	Afuah, 00
20	Lakhani & von Hippel, 03	45	Deeds & Hill, 96	70	Ettlie & Reza, 92	95	Prahalad & Hamel, 94
21	Christensen & Rosenbloom, 95	46	Franke & Shah, 03	71	Mac Cormack *et al.*, 01	96	Dutta *et al.*, 99
22	Tripsas, 97	47	Geels, 04	72	Pittaway *et al.*, 04	97	Leonard & Rayport, 97
23	Furman *et al.*, 02	48	Zhou *et al.*, 05	73	Franke & von Hippel, 03	98	Stewart *et al.*, 99
24	Danneels, 02	49	Glynn, 96	74	Iansiti & Mac Cormack, 97	99	Harhoff *et al.*, 03
25	Bierly & Chakrabarti, 96	50	Hill & Rothaermel, 03	75	Meuter *et al.*, 05	100	Bhave, 94

Fig. 2. Pathfinder analysis.

otherwise be relatively isolated from each other.[17] The paper is central in many respects for two important reasons. First, it groups together a dense cluster of papers that are directly linked to it and constitute the core of the network. Second, it is positioned between the other two main visible clusters, i.e., the one around von Hippel (1994, marked as 2 in the network) and the one originating from Christensen and Bower (1996, marked as 5 in the network).

In more formal terms, the article by Teece et al. (1997) displays high centrality scores, i.e., it is highly prominent and influent in the field (Wasserman and Faust, 1994). The fact that, compared to other papers in the network, it presents a very high number of direct ties if compared means that it exhibits a high degree centrality (Freeman, 1979). This implies a potential for encouraging a strong and integrated cluster of knowledge that is specialized to a localized thought domain (Burt, 2005). The cluster of papers more closely related to Teece consists of papers loading on Factor 1 and therefore dealing with technology and competences for innovation. This cluster emphasizes technology as the main source of opportunities and is influenced by the Resource-based and Knowledge-based Views in stressing the role that firm-specific inputs have in exploiting these opportunities. It focuses on the firm internal perspective, and is more oriented toward technology. It is important to note that the centrality of Teece et al. (1997) is consistent with the findings of the previous MDS analysis. Indeed, the paper is famous for being considered the founding article of the dynamic capability field and defines dynamic capabilities as "firm's ability to integrate, build, reconfigure firm internal and external competences to address rapidly changing environment" (Teece et al., 1997, p. 516). This paper is therefore the quintessential synthesis of the role of internally generated competences to absorb external technological and market knowledge.

Stemming from Teece et al. (1997), we note the formation of two main clusters of papers. The first is a very dense cluster of contributions is the one around von Hippel (1994, marked as 2 in the network). The article is central to papers loading on Factor 3 and emphasizing the role of demand, as well as on papers loading on Factor 5 and discussing issues of technology diffusion and adoption. This contribution points to one characteristic of information – i.e., stickiness – which makes it difficult to transfer, hence highlighting the need for learning with the market. In fact, moving innovation-related activities from suppliers to users may be economically convenient under conditions of high stickiness of the information held by users, the low stickiness of the information held by suppliers, as well as the heterogeneous demand for a product or high agency costs for users who outsource design activities (von Hippel, 1998).

In formal terms, von Hippel (1994) is characterized by a very high number of direct ties, i.e., high degree centrality, thus indicating the presence of a strongly interconnected cluster of contributions. These contributions have more openly worked in the direction of identifying the mechanisms that can enable firms to embrace a pure demand-pull approach (coined by von Hippel, 1976 as "customer active paradigm" as opposed to the "research active paradigm" and "manufacturing active paradigm" that in his theorizing represent the tradition of technology push at a more micro level of analysis). These mechanisms range from communication systems and communication incentives, to more elaborated factors such as virtual communities and open-source systems and have granularly been observed in most of the papers of Factor 3.

A second cluster of contributions deriving from Teece et al. (1997) is the one starting from Christensen and Bower (1996, marked as 5 in the paper). This study develops the concept of disruptive innovations. It shows how incumbents may fail to develop innovations because they tend to allocate resources to current customers presenting mainstream needs. Instead, new ventures can focus on developing technologies for the emerging, latent needs of niche markets that, in the long run, can also become dominant in the mainstream market. Overall, this study highlights that less explicit demand elements or less evident market segments can influence the success of innovation and firm competences determine the ultimate success of new technologies. As such, it is directly connected to Teece et al. (1997), but it also connects the domain of competences to that of successful new product development and market learning (Factor 2). Through Gatignon and Xuereb (1997, marked as 7 in the network) and Henard and Szymanski (2001, marked as 18 in the network), this domain also connects to papers loading on Factor 4b (the system perspective centered on customers). Moreover, through its link to the discussion of tools for incorporating market learning in the design process (Leonard-Barton and Rayport, 1997, marked as 97 in the network), the paper by Christensen and Bower (1996) is also connected to contributions looking at the systemic side of innovation, and hence loading on Factor 4a (systems of innovation).

As much as Teece et al. (1997) represents the role of internally generated competences, the article by Christensen and Bower points directly to the second result of our MDS analysis, namely the importance of matching technological innovations with the characteristics of the market. In fact, the article by Christensen and Bower (1996) has thoroughly illustrated the importance of not simply thinking in terms of technology but devoting attention to finding the right market segment and allocating the right resources to it. Therefore, as demonstrated, the article represents a classic bridge between strategy and marketing communities. It also played a brokering role in our graph due to debate it triggered in strategy and marketing journals (e.g., Slater and Narver, 1998; Danneels, 2006).

6. Discussion and conclusions

In this paper we have provided a detailed review of academic articles dealing with the sources of innovation. After debating the juxtaposition between technology and demand as sources of innovations, classic works on the sources of innovation converged on the mutual importance of the two sources. While science and technology provide the trajectories of innovation, demand is a crucial component in order to direct the trajectory towards the right economic venues (e.g., Dosi, 1982; Kline and Rosenberg, 1986). Despite an agreement was reached, many questions were left open in the debate. For instance: does demand generate innovation in addition to selecting it? How can firms capitalize both technology and demand in the process of innovation development and commercialization? Are firms passive or active actors in the process of leveraging on technological or demand sources? What are the mechanisms that enable firms to leverage the different sources of innovation? In the attempt to see how scholars have addresses these and related questions, we have carried out a thoroughout review of papers published in business and management journals. In so doing, we believe we have contributed to the field of innovation studies by providing a systematization of journal articles on the topic of the sources of innovation.

Like all review based on bibliometrics, this paper presents a number of limitations. First of all, it excludes books, book chapters, and working papers from the set of papers. Second, it selects papers based on keywords. Third, it limits the number of reviewed papers to the most cited. Finally, it works on co-citation as a pattern of analysis. While these limitations enable researchers to work on a

[17] In this respect, please note that these clusters can be interpreted as homogeneous topical domains, and indeed they find a direct comparison in the results of the factor analysis.

robust database, we are perfectly aware of alternative approaches to some of them. For instance, the recent work by Fagerberg et al. (2012) uses cluster analysis to study the broader topic of innovation as it has been published in handbooks. The work by Martin (2012) is based on a review of highly cited papers and traces the innovation of the field of science policy and innovation over the last 50 years. Both studies can be seen as complementary to our approach in both the method used and the more "macro" focus presented.

While we are aware of the limitations of our review, we believe that our investigation has brought to light three important findings. First of all, our contribution has more precisely highlighted the role of demand as a source of innovation. Scholars in the past have criticized the actual role of demand and narrowed it to the role of a selection force of technology (e.g., Mowery and Rosenberg, 1979; Dosi, 1982). While the lever of demand is particularly important in the case of selection (e.g., Factor 2; Factor 4b), our analysis has also unveiled how an interrelates set of more recent studies have provided a better understanding of the role of demand as a source of innovation (Factor 3).

Second, in addition to confirming the importance of technology as a source of innovation and clarifying the role of demand, our contribution has identified resources, competences, and knowledge as a crucial dimension in providing a synthesis of the two. Indeed, many technological innovations have their origin in science and technology but still need a market and the related complementary assets (Teece, 1986) to be successfully commercialized (e.g., Christensen and Bower, 1996; Gatignon and Xuereb, 1997; and, more broadly, Factors 1, 2, and 4a). Similarly, innovations that stem from a pure demand pull perspective (von Hippel, 1976, 1994; and, more broadly, Factors 3 and 4b) still require technological competences to be developed effectively. In all these cases, competences are at the basis of this fundamental synthesis, as demonstrated by most of the articles linked to these factors.

Third, resources, competences, and knowledge can themselves be a source of innovation. This means that in some cases the competences serve the need of simply importing external sources within the firm (e.g., the case of sticky information of von Hippel, 1994 and more broadly of Factor 3). Most often, competences are internally generated and help the firm absorb the signals of technology and/or demand according to the firm characteristics (e.g., Teece et al., 1997; and, more broadly, Factor 1). This result brings in the issue of the firm's absorptive capacity (Cohen and Levinthal, 1989, 1990) as a crucial ability of the innovator to absorb such signals.

While the previous findings represent the more objective conclusions that can be drawn from our analysis, we also see other important implications of our study. In particular, and in a more interpretative fashion, we believe that our analysis can be seen as uncovering three potential venues for future research on the topic, related respectively to: methodology, microfoundations, and entrepreneurship.

First of all, some methodological issues emerged after examining the contributions collected in our analysis. We believe it is important to rely more on methods that today appear to be under-utilized in order to enrich the field with heterogeneous perspectives. Let us consider some examples that emerged in our analysis and how they contributed to research in this area. Studies based on primary data and in-depth case study, both at the supplier and user level, such as those by von Hippel (1994, 1998), have provided important insights on users' characteristics and their impact on innovation. Longitudinal analyses, such as the one performed by Christensen and Rosenbloom (1995) and Christensen and Bower (1996) on the disk drive industry, have helped to better understand the impediments driven by mainstream customers in launching technological innovation. Analytical models, such as the one by Adner and Levinthal (2001), have highlighted the impact on technological innovation of factors such as customer preferences and their heterogeneity. Studies based on experimental design characterized primarily the discipline of marketing, but they can provide important base of exploration even when adopting other views of innovation. Overall, a wealth of methods means a wealth of findings, perspectives, and details, and has to be fostered if the field of innovation is to develop and, in particular, the sources of innovation better understood.

Second, in addition to stimulating the importance of a pluralism of methodologies, we believe that our analysis should encourage future research to combine micro and macro levels of information, and to go into the microfoundations of the relationship under study. Indeed, the study of microfoundations of capabilities can enhance our understanding of strategy making but also of competence-leverage (Teece, 2007) and as such can improve our understanding of the sources of innovation. As pointed out by Rothaermel and Hess (2007), academic research has tended to focus on only one level of analysis at a time (individual, firm or network), assuming that the other levels are homogeneous and that the chosen level is independent from the others. Taken together, these two assumptions can potentially harm the reliability of empirical findings by suggesting that research be carried out at multiple levels in order to capture most of the heterogeneity. With reference to the issue of microfoundations, in examining the research on the relationship under study, most of the attention seems to have been devoted to the firm or network level of analysis, except for the longstanding tradition of research on lead users (von Hippel, 2005) and recent contributions on managerial cognitive frames (Tripsas and Gavetti, 2000). The study of microfoundations seems to be an emerging and interesting path to follow in this domain: substantial attention needs to be devoted to explanatory mechanisms at the individual level. Consider the exemplary case of the long-debated research on disruptive technologies. The question stemming from this debate is whether incumbent firms will inevitably fail to seize radical innovation opportunities. Research in this area started by examining industries in which incumbent firms were unable to capture radical innovations, because of managerial focus on target markets in the allocation of innovation resources. However, the fortune of firms is not the fortune of the industry, and disruptive innovations have been shown to create new markets and net growth, even though incumbents still do not always seize the opportunities associated with these innovations. The attention has therefore moved to a more fine-grained analysis at the firm and individual level. At the firm level, research has examined incumbent inertia from two viewpoints (Gilbert, 2005), i.e., in terms of resource rigidity (Christensen and Bower, 1996; Henderson, 1993) and routine rigidity (Leonard-Barton, 1992; Nelson and Winter, 1982). Recently, also institutional explanations for incumbent inertia have also been advanced, according to which pressures from financial markets during periods of radical change may impede incumbents from responding to change (Benner, 2007). At a more detailed level, research has even examined organizational inertia in terms of distinctive competences and official corporate strategy (Burgelman, 1994), as well as managerial cognitive frames (Gilbert, 2006). Since firms have an opportunity cost in capturing innovation opportunities, current literature has tried to identify ways through which incumbent firms can overcome inertia. At the industry level, the role of complementary assets has been widely examined starting from the seminal contribution by Teece (1986). Indeed, complementary assets can dramatically affect the division of returns to innovation in industries where they are important (Tripsas, 1997; Gans and Stern, 2003; Rothaermel, 2001; McGahan and Silverman, 2006). Additionally, at the industry level, incumbents have been shown to adapt to change by devising start-ups to operate in new fields (Allen, 1998), or being subject to the phenomenon of spinoffs (Klepper, 2007). At lower levels, literature has studied economic, organizational and strategic factors allowing incumbents to successfully respond to radical technological change (see, for a review, e.g., Hill and Rothaermel, 2003), as well as the impact of managerial cognitive frames (Tripsas and Gavetti, 2000). To sum up, it is by looking at multiple levels of analysis, with an integrative and contingent perspective, that one can better understand why firms may be unable to see emerging trends in the industry, and how they can improve their ability to do so. In this respect microfoundations seem the level that it is more penalized thus far.

Third, our results highlight one final important aspect relates to the field of entrepreneurship. Although sometimes developed as separate fields, entrepreneurship and innovation are closely interrelated – see also the papers by Aldrich (2012) and Bhupatiraju et al. (2012). It is no accident that reviews of each of the two fields highlight the importance of the other: innovation turns out to be one of the core domains of entrepreneurship (Hitt and Ireland, 2000) and entrepreneurship is one of the core themes within the innovation domain (Shane and Ulrich, 2004). More specifically, on the one hand, the process of creating new products, processes, markets and ways of organizing is primarily based on entrepreneurship (Schumpeter, 1934). On the other, the very definition of entrepreneurship incorporates the idea of exploiting environmental opportunities through innovation for the purpose of wealth creation (Hitt et al., 2001). In the words of Drucker (2007, p. 25), "the entrepreneur always searches for change, responds to it and exploits it as an opportunity". And he can do so primarily through the process of innovation. In fact, entrepreneurial actions entail creating new resources or combining existing resources in new ways (Hitt et al., 2001; Ireland et al., 2001). Entrepreneurship research has started to focus its attention on a new, active relationship between the firm and its external environment, calling for the need to focus on opportunities created by supply-driven as well as demand-driven changes (Eckhardt and Shane, 2003). Linking more formally these first results to innovation studies would benefit both themes.

In conclusion, we hope that scholars will benefit from our effort to better untangle emerging topics in this field of inquiry, which seems to be increasingly important in business practice and research. In this respect, we believe our contribution will help the literature dealing with the sources of innovation move from a bifurcation between market-pull and technology-push to a more comprehensive and balanced consideration of the different foundations of innovation, in which demand and technology are understood to be the levers and sources of innovation.

Acknowledgements

This paper has benefitted from the comments and suggestions of many friends and colleagues. Among others, we would like to thank in particular Stefano Brusoni, Erwin Danneels, Gianfranco Forte, Richard Priem, Paul Robertson, and Giovanni Valentini. We would also like to thank Ben Martin and four anonimous reviewers for their comments and critiques. The usual disclaimers apply.

References

Acedo, F.J., Barroso, C., Galan, J.L., 2006. The resource-based theory: dissemination and main trends. Strategic Management Journal 27 (7), 621–636.

Adner, R., Levinthal, D.A., 2001. Demand heterogeneity and technology evolution: implications for product and process innovation. Management Science 47 (5), 611–628.

Afuah, A., 2000. How much do your co-opetitors' capabilities matter in the face of technological change? Strategic Management Journal 21 (3), 387–404.

Aldrich, H., 2012. The Emergence of entrepreneurship as an academic field: a paradigmatic case of institutional entrepreneurship. Research Policy, doi:10.1016/j.respol.2012.03.013, in press.

Allen, J.W., 1998. Capital markets and corporate structure: the equity carve-outs of thermo electron. Journal of Financial Economics 48 (1), 99–124.

Arnold, M.J., Reynolds, K.E., 2003. Hedonic shopping motivations. Journal of Retailing 79 (2), 77–95.

Arora, A., Gambardella, A., 1994. The changing technology of technological change: general and abstract knowledge and the division of innovative labor. Research Policy 23 (5), 523–532.

Attewell, P., 1992. Technology diffusion and organizational learning: the case of business computing. Organization Science 3 (1), 1–19.

Atuahene-Gima, K., 2005. Resolving the capability-rigidity paradox in new product innovation. Journal of Marketing 69 (4), 61–83.

Bass, F.M., Krishnan, T.V., Jain, D.C., 1994. Why the Bass model fits without decision variables. Marketing Science 13 (3), 203–223.

Baumgartner, H., Pieters, R., 2003. The structural influence of marketing journals: a citation analysis of the discipline and its sub areas over time. Journal of Marketing 67 (April), 123–139.

Benner, M.J., 2007. The incumbent discount: stock market categories and response to radical technological change. Academy of Management Review 32 (3), 703–720.

Bhave, M.P., 1994. A process model of entrepreneurial venture creation. Journal of Business Venturing 9 (3), 223–242.

Bhupatiraju, S., Nomaler, Ö., Triulzi, G., Verspagen, B., 2012. Knowledge flows – analyzing the core literature of innovation, entrepreneurship and science and technology studies. Research Policy, doi:10.1016/j.respol.2012.03.011, in press.

Bierly, P., Chakrabarti, A., 1996. Generic knowledge strategies in the U.S. pharmaceutical industry. Strategic Management Journal Special Issue 17, 123–135.

Bruner, G.C., Kumar, A., 2005. Explaining consumer acceptance of handheld Internet devices. Journal of Business Research 58 (5), 553–558.

Burgelman, R., 1994. Fading memories: a process theory of strategic business exit in dynamic environments. Administrative Science Quarterly 39 (1), 24–56.

Burke, R.R., 2002. Technology and the customer interface: what consumers want in the physical and virtual store. Journal of the Academy of Marketing Science 30 (4), 411–432.

Burt, R.S., 2005. Brokerage and Closure: An Introduction to Social Capital. New York, Oxford University Press.

Cantwell, J., Mudambi, R., 2005. MNE competence-creating subsidiary mandates. Strategic Management Journal 18 (4), 247–257.

Chandy, R.K., Tellis, G.J., 2000. The incumbent's curse? Incumbency, size, and radical product innovation. Journal of Marketing 18 (4), 247–257.

Chesbrough, H., 2003. Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business School Press, Boston, MA.

Christensen, C.M., Bohmer, R., Kenagy, J., 2000. Will disruptive innovations cure health care? Harvard Business Review 78 (5), 102–112.

Christensen, C.M., Bower, J.L., 1996. Customer power, strategic investment, and the failure of leading firms. Strategic Management Journal 17 (3), 197–218.

Christensen, C.M., Rosenbloom, R.S., 1995. Explaining the attacker's advantage: technological paradigms, organizational dynamics, and the value network. Research Policy 24 (2), 233–257.

Cohen, J., 1960. A coefficient of agreement for nominal scales. Educational and Psychological Measurement 20 (1), 37–46.

Cohen, W., Levinthal, D.A., 1989. Innovation and learning: the two faces of R&D. The Economic Journal 99, 569–596.

Cohen, W., Levinthal, D.A., 1990. Absorptive capacity: a new perspective on learning and innovation. Administrative Science Quarterly 35 (1), 128–152.

Conner, K.R., Rumelt, R.P., 1991. Software piracy: an analysis of protection strategies. Management Science 37 (2), 125–139.

Crane, D., 1972. Invisible Colleges: Diffusion of Knowledge in Scientific Communities. University of Chicago Press, Chicago, IL.

Dabholkar, P.A., Bagozzi, R.P., 2002. An attitudinal model of technology-based self-service: moderating effects of consumer traits and situational factors. Journal of the Academy of Marketing Science 30 (3), 184–201.

Danneels, E., 2002. The dynamics of product innovation and firm competences. Strategic Management Journal 23 (12), 1095–1121.

Danneels, E., 2006. From the guest editor: dialogue on the effects of disruptive technology of firms and industries. Journal of Product Innovation Management 23 (1), 2–4.

Danneels, E., Kleinschmidt, E.J., 2001. Product innovativeness from the firm's perspective: its dimensions and their relation with project selection and performance. Journal of Product Innovation Management 18 (6), 357–373.

Dearholt, D.W., Schvaneveldt, R.W., 1990. Properties of Pathfinder networks. In: Schvaneveldt, R.W. (Ed.), Pathfinder Associative Networks: Studies in Knowledge Organization. Ablex, Norwood, NJ, pp. 1–30.

Deeds, D.L., Hill, C.W.L., 1996. Strategic alliances and the rate of new product development: an empirical study of entrepreneurial biotechnology firms. Journal of Business Venturing 11 (1), 41–55.

Demarest, M., 1997. Understanding knowledge management. Long Range Planning 31 (9), 1389–1403.

de Solla Price, D.J., 1963. Little Science, Big Science. Columbia University Press, New York.

Di Stefano, G., Peteraf, M.A., Verona, G., 2010. Dynamic capabilities deconstructed: a bibliographic investigation into the origins, development, and future directions of the research domain. Industrial and Corporate Change 19 (4), 1187–1204.

Dosi, G., 1982. Technological paradigms and technological trajectories. A suggested interpretation of the determinants and directions of technical change. Research Policy 11, 147–162.

Drucker, P.F., 2007. Innovation and Entrepreneurship. Harper Collins, New York, NY.

Dutta, S., Narasimhan, O., Rajiv, S., 1999. Success in high-technology markets: is marketing capability critical? Marketing Science 21 (3), 387–404.

Eckhardt, J.T., Shane, S.A., 2003. Opportunities and entrepreneurship. Journal of Management 29 (3), 333–349.

Elberse, A., Eliashberg, J., 2003. Demand and supply dynamics for sequentially released products in international markets: the case of motion pictures. Marketing Science 22 (3), 329–354.
Ettlie, J.E., Reza, E.M., 1992. Organizational integration and process innovation. Academy of Management Journal 35 (4), 795–827.
Etzkowitz, H., Webster, A., Gebhardt, C., Terra, B.R.C., 2000. The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. Research Policy 29 (2), 313–330.
Fisher, M.L., 1997. What is the right supply chain for your product? Harvard Business Review 75 (2), 105–116.
Fagerberg, J., Fosaas, M., Sapprasert, K., 2012. Innovation: exploring the knowledge base. Research Policy, doi:10.1016/j.respol.2012.03.008, in press.
Frambach, R.T., Schillewaert, N., 2002. Organizational innovation adoption – a multi-level framework of determinants and opportunities for future research. Journal of Business Research 76 (2).
Franke, N., Shah, S., 2003. How communities support innovative activities: an exploration of assistance and sharing among end-users. Research Policy 32 (1), 157–178.
Franke, N., von Hippel, E., 2003. Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software. Research Policy 32 (7), 1199–1215.
Freeman, L.C., 1979. Centrality in social network. Conceptual clarification. Social Networks 1, 215–239.
Furman, J.L., Porter, M.E., Stern, S., 2002. The determinants of national innovative capacity. Research Policy 31 (6), 899–933.
Gallouj, F., Weinstein, O., 1997. Innovation in services. Research Policy 26 (4), 537–556.
Gans, J.S., Stern, S., 2003. The product market and the market for ideas: commercialization strategies for technology entrepreneurs. Research Policy 32 (2), 330–350.
Garfield, E., 1979. Citation indexing: its theory and application in science, technology, and humanities. In: Garfield, E. (Ed.), Mapping the Structure of Science. John Wiley & Sons, New York, NY, pp. 98–147.
Garud, R., Karnoe, P., 2003. Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. Research Policy 32 (2), 277–300.
Garud, R., Kumaraswamy, A., 1995. Technological and organizational designs for realizing economies of substitution. Strategic Management Journal 16 (5), 93–109.
Garud, R., Rappa, M.A., 1994. A sociocognitive model of technology evolution – the case of Cochlear implants. Organization Science 5 (3), 344–362.
Gatignon, H., Tushman, M.L., Smith, W., Anderson, P., 2002. A structural approach to assessing innovation: construct development of innovation locus, type, and characteristics. Management Science 48 (9), 1103–1122.
Gatignon, H., Xuereb, J.M., 1997. Strategic orientation of the firm and new product performance. Journal of Marketing Research 34 (1), 77–90.
Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems – insights about dynamics and change from sociology and institutional theory. Research Policy 33 (6), 897–920.
Gilbert, C.G., 2005. Unbundling the structure of inertia: resource versus routine rigidity. Academy of Management Journal 48 (5), 741–763.
Gilbert, C.G., 2006. Change in the presence of residual fit: can competing frames coexist? Organization Science 17 (1), 150–167.
Glynn, M.A., 1996. Innovative genius: a framework for relating individual and organizational intelligences to innovation. Academy of Management Review 21 (4), 1081–1111.
Hagedoorn, J., Duysters, G., 2002. External sources of innovative capabilities: the preference for strategic alliances or mergers and acquisitions. Journal of Management Studies 47 (5), 611–628.
Handfield, R.B., Ragatz, G.L., Petersen, K.J., Monczka, R.M., 1999. Involving suppliers in new product development. California Management Review 42 (1), 59–82.
Harhoff, D., Henkel, J., von Hippel, E., 2003. Profiting from voluntary information spillovers: how users benefit by freely revealing their innovations. Research Policy 32 (10), 1753–1769.
Hauser, J.R., Tellis, G.J., Griffin, A., 2006. Research on innovation: a review and agenda for marketing science. Marketing Science 40 (1).
Helfat, C.E., 1997. Know-how and asset complementarity and dynamic capability accumulation: the case of R&D. Strategic Management Journal 18 (5), 339–360.
Henard, D.H., Szymanski, D.M., 2001. Why some new products are more successful than others. Journal of Marketing Research 14 (2), 209–223.
Henderson, R., 1993. Under-investment and incompetence as responses to radical innovation: evidence from the photolithographic alignment equipment industry. RAND Journal of Economics 24 (2), 248–270.
Hill, C.W.L., Rothaermel, F.T., 2003. The performance of incumbent firms in the face of radical technological innovation. Academy of Management Review 28 (2), 257–274.
Hitt, M.A., Ireland, R.D., 2000. Technological learning, knowledge management, firm growth and performance: an introductory essay. Journal of Engineering & Technology Management 17 (3–4), 231–246.
Hitt, M.A., Ireland, R.D., Camp, S.M., Sexton, D.L., 2001. Guest editors' introduction to the special issue. Strategic entrepreneurship: entrepreneurial strategies for wealth creation. Strategic Management Journal 22 (6–7), 479–491.
Hobday, M., 1998. Product complexity, innovation and industrial organization. Research Policy 26 (6), 689–710.
Hobday, M., 2000. The project-based organization: an ideal form for managing complex products and systems? Research Policy 29 (7), 871–893.
Iansiti, M., MacCormack, A., 1997. Developing products on Internet time. Harvard Business Review 75 (5), 108–117.
Im, S., Workman, J.P., 2004. Market orientation, creativity, and new product performance in high-technology firms. Journal of Marketing 68 (2), 114–132.
Ireland, R.D., Hitt, M.A., Camp, S.M., Sexton, D.L., 2001. Integrating entrepreneurship and strategic management actions to create firm wealth. Academy of Management Executive 15 (1), 49–63.
Kemp, R., Schot, J., Hoogma, R., 1998. Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technology Analysis & Strategic Management 10 (2), 175–195.
Kim, D.J., Kogut, B., 1996. Technological platforms and diversification. Organization Science 7 (3), 283–301.
Klein, K.J., Sorra, J.S., 1996. The challenge of innovation implementation. Academy of Management Review 21 (4), 1055–1080.
Klepper, S., 2007. Disagreement, spinoffs, and the evolution of Detroit as the capital of the U.S. automobile industry. Management Science 53 (4), 616–631.
Klevorick, A.K., Levin, R.C., Nelson, R.R., Winter, S.G., 1995. On the sources and significance of inter-industry differences in technological opportunities. Research Policy 24 (2), 185–205.
Kline, S.J., Rosenberg, N., 1986. An overview of innovation. In: Landau, R., Rosenberg, N. (Eds.), The Positive Sum Strategy: Harnessing Technology for Economic Growth. National Academy Press, Washington, DC, pp. 275–305.
Kogut, B., Zander, U., 1996. What firms do? Coordination, identity, and learning. Organization Science 7 (5), 502–518.
Kraut, R.E., Rice, R.E., Cool, C., Fish, R.S., 1998. Varieties of social influence: the role of utility and norms in the success of a new communication medium. Organization Science 9 (4), 437–453.
Kruskal, J.B., Wish, M., 1978. Multidimensional Scaling. Sage, Beverly Hills.
Lakhani, K.R., von Hippel, E., 2003. How open source software works: free user-to-user assistance. Research Policy 32 (6), 923–943.
Langlois, R.N., Robertson, P.L., 1992. Networks and innovation in a modular system: lessons from the microcomputer and stereo component industries. Research Policy 21 (4), 297–313.
Lee, Y.S., 1996. 'Technology transfer' and the research university: a search for the boundaries of university–industry collaboration. Research Policy 25 (6), 843–863.
Leonard-Barton, D., 1992. Core capabilities and core rigidities: a paradox in managing new product development. Strategic Management Journal Special Issue 13, 111–125.
Leonard-Barton, D., Rayport, J.F., 1997. Spark innovation through empathic design. Harvard Business Review 75 (6), 102–113.
Lumpkin, G.T., Dess, G.G., 2001. Clarifying the entrepreneurial orientation construct and linking it to performance. Academy of Management Review 21 (1), 135–172.
Luo, X.M., Bhattacharya, C.B., 2006. Corporate social responsibility, customer satisfaction, and market value. Journal of Marketing 70 (4), 1–18.
Lynn, G.S., Morone, J.G., Paulson, A.S., 1996. Marketing and discontinuous innovation: the probe and learn process. California Management Review 38 (3), 8–37.
MacCormack, A., Verganti, R., Iansiti, M., 2001. Developing products on Internet time: the anatomy of a flexible development process. Management Science 47 (1), 133–150.
Magretta, J., Dell, M., 1998. The power of virtual integration: an interview with Dell computer's Michael Dell. Harvard Business Review 76 (2), 73–84.
Makri, M., Hitt, M.A., Lane, P.J., 2010. Complementary technologies, knowledge relatedness, and invention outcomes in high technology mergers and acquisitions. Strategic Management Journal 31 (6), 602–628.
Malerba, F., 2002. Sectoral systems of innovation and production. Research Policy 31 (2), 247–264.
Marion, L., McCain, K.W., 2001. Contrasting views of software engineering journals: author co-citation choices and indexer vocabulary assignments. Journal of the American Society for Information Science and Technology 52 (4), 297–308.
Martin, B.R., 2012. The evolution of science policy and innovation studies. Research Policy, doi:10.1016/j.respol.2012.03.012, in press.
Martin, B.R., Nightingale, P., Yegros-Yegros, A., 2012. Science and technology studies: exploring the knowledge base. Research Policy, doi:10.1016/j.respol.2012.03.010, in press.
McCain, K.W., 1990. Mapping authors in intellectual space: a technical overview. Journal of the American Society for Information Science 41 (6), 433–443.
McGahan, A.M., Silverman, B.S., 2006. Profiting from technological innovation by others: the effect of competitor patenting on firm value. Research Policy 35 (8), 1222–1242.
McMillan, G.S., 2008. Mapping the invisible colleges of R&D management. R&D Management 38 (1), 69–83.
Meuter, M.L., Bitner, M.J., Ostrom, A.L., Brown, S.W., 2005. Choosing among alternative service delivery modes: an investigation of customer trial of self-service technologies. Journal of Marketing 39 (2), 167–188.
Meyers, S., Marquis, D.G., 1969. Successful Industrial Innovation. National Science Foundation, Washington, DC.
Mick, D.G., Fournier, S., 1998. Paradoxes of technology: consumer cognizance, emotions, and coping strategies. Journal of Consumer Research 25 (2), 123–143.
Moreau, C.P., Lehmann, D.R., Markman, A.B., 2001. Entrenched knowledge structures and consumer response to new products. Journal of Marketing Research 66 (3), 47–60.
Morrison, P.D., Roberts, J.H., von Hippel, E., 2000. Determinants of user innovation and innovation sharing in a local market. Management Science 46 (12), 1513–1527.
Mowery, D., Rosenberg, N., 1979. The influence of market demand upon innovation: a critical review of some recent empirical studies. Research Policy 8 (2), 102–153.

Murray, F., 2002. Innovation as co-evolution of scientific and technological networks: exploring tissue engineering. Research Policy 31 (8), 1389–1403.
Nambisan, S., 2002. Designing virtual customer environments for new product development: toward a theory. Academy of Management Review 27 (3), 392–413.
Narver, J.C., Slater, S.F., MacLachlan, D.L., 2004. Responsive and proactive market orientation and new-product success. Journal of Product Innovation Management 21 (5), 334–347.
Nelson, R.R., Winter, S.G., 1982. An Evolutionary Theory of Economic Change. Harvard University Press, Cambridge, MA.
Nerur, S.P., Rasheed, A.A., Natarajan, V., 2008. The intellectual structure of the strategic management field: an author co-citation analysis. Strategic Management Journal 29 (3), 319–336.
O'Connor, G.C., 1998. Market learning and radical innovation: a cross case comparison of eight radical innovation projects. Journal of Product Innovation Management 15 (2), 151–166.
Pittaway, L., Robertson, M., Munir, K., Denyer, D., Neely, A., 2004. Networking and innovation: a systematic review of the evidence. International Journal of Management Reviews 47 (1), 133–150.
Ponzi, L.J., 2002. The intellectual structure and interdisciplinary breadth of knowledge management: a bibliometric study of its early stage of development. Scientometrics 55 (2), 259–272.
Prahalad, C.K., Hamel, G., 1994. Strategy as a field of study: why search for a new paradigm. Strategic Management Journal 15 (0), 5–16.
Ramos-Rodríguez, A.R., Ruíz-Navarro, J., 2004. Changes in the intellectual structure of strategic management research: a bibliometric study of the Strategic Management Journal, 1980–2000. Strategic Management Journal 25 (10), 981–1004.
Rosenberg, N., 1982. Inside the Black Box: Technology and Economics. Cambridge University Press, New York.
Rothaermel, F.T., 2001. Incumbent's advantage through exploiting complementary assets via interfirm cooperation. Strategic Management Journal 22 (6–7), 687–699.
Rothaermel, F.T., Deeds, D.L., 2004. Exploration and exploitation alliances in biotechnology: a system of new product development. Strategic Management Journal 25 (3), 201–221.
Rothaermel, F.T., Hess, A., 2007. Building dynamic capabilities: innovation driven by individual, firm, and network-level effects. Organization Science, 18.
Rothwell, R., 1992. Successful industrial innovation – critical factors for the 1990. R&D Management 22 (3), 221–239.
Rowlands, I., 1999. Patterns of author co-citation in information policy: evidence of social, collaborative and cognitive structure. Scientometrics 44 (3), 533–546.
Schmookler, J., 1966. Invention and Economic Growth. Harvard University Press, Cambridge, MA.
Schumpeter, J.A., 1934. The Theory of Economic Development. Harvard University Press, Cambridge, MA.
Schvaneveldt, R.W. (Ed.), 1990. Pathfinder Associative Networks: Studies in Knowledge Organization. Ablex, Norwood, NJ.
Shane, S.A., 1993. Cultural influences on national rates of innovation. Journal of Business Venturing 8 (1), 59–73.
Shane, S.A., Ulrich, K.T., 2004. Technological innovation, product development, and entrepreneurship in Management Science. Management Science 50 (2), 133–144.
Slater, S.F., Narver, J.C., 1998. Customer-led and market-oriented: let's not confuse the two. Strategic Management Journal 19 (10), 1001–1006.
Song, X.M., Parry, M.E., 1996. What separates Japanese new product winners from losers. Journal of Product Innovation Management 13 (5), 422–439.
Sorensen, J.B., Stuart, T.E., 2000. Aging, obsolescence, and organizational innovation. Administrative Science Quarterly 45 (1), 81–112.
Srinivasan, R., Lilien, G.L., Rangaswamy, A., 2002. Technological opportunism and radical technology adoption: an application to e-business. Journal of Marketing 38 (1), 14–29.
Stewart, W.H., Watson, W.E., Carland, J.C., Carland, J.W., 1999. A proclivity for entrepreneurship: a comparison of entrepreneurs, small business owners, and corporate managers. Journal of Business Venturing 14 (2), 189–214.
Stigler, G.J., Becker, G.S., 1977. De gustibus non est disputandum. American Economic Review 67 (2), 76–90.
Stuart, T.E., 2000. Interorganizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry. Strategic Management Journal 21 (8), 791–811.
Teece, D.J., 1986. Profiting from technological innovation. Research Policy 15 (6), 285–305.
Teece, D.J., 2007. Explicating dynamic capabilities: the nature and micro foundations of (sustainable) enterprise performance. Strategic Management Journal 28 (13), 1319–1350.
Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strategic Management Journal 18 (7), 509–533.
Torkzadeh, G., Doll, W.J., 1999. The development of a tool for measuring the perceived impact of information technology on work. Omega – International Journal of Management Science 27 (3), 327–339.
Treacy, M., Wiersema, F., 1993. Customer intimacy and other value disciplines. Harvard Business Review 71 (1), 84–93.
Tripsas, M., 1997. Unraveling the process of creative destruction: complementary assets and incumbent survival in the typesetter industry. Strategic Management Journal 18 (6), 119–142.
Tripsas, M., Gavetti, G., 2000. Capabilities, cognition, and inertia: evidence from digital imaging. Strategic Management Journal 21 (10–11), 1147–1161.
Tyre, M.J., Orlikowski, W.J., 1994. Windows of opportunity: temporal patterns of technological adaptation in organizations. Organization Science 5 (1), 98–118.
Venkatraman, N., Henderson, J.C., 1998. Real strategies for virtual organizing. MIT Sloan Management Review 40 (1), 33–48.
Veryzer, R.W., 1998. Discontinuous innovation and the new product development process. Journal of Product Innovation Management 15 (4), 304–312.
von Hippel, E., 1976. The dominant role of users in the scientific instrument innovation process. Research Policy 5 (3), 212–239.
von Hippel, E., 1994. Sticky information and the locus of problem-solving: implications for innovation. Management Science 40 (4), 429–439.
von Hippel, E., 1998. Economics of product development by users: the impact of sticky local information. Management Science 44 (5), 629–644.
von Hippel, E., 2001. Perspective: user toolkits for innovation. Journal of Product Innovation Management 18 (4), 247–254.
von Hippel, E., 2005. Democratizing Innovation. MIT Press, Cambridge, MA.
von Hippel, E., von Krogh, G., 2003. Open Source Software and the private-collective innovation model: issues for organization sciences. Organization Science 14 (2), 209–223.
Wasserman, S., Faust, K., 1994. Social Network Analysis: Methods and Applications. Cambridge University Press, Cambridge, UK.
White, H.D., 2003. Pathfinder networks and author co citation analysis: a remapping of paradigmatic information scientists. Journal of the American Society for Information Science and Technology 54 (5), 423–434.
White, H.D., Griffith, B.C., 1981. Author co-citation: a literature measure of intellectual structure. Journal of the American Society for Information Science 32, 163–171.
White, H.D., McCain, K.W., 1998. Visualizing a discipline: an author co-citation analysis in information science, 1992–1995. Journal of the American Society for Information Science 49, 326–356.
Yli-Renko, H., Autio, E., Sapienza, H.J., 2001. Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. Strategic Management Journal 22 (6–7), 587–613.
Zahra, S.A., Nielsen, A.P., 2002. Sources of capabilities, integration and technology commercialization. Strategic Management Journal 23 (5), 377–398.
Zaltman, G., 1997. Rethinking market research: putting people back in. Journal of Marketing Research 34 (4), 424–437.
Zhou, K.Z., Yim, C.K., Tse, D.K., 2005. The effects of strategic orientations on technology- and market-based breakthrough innovations. Journal of Marketing 33 (7), 897–920.