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Jin Chen, Alexander Brem, Eric Viardot, Poh Kam Wong

Intellectual property and innovation management

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Can Huang, Suli Zheng
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INTELLECTUAL PROPERTY AND INNOVATION MANAGEMENT

Can Huang and Suli Zheng

Introduction

Intellectual property (IP) refers to an intellectual creation for which the law assigns a monopoly right to designated owners (Markman, Espina, and Phan, 2004). It manifests in various forms, including copyright, trademarks, patents, industrial designs and trade secrets. IP has been defined in and protected by laws for several centuries; however, only in recent decades has IP become the primary locus of value for many organizations (Al-Aali and Teece, 2013). In business practice, IP is usually integrated into organizations' overall business models and innovation activities and plays an increasing role in the contemporary competitive world. In the academic literature, an increasing number of studies from management and economics focus on IP as their central topic and research its implications for business strategy, organizational behavior, innovation, competitiveness and economic development.

The protection of intellectual property rights (IPRs) can provide incentives for innovation (Mazzoleni and Nelson, 1998). Innovators would not have an incentive to invest in R&D if they were unable to appropriate the returns from innovation. Abraham Lincoln's succinct description of IP law – "adding the fuel of interest to the fire of genius" – demonstrates the importance of IP in reaping the benefits of private investment in innovation. However, social welfare can be increased if competitors can imitate and improve on innovations (Levin, Klevorick, Nelson, and Winter, 1987). IP law seeks to resolve this tension between the incentives for innovation and the widespread diffusion of its benefits. For example, the patent laws in most countries offer patent protection for 20 years. Eighteen months after a patent application is filed, many patent offices will disclose the application document, revealing the invention to society. After a patent expires at the end of the 20-year protection period, the patented innovation becomes public knowledge and can be practiced by anyone.

As IPRs become increasingly important in the knowledge economy, a crucial element of formulating a firm's innovation strategy is to determine how to protect its technological innovation through IPRs. Traditionally, economic and strategic studies have emphasized the importance of vigorously protecting an innovation to reap its rewards, but the decision of whether and how to protect an innovation is a more complex issue. Fisher and Oberholzer-Gee (2013) argued that the ways in which a firm can use IP to appropriate returns from innovation depend

on the firm's strategy, its position in the marketplace and the rapidly changing IP laws in the countries in which the firm operates.

This chapter analyzes the literature on IP and innovation management in the period 1986–2018. Our primary goal is to review the development of IP and innovation studies and provide a quick reference for researchers interested in technology and innovation management, strategy or entrepreneurship.

In the next section, our literature review shows that scholarly interest in IP has grown considerably over the past 30 years, especially since the 2000s. To paint a broad picture of developments in this field, we identify a set of IP-related articles from 29 premier academic journals. In doing so, we build on Ziedonis (2008), who provided an excellent review of the IP-related literature published from 1986 to 2007 and introduce some extensions: First, we broaden the journal scope to include more innovation journals such as *Technovation, Journal of Product Innovation Management* and several leading business journals such as *Harvard Business Review* and *MIT Sloan Management Review*; second, the time frame for this study extends from 1986 to 2018, and we center our discussion on the articles published after 2000, which were not discussed in detail in Ziedonis's (2008) review. We first describe the overall profile of all the articles retrieved from a comprehensive search and then identify the most-cited 48 management and innovation articles according to the number of average annual citations that they received in the Web of Knowledge database by March 2018. We organize and review these articles according to five themes and discuss the main findings, methodological advances and unanswered questions of these studies.

Methodology

Considering the multidisciplinary nature of IP and innovation studies, we consult a relatively broad literature, searching for works on IP and innovation in the economics, management, business, legal and innovation fields. We select 29 leading academic journals for the search and retrieve a total of 2,081 articles that include the following IP-related terms in their titles, abstracts or keywords: IP, intangible asset, intellectual capital, patent, trademark, copyright or secret (secrecy). Book reviews, research notes and articles in conference proceedings are excluded.

Table 23.1 reports the journals from which the research articles related to IP and innovation are identified. Although far from comprehensive, the list includes prominent peer-reviewed

Table 23.1 Source journals of IP and innovation studies

Journal name	*Subject domains*	*Abbreviation*
Academy of Management Journal	Management	AMJ
Administrative Science Quarterly	Management	ASQ
American Economic Review	Economics	AER
California Management Review	Business	CMR
Econometrica	Economics	ECTR
Economics of Innovation and New Technology	Innovation and Economics	EINT
Harvard Business Review	Business	HBR
Industrial and Corporate Change	Innovation and Economics	ICC
International Journal of Industrial Organization	Economics	IJIO
Journal of Finance	Economics	JOF
Journal of Financial Economics	Economics	JFE
Journal of Industrial Economics	Economics	JIE

Journal name	*Subject domains*	*Abbreviation*
Journal of Law & Economics	Law and Economics	JLE
Journal of Law Economics & Organization	Law and Economics	JLEO
Journal of Legal Studies	Law	JLS
Journal of Management	Management	JOM
Journal of Management Studies	Management	JMS
Journal of Political Economy	Economics	JPE
Journal of Product Innovation Management	Innovation	JPIM
Management Science	Management	MS
MIT Sloan Management Review	Business	SMR
Organization Science	Management	OS
Quarterly Journal of Economics	Economics	QJE
Rand Journal of Economics	Economics	RJE
Research Policy	Innovation	RP
Review of Economic Studies	Economics	RES
Review of Economics and Statistics	Economics	REAS
Strategic Management Journal	Management	SMJ
Technovation	Innovation	TNV

outlets in management (e.g. *Academy of Management Journal, Strategic Management Journal and Management Science*), economics (e.g. *American Economic Review and Quarterly Journal of Economics*), law and economics (e.g. *the Journal of Law, Economics, and Organization* and *the Journal of Law and Economics*) and innovation (e.g. *Research Policy*, *Technovation* and *Journal of Product Innovation Management*). Due to their significance as outlets for research on IP and innovation, business journals such as *Harvard Business Review, MIT Sloan Management Review* and *California Management Review* are also included.

General profile of IP-related articles between 1986 and 2018

Figure 23.1 plots the number of IP-related articles according to publication year. Before 1996, the number of IP articles published annually in these journals remained quite stable, at roughly 20 publications per year. Between 1997 and 2006, the number of related articles grew steadily and reached approximately 80 in 2006. During the past decade, however, the number of IP publications has climbed sharply, with over 144 IP-related articles published in 2016 alone. This demonstrates an increasing level of academic interest in the topic.

To demonstrate the impact of these studies on the topic, we further examine the forward citations of these articles. Although several pioneering studies were published before 1996, they have generated few citations in total, and each of these papers had approximately one accumulated citation in the period 1986–1996. Between 1997 and 2006, the annual total citations increased from 341 to 4,011, with an annual growth rate of 120 percent. As the number of publications increased, the citations soared. In 2017, the accumulated number of citations increased to 16,586. As seen in Figures 23.1 and 23.2, the development of IP-related studies has gained momentum since the 2000s, as reflected by the rapidly growing numbers of publications and citations in the period.

Of these 2,081 articles, 342 received more than 100 citations and 49 attracted considerable attention, with more than 500 citations, and the total number of citations for these 49 papers amounted to 42,826, which accounts for 30 percent of the total citations of the 2,081 papers. An

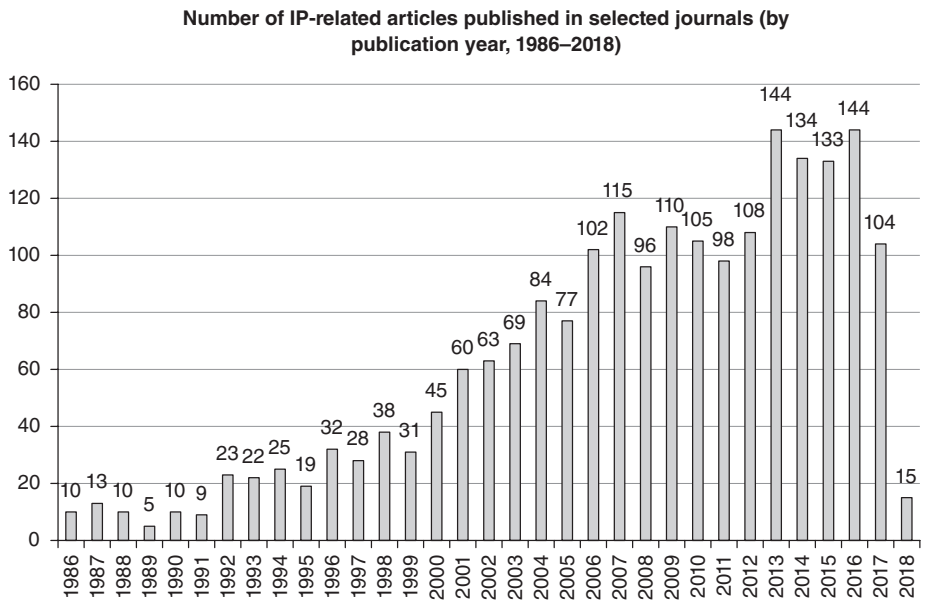

Figure 23.1 Number of IP-related articles published in selected journals

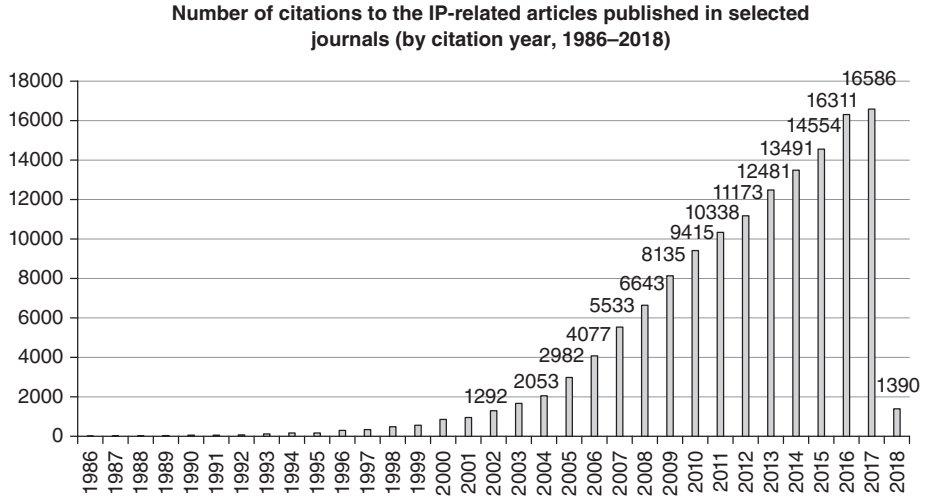

Figure 23.2 Number of citations to the IP-related articles in selected journals

example of a highly cited article is "Geographic localization of knowledge spillovers as evidenced by patent citations" written by Jaffe, Trajtenberg and Henderson and published in 1993. It has been cited 2,498 times and ranks first among all articles by the accumulated number of total citations.

The number of publications broken down by journal indicates that IP-related articles are distributed across a variety of subject domains (Figure 23.3). The leading journal in innovation, *Research Policy*, has published 647 articles in the last three decades, accounting for 31.1 percent

Figure 23.3 Number of publications in selected journals

of all the publications. Another innovation journal, *Technovation*, ranks second, having published 182 articles, followed by *Harvard Business Review* (136 articles), *Strategic Management Journal* (127 articles), *International Journal of Industrial Organization* (110 articles) and *Industrial and Corporate Change* (104 articles).

Figure 23.4 displays the distribution of citations across different journals. The articles in *Research Policy* received 37,971 citations, which accounts for 26.7 percent of all the citations in our sample. *Strategic Management Journal* and *Management Science* received 18,688 and 10,489 citations, respectively. The average citations per article amounts to 147 for these two journals, demonstrating their leading positions in the field. *Rand Journal of Economics, American Economic Review* and *Academy of Management Journal* all received more than 6,000 citations, demonstrating their considerable impact on IP and innovation research as a whole.

Because of the time lag in citations, many articles published in journals in the 2010s have yet to receive significant numbers of citations. Because Ziedonis (2008) offered a thorough review of the widely cited studies published in the 1980s and 1990s, in the present review, we focus on the management and innovation studies that were published after 2000 and are not discussed in detail in her work.

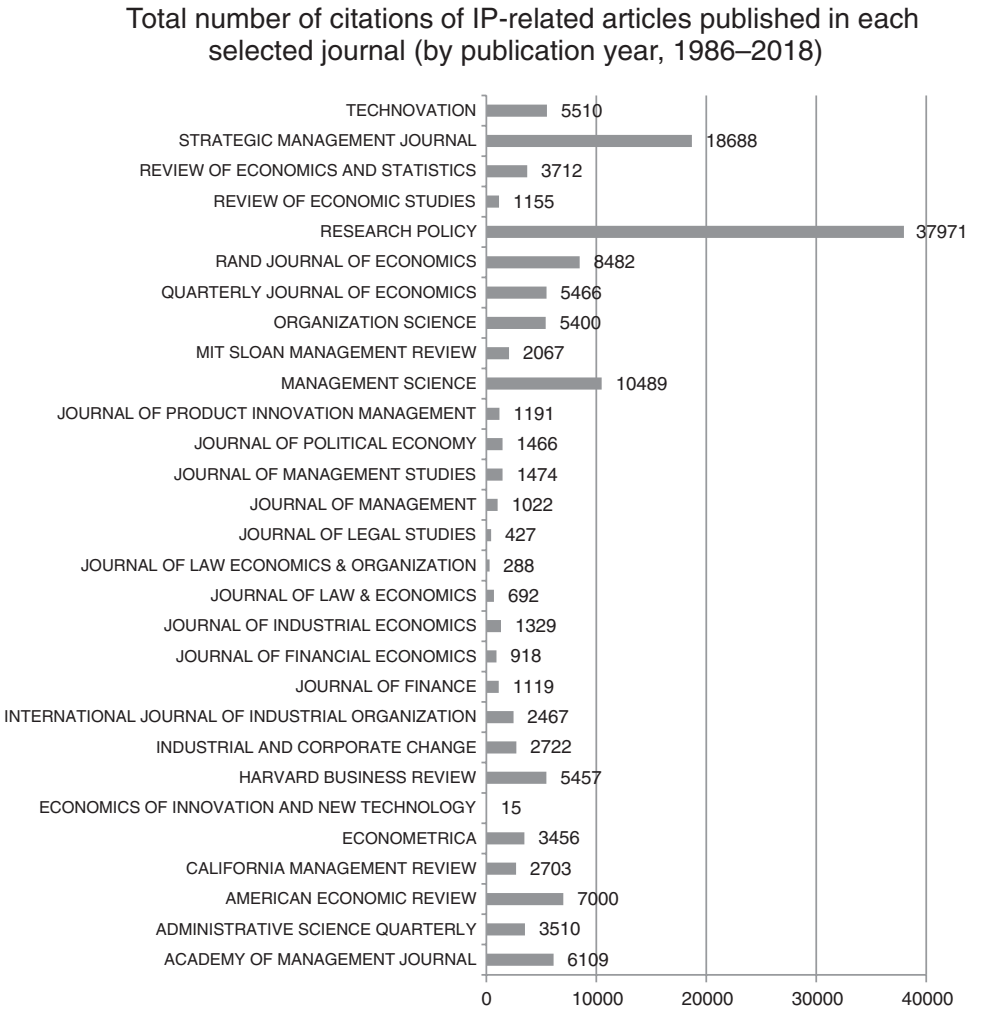

Figure 23.4 Number of citations to publications in selected journals

Table 23.2 lists the 48 most-cited articles published after 2000. As we can see from Table 23.2, 14 of the 48 papers were published in *Research Policy* and 9 papers each were published in *Strategic Management Journal* and *Management Science*. The remaining 16 appear in *Academy of Management Journal, Administrative Science Quarterly, Organization Science, Technovation, Harvard Business Review, Industrial and Corporate Change* and *Journal of Management Studies*.

Teece's article "Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance" published in *Strategic Journal of Management* tops the list, with 2,139 total citations and 178 average annual citations since its publication in 2007. Another article by Teece (1986) referenced in Ziedonis's (2008) review, "Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy," ranks first on the list of articles published before 2007. Fleming contributed four papers on this list, and Ahuja and Almeida both have three articles on this list. Hence, these scholars have made the greatest contributions to IP and innovation research in recent decades.

Table 23.2 List of 48 most-cited articles between 2000 and March 2018

Rank [a]	*Author*	*Article title*	*Journal* [b]	*Year*	*# Cites*	*# Annual Average cites*
1	Teece, David J.	Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance	SMJ	2007	2139	178.3
2	Ahuja, G	Collaboration networks, structural holes, and innovation: A longitudinal study	ASQ	2000	1501	79.0
3	Subramaniam, M; Youndt, MA	The influence of intellectual capital on the types of innovative capabilities	AMJ	2005	971	69.4
4	Huizingh, Elk K. R. E.	Open innovation: State of the art and future perspectives	TNV	2011	423	52.9
5	Owen-Smith, J; Powell, WW	Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community	OS	2004	780	52.0
6	Rosenkopf, L; Nerkar, A	Beyond local search: Boundary-spanning, exploration, and impact in the optical disk industry	SMJ	2001	903	50.2
7	Perkmann, Markus; Tartari, Valentina; et al.	Academic engagement and commercialization: A review of the literature on university-industry relations	RP	2013	288	48.0
8	Roberts, PW; Dowling, GR	Corporate reputation and sustained superior financial performance	SMJ	2002	711	41.8
9	Ahuja, G; Katila, R	Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study	SMJ	2001	738	41.0
10	O'Reilly, CA; Tushman, ML	The ambidextrous organization	HBR	2004	607	40.5
11	Stuart, TE	Interorganizational alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry	SMJ	2000	768	40.4
12	von Hippel, E; von Krogh, G	Open source software and the private-collective innovation model: Issues for organization science	OS	2003	636	39.8
13	Furman, JL; Porter, ME; Stern, S	The determinants of national innovative capacity	RP	2002	655	38.5
14	Rothaermel, Frank T.; Agung, Shanti D.; Jiang, Lin	University entrepreneurship: a taxonomy of the literature	ICC	2007	460	38.3
15	Fleming, L	Recombinant uncertainty in technological search	MS	2001	657	36.5
16	Schilling, Melissa A.; Phelps, Corey C.	Interfirm collaboration networks: The impact of large-scale network structure on firm innovation	MS	2007	433	36.1
17	Ahuja, G	The duality of collaboration: Inducements and opportunities in the formation of interfirm linkages	SMJ	2000	643	33.8
18	D'Este, P.; Patel, P.	University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry?	RP	2007	405	33.8
19	Rosenkopf, L; Almeida, P	Overcoming local search through alliances and mobility	MS	2003	516	32.3

(*Continued*)

Table 23.2 (Continued)

Rank [a]	*Author*	*Article title*	*Journal* [b]	*Year*	*# Cites*	*# Annual Average cites*
20	Sampson, Rachelle C.	R&D alliances and firm performance: The impact of technological diversity and alliance organization on innovation	AMJ	2007	381	31.8
21	Sorensen, JB; Stuart, TE	Aging, obsolescence, and organizational innovation	ASQ	2000	603	31.7
22	Lu, JW; Beamish, PW	International diversification and firm performance: The S-CURVE hypothesis	AMJ	2004	476	31.7
23	Shane, S; Stuart, T	Organizational endowments and the performance of university start-ups	MS	2002	517	30.4
24	Acs, ZJ; Anselin, L; Varga, A	Patents and innovation counts as measures of regional production of new knowledge	RP	2002	516	30.4
25	Hitt, MA; Dacin, MT; et al.	Partner selection in emerging and developed market contexts: Resource-based and organizational learning perspectives	AMJ	2000	556	29.3
26	Mowery, DC; Nelson, RR; et al.	The growth of patenting and licensing by US universities: an assessment of the effects of the Bayh-Dole act of 1980	RP	2001	520	28.9
27	Benner, MJ; Tushman, M	Process management and technological innovation: A longitudinal study of the photography and paint industries	ASQ	2002	471	27.7
28	Hagedoorn, J; Cloodt, M	Measuring innovative performance: is there an advantage in using multiple indicators?	RP	2003	442	27.6
29	Di Gregorio, D; Shane, S	Why do some universities generate more start-ups than others?	RP	2003	441	27.6
30	Bozeman, B	Technology transfer and public policy: a review of research and theory	RP	2000	500	26.3
31	Harhoff, D; Scherer, FM; Vopel, K	Citations, family size, opposition and the value of patent rights	RP	2003	397	24.8
32	Fleming, Lee; Mingo, Santiago; Chen, David	Collaborative brokerage, generative creativity, and creative success	ASQ	2007	287	23.9
33	Gans, JS; Stern, S	The product market and the market for ideas: commercialization strategies for technology entrepreneurs	RP	2003	382	23.9
34	Fleming, L; Sorenson, O	Science as a map in technological search	SMJ	2004	357	23.8
35	Agrawal, A; Henderson, R	Putting patents in context: Exploring knowledge transfer from MIT	MS	2002	402	23.7
36	Singh, J	Collaborative networks as determinants of knowledge diffusion patterns	MS	2005	328	23.4
37	Youndt, MA; Subramaniam, M; Snell, SA	Intellectual capital profiles: An examination of investments and returns	JMS	2004	344	22.9
38	Zucker, LG; Darby, MR; Armstrong, JS	Commercializing knowledge: University science, knowledge capture, and firm performance in biotechnology	MS	2002	386	22.7
39	Song, J; Almeida, P; Wu, G	Learning-by-hiring: When is mobility more likely to facilitate interfirm knowledge transfer?	MS	2003	339	21.2
40	Fleming, L; Sorenson, O	Technology as a complex adaptive system: evidence from patent data	RP	2001	375	20.8
41	Lockett, A; Wright, M	Resources, capabilities, risk capital and the creation of university spin-out companies	RP	2005	287	20.5

42	Almeida, P; Phene, A	Subsidiaries and knowledge creation: The influence of the MNC and host country on innovation	SMJ	2004	306	20.4
43	Thursby, JG; Thursby, MC	Who is selling the Ivory Tower? Sources of growth in university licensing	MS	2002	342	20.1
44	Delios, A; Beamish, PW	Survival and profitability: The roles of experience and intangible assets in foreign subsidiary performance	AMJ	2001	329	18.3
45	Romijn, H; Albaladejo, M	Determinants of innovation capability in small electronics and software firms in southeast England	RP	2002	305	17.9
46	Frost, TS	The geographic sources of foreign subsidiaries' innovations	SMJ	2001	306	17.0
47	Cohen, WM; Goto, A; et al.	R&D spillovers, patents and the incentives to innovate in Japan and the United States	RP	2002	288	16.9
48	Bouty, I	Interpersonal and interaction influences on informal resource exchanges between R&D researchers across organizational boundaries	AMJ	2000	294	15.5

Notes:
1. Because the more recent articles have relatively fewer total citations in comparison to the earlier publications, this ranking is based on the average annual citations received by each article.
2. Journal abbreviations are reported in Table 23.1.
3. Insights from highly cited articles.

In this section, we examine the most-cited IP-related articles published after 2000 and group them according to the following five themes:

- Intangible assets and innovation
- Alliance, network and innovation
- Patenting as a proxy for innovation activities
- IP management and innovation
- University technology transfer

These themes reflect the academic community's growing interest in IP-related issues. We will highlight the selected articles, the methodologies that they employ, their main findings and remaining issues in the following discussion.

Intangible assets and innovation

As firms' business activities have become increasingly knowledge-intensive, intangible assets have accounted for a growing share of the total value of public companies. In 1975, only 17 percent of the market value of Standard and Poor's 500 companies was from intangible assets, but this figure had increased to 87 percent by 2015 (Ocean Tomo, 2015). Among the highly cited articles, the following contributions discussed the importance of intangible assets and how companies can better manage them.

As introduced in the previous section, in an influential article, Teece (2007) proposed a framework of dynamic capabilities. He argued that firms that compete in an open economy with rapid innovation need dynamic capabilities to sense the opportunities and threats associated with technological change; to seize these opportunities; and to strengthen their competitiveness through protecting, enhancing and reconfiguring their intangible and tangible assets. According to Teece, to improve its dynamic capabilities, a firm needs to sharpen its skills and improve its process, procedure, organizational structures, decision rules and disciplines to realize firm-level sensing, seizing and reconfiguring capacities. The firm not only needs to adjust itself to business ecosystems but also to shape them through innovating and collaborating with other firms and organizations. Related to the framework of dynamic capabilities, O'Reilly and Tushman (2004) emphasized that established companies need to explore new business opportunities while simultaneously exploiting the potential of existing businesses. Companies need to establish an ambidextrous organization, in which the new and exploratory units are separated from the traditional and exploitative ones, but both units are tightly integrated at the senior executive level.

Roberts and Dowling (2002) demonstrated by analyzing a dynamic model that firms with good reputation, which is an intangible asset, are able to sustain superior financial performance over time. The reputation data came from an annual survey of Fortune 1000 firms, which cover eight scales: asset use, community and environmental friendliness, the ability to develop and keep key people, financial soundness, the degree of innovativeness, investment value, management quality and product quality. The authors decomposed the overall reputation score into a component that can be explained by previous financial performance and another component that can be considered a residual ("left over"). They showed that both components contribute to the persistence of above-average firm financial performance over time.

Based on a longitudinal data set of 1,489 Japanese firms and their internationalization activities from 1986 to 1997, Lu and Beamish (2004) researched the relationship between multinationality and firm performance. They found that the relationship between firms' internationalization

activities and performance can be best described as a horizontal S-curve. Specifically, firm performance first declines with increased internationalization activities, which are measured by the number of overseas subsidiaries and the number of countries in which a firm had overseas subsidiaries. Performance then increases with increasing geographical diversification and declines again at a very high level of multinationality. The authors also found that firms investing more heavily in intangible assets, such as technology and advertising, achieved greater profitability from their investment in foreign countries. In a related study, Delios and Beamish (2001) studied how a firm's intangible assets, which are measured by R&D and advertising intensity, and its experience affect subsidiary survival and profitability. The authors suggested that internationalizing firms should adapt their existing intangible asset advantage to compete in new foreign markets. In addition, the host country experience contributes to the positive relationship between a multinational firm's intangible assets and subsidiary profitability.

Studying the international partner selection of firms from emerging and developed markets Hitt et al. (2000) suggested that firms select alliance partners to obtain access to resources and gain organizational learning opportunities. They found that emerging market firms emphasized financial assets, technical capabilities, intangible assets (including technical and managerial capabilities, unique competencies, market knowledge, and access) and willingness to share expertise in the selection of partners. In contrast, developed market firms highlighted unique capabilities and local market knowledge and access in their partner selection. This research demonstrates that both tangible and intangible assets are the critical factors that firms would consider when selecting international alliance partners.

Alliance, network and innovation

Firms establish strategic alliances to exchange and share resources to develop products and services (Hoang and Rothaermel, 2005; Krishnan, Martin, and Noorderhaven, 2006). While alliances are used as a ubiquitous strategic tool in many industries, scholars are interested in their impact on firms' innovation activities or performance. In addition, an alliance relationship connects firms in an industry or a cluster to form a network, the structure, feature and characteristics of which have separate influences on firm performance. The following influential articles represent efforts at examining the relationship among alliances, networks and innovation, and many of them used patent data to construct their network measures. They provide insights into how a firm can leverage its alliances and position in a network to promote innovation activities.

Stuart (2000) researched the relationship between technology alliances and firm performance, which is measured by sales growth and the number of granted patents. He argued that how much a focal firm can benefit from strategic alliance largely depends on the resource of its alliance partners. Large or leading firms are the most valuable partners because of their reliability, reputation and track record of prior accomplishments. For young or small firms, forming an alliance with a large and innovative partner can be regarded as endorsement, because to form such an alliance, young or small firms have to survive the due diligence of their prominent partners.

Studying the relationship between a firm's position in the industry network of interfirm collaborative linkages and its innovation output, Ahuja (2000a) argued that direct ties, indirect ties and structural holes have differential impacts on the firm's subsequent innovation output. The direct and indirect ties both positively influence innovation, and the number of direct ties moderates the relationship between indirect ties and innovation. Increasing structural holes has a negative effect on innovation. In a related study, Ahuja (2000b) argued that linkage formation by firms can be explained by the incentives and opportunities to do so. He drew upon the theories of the resource-based view and social networks to identify three forms of accumulated

capital – technical, commercial and social – that can affect a firm's incentives and opportunities to form linkages. Examining the networks of 35,400 collaborative patent inventors, Fleming, Mingo, and Chen (2007) examined the career histories of inventors using data on U.S. patents from 1975 to 2002. They found that collaboration in a cohesive network, in which most individuals have direct ties to one another, only produces marginal benefits for creating novel patent subclass combinations. In addition, the marginal benefits of cohesion are only two-thirds as much as its negative first-order effect on the generation of novel patent subclass combinations. Fleming et al., also found that the novel patent subclass combinations produced by brokered collaboration, in which one person links two or more others who have no direct ties to one another, are less likely to be used in the future.

Intrigued by the questions regarding the extent to which a firm is able to learn from its partners, Sampson (2007) studied the influence of partner technological diversity and the organizational forms of alliances on firm innovation performance. She found that alliances contribute far more to firm innovation when the difference between allied firms' technological capabilities is moderate, rather than low or high, irrespective of the chosen organizational form of the alliance. In terms of the impact of the organizational form of alliances, firms benefit from organizational alliances that take the form of an equity joint venture when the technological diversity between partners is high. The benefits from collaborative activities organized as equity joint ventures are greater than those of collaborations taking the form of a bilateral contract with either a moderate or high level of diversity.

Schilling and Phelps (2007) studied the impact of the structure of alliance networks on their potential for knowledge creation based on a panel of firms operating in 11 industry-level alliance networks. They argued that firms are able to perform better in terms of innovation output in the alliance networks that are characterized by both high clustering and high reach (short average path lengths to a wide range of firms) than in the networks that do not show these characteristics. The reason is that dense connectivity of clusters creates transmission capacity in a network, which enables a large amount of information to diffuse rapidly, while reach ensures that a large quantity and diversity of information can be brought to firms in the network within relatively close range.

Knowledge flow tends to be limited within regional and firm boundaries. Singh (2005) attributed this phenomenon to the distribution of interpersonal networks. He used collaboration information for patents registered with the U.S. Patent and Trademark Office (USPTO) to construct a database of interpersonal relations among all inventors recorded by the USPTO since 1975. He found that knowledge flows, which are measured by patent citations, are stronger within than between regions and firms. However, Singh also found that geographic proximity and firm boundaries have little additional effect on the probability of knowledge flows between inventors who are already closely connected in the collaboration network. The regional and firm boundaries continue to matter more for the knowledge flows between inventors with no or only very indirect ties. Owen-Smith and Powell (2004) studied the human therapeutic biotechnology firms located in the Boston metropolitan area and argued that two features of formal interorganizational networks (i.e., geographic proximity and organizational form) change the flow of information through a network and thus enable a firm to leverage its position within a large network to strengthen its innovation performance.

Patenting as a proxy for innovation activities

Knowledge creation manifests as invention. After being examined by patent examiners at the patent office, invention can be protected through patents. As multiple studies have demonstrated

(Trajtenberg, 1990; Hagedoorn and Cloodt, 2003), patents are valid and robust indicators of knowledge creation. In the following studies, patenting activities are considered a proxy for innovation activities at the firm level and country level, and the information contained in the patent document, such as citations, is often used to study firms' innovation activities.

Sorensen and Stuart (2000) advanced two seemingly contradictory theories for the relationship between the age of companies and their innovations, which are measured by patents. One theory is that firms' innovations increase with age. The other is that firms' innovations decrease with age, as technological leadership is temporal, and the firms at the technological frontier are quickly outcompeted by new rivals. Based on the patent data of firms in the semiconductor and biotechnology industries, they provided evidence that as organizations age, they become better able to generate new innovations (patents). However, the authors also showed that as firms age, they become increasingly likely to exploit existing competences and improve on older areas of technology, and thus, their patents are less likely to be cited by other firms than the patents owned by younger firms.

Researching the relationship between process management and technological innovation, measured by patents, Benner (2002) hypothesized that process management would reduce variance in organizational routines and thereby encourage exploitative innovations but reduce exploratory innovation. The author used ISO 9000 quality program certifications to represent process management activities and developed several measures of exploitation and exploration based on the extent to which a firm's patents cited its own patents or patents that it had previously cited. The empirical evidence supports the hypothesis that firms tend to exploit existing knowledge and capabilities rather than engage in exploratory activities as organizational routines are established and repeated.

Drawing on the resource-based view and the theories of technological innovation and learning, Ahuja and Katila (2001) studied the influence of acquisitions on the subsequent innovation performance of acquiring firms in the chemicals industry. They measured innovation performance by the patenting frequency of the acquiring firms, and they distinguished technological and nontechnological acquisitions according to whether technology was a component of the acquired firm's assets. Ahuja and Katila found that for technological acquisitions, the absolute size of the acquired knowledge base is positively associated with innovation output, while the relative size of the acquired knowledge base is negatively associated with innovation output. The relationship between the relatedness of acquired and acquiring knowledge bases and the innovation output of acquiring firms is nonlinear. As the degree of relatedness increases, the innovation performance of acquiring firms first increases and then decreases.

Studying the patenting activities of engineers who moved from U.S. firms to non-U.S. firms, Song, Almeida, and Wu (2003) argued that firms are able to acquire knowledge beyond their current technological and geographic boundaries by hiring experts from other firms. The authors termed this mechanism "learning-by-hiring" and found that mobility is more likely to result in interfirm knowledge transfer if the hiring firm is less path dependent, if the hired engineers possess technological knowledge that is distant from that of the hiring firm or if the hired engineers work in noncore technological areas in the new firm. In a related study, Rosenkopf and Nerkar (2001) suggested that mobility of inventors and the formation of strategic alliances can enable firms to overcome geographic and technological constraints in searching for new knowledge. They found that mobility of inventors facilitates interfirm knowledge flows, notwithstanding geographical distance. However, when technological distance rises, the usefulness of alliances and mobility also increases.

Examining a sample of U.S. semiconductor firms, Almeida and Phene (2004) found that the knowledge linkages of multinational corporations' (MNCs') subsidiaries to host country firms

and the technological diversity within the host country positively influence the innovation of subsidiaries of MNCs. Frost (2001) studied the subsidiaries of foreign companies located in the United States and argued that subsidiary innovations that build on the existing technology of the parent firm are more likely to cite patents originating in the home base of parent firms. The larger the share of company patents generated by the subsidiary is, the more likely these patents are to cite patents originating from the host country. Moreover, subsidiaries are more likely to draw upon knowledge from the host country environment if the parent firm has a greater presence in the host country.

Fleming (2001) synthesized the theories on the sources of technological novelty: invention is a recombination and local search process, and technological uncertainty arises when an inventor searches unfamiliar components and component combinations. By analyzing the 17,264 U.S. patents granted during May and June 1990, Fleming found that experimentation with new components and new combinations produces less useful inventors on average, but it may also result in an increase in the variability that can lead to breakthroughs. In a related study, Fleming and Sorenson (2004) researched how scientific research can increase the rate of technological advance. They argued that science would not have a material impact when inventors work with relatively independent components but can become beneficial when inventors seek to combine highly coupled components.

Advancing the studies on exploitation and exploration activities, Rosenkopf and Nerkar (2001) argued that moving beyond local search requires exploratory activities that cross some boundary. The authors created a typology of exploratory activities by distinguishing organizational and technological boundaries: local exploration spans neither organizational nor technological boundaries, external boundary-spanning exploration spans the organizational boundary only, internal boundary-spanning exploration spans the technological boundary only and radical exploration spans both boundaries. Analyzing the patenting data of optical disk firms, Rosenkopf and Nerkar found that exploration that does not cross either boundary has a smaller impact on subsequent technological development. When exploration spans both boundaries, it has the greatest impact on subsequent technological evolution, even beyond the optical disk domain.

In addition to being used as indicators of innovation activity at the firm level, patents are used as indicators at the country level. Acs, Anselin, and Varga (2002) compared innovation count data and patent count data at the lowest possible levels of geographical aggregation in the United States (i.e. metropolitan statistical areas) and confirmed that the patent data developed by the USPTO is a valid proxy for innovative activity at the regional level. Furman, Porter, and Stern (2002) defined national innovative capacity as the extent to which a country can produce and commercialize new-to-the-world technologies in the long run. National innovative capacity depends on a strong common innovation infrastructure, innovation environments in a country's industry cluster and the connection between the common innovation infrastructure and various clusters. They also found that the estimated level of national innovative capacity affects total factor productivity growth and a nation's share of high-technology exports, and they suggested that a country's international patents are driven by a small number of factors that determine a country's national innovative capacity.

IP management and innovation

Several topics emerge from the highly cited articles on the theme of IP management and innovation, which include how to protect and leverage IP in an open innovation environment (Huizingh, 2011; von Hippel and von Krogh, 2003; Bouty, 2000; Gans and Stern, 2003), how to protect and promote innovation to enhance firm performance (Cohen et al., 2002; Romijn and

Albaladejo, 2002; Youndt, Subramaniam, and Snell, 2004; Subramaniam and Youndt, 2005) and determinants of the value of patents (Harhoff, Scherer, and Vopel, 2003).

Open innovation has become one of the most popular topics in innovation management (Huizingh, 2011) over the past two decades. von Hippel and von Krogh (2003) described two models of innovation. One is the private investment model in which private goods production and effective intellectual property protection brings returns to innovation. The other is the collective action model in which innovators collaborate to produce a public good. They argued that open-source software development is an example of a combined "private-collective" model of innovation that sits in between the private investment and the collective action models. Bouty (2000) studied the paradox of interpersonal exchanges of resources between R&D scientists across organizational boundaries, which can enhance both innovation and the potential risk of intellectual property leaks. She found that social capital is the key success factor in the resource acquisition process and that strategic resources can only be exchanged under conditions of acquaintance and mutual trust. She also revealed that social capital is a major success factor in these particular organizational learning processes and that community is an important conduit for sharing resources and knowledge.

Advocating a synthetic framework for identifying the drivers of start-up commercialization strategy, Gans and Stern (2003) suggested that for many start-up innovators, the collaborators who control complementary assets are most likely the current market players with an incentive to expropriate the start-ups' technology. Therefore, the interaction between start-up innovators and incumbent firms is largely shaped by whether there is a market for the idea in question. The authors' key insights are that when intellectual property protection is effective and important complementary assets are held by incumbent firms, start-up innovators can generate more rents if they pursue cooperation with incumbent firms. In contrast, when intellectual property protection is weak and barriers to entry are low, start-up innovators may pursue competitive commercialization strategies.

To investigate the methods that firms use to protect and promote innovation, Cohen et al. (2002) conducted a survey of the managers of R&D units of manufacturing firms in the United States and Japan. They found that secrecy appears to be the predominant appropriability strategy of the U.S. firms but not of the Japanese firms. In contrast, patents represent the most important channel for information flows in Japan. This may be due to the lower number and narrow claims per patent in Japan, which give rise to greater mutual dependence across the patent portfolios of competing firms and thus promote greater information-sharing among rivals. Romijn and Albaladejo (2002) surveyed 33 small software and electronics manufacturing companies in the UK in 1998. They found that the important internal factors determining innovation performance include the owner's or manager's prior experience in a scientific environment and the staff's science and engineering degrees. The initial support from the science laboratory or university department from which the companies had spun off and public R&D support are the important external factors contributing to the companies' innovation performance.

Youndt, Subramaniam, and Snell (2004) adopted a configural approach to study how investment in human, social and organization capital, which forms intellectual capital, affects firm performance. Human capital refers to the knowledge, skills and abilities of employees. Social capital describes the resources available from the networks of relationships that firms establish. Organizational capital represents a firm's institutionalized knowledge and codified experience stored in media such as patents, databases, manuals and routines. Youndt et al., found that human resource management and IT investment influence intellectual capital formation more than R&D investment does. Moreover, human resource management, IT investment and R&D investment are all high in a small group of high-performing companies with high levels of human, social and

organization capital. In a related study, Subramaniam and Youndt (2005) found that human, social and organizational capital differentially influenced the incremental and radical innovative capabilities of firms. Specifically, social capital positively influences both incremental and radical innovative capabilities, while organizational capital only influences incremental innovative capabilities. Subramaniam and Youndt also found that human capital when being interacted with social capital can affect radical innovative capability.

In a survey of all 772 granted patents with 1977 German priority dates that were renewed to full term until 1995, Harhoff, Scherer, and Vopel (2003) found that the backward citations contained in a patent and the forward citations that a patent receives are positively related to its value. Citations to the nonpatent literature can indicate the value of patents in the pharmaceutical and chemical fields, but the authors did not find the similar results in other technical fields. Patents associated with large patent families and patents that are still valid after going through opposition procedure are highly valuable.

University technology transfer

Bozeman (2000) provided a comprehensive literature review on domestic technology transfer from universities and government laboratories. He advocated a contingent effectiveness model of technology transfer, which includes five dimensions that determine effectiveness: (1) transfer agent, (2) transfer media, (3) transfer object, (4) demand environment and (5) transfer recipient. Rothaermel, Agung, and Jiang (2007) reviewed 173 academic articles on the topic of university entrepreneurship and classified them into four areas: entrepreneurial research university; the productivity of technology transfer offices; new firm creation; and the environmental context, including networks of innovation. Specifically, the literature on entrepreneurial university discusses the factors related to the organization designs of universities that may dampen or promote the commercialization of university inventions. The literature on the productivity of technology transfer office regards university entrepreneurship as a function of the productivity of technology transfer offices and discusses the factors that are important to their productivity. The literature on new firm creation discusses the factors inhibiting or enhancing the creation of new ventures as a result of university entrepreneurial activities. The articles on environmental context regard university entrepreneurial activities as being embedded in networks of innovation and influenced by the external environment. In another review, Perkmann et al. (2013) defined "academic engagement" as collaborative research, contract research, consulting and informal relationships for university-industry knowledge transfer and described commercialization as creation of intellectual property and academic entrepreneurship. They analyzed and compared the individual, organizational and institutional antecedents and consequences of academic engagement and commercialization.

Mowery, Nelson, Sampat, and Ziedonis (2001) argued that the Bayh-Dole Act was only one of the several important factors stimulating the rise of university patenting and licensing activity after the 1980s. The act seems to have had little effect on the content of academic research at the three leading universities (i.e., the University of California, Stanford University and Columbia University). They suggested that for universities already active in patenting and licensing, such as University of California and Stanford University, the Bayh-Dole Act led to these universities' expanded efforts to market academic inventions. For universities that were inactive in this area, such as Columbia University, the Act prompted them to change the course of their policies and start large-scale patenting and licensing activities. Thursby and Thursby (2002) echoed Mowery, Nelson, Sampat, and Ziedonis's (2001) arguments and suggested that the increasing licensing activities of U.S. universities after the Bayh-Dole Act were primarily due to an increased

willingness of university administrations to license and a growing dependence of industry on external R&D rather than a change of faculty research.

Analyzing the data of 101 U.S. universities over the 1994–1998 period, Di Gregorio and Shane (2003) investigated why some universities are able to generate more start-ups than others. They argued that intellectual prominence and two particular policies, namely, making equity investments in start-ups and maintaining a low inventor's share of royalties, promote new firm formation. Zucker, Darby, and Armstrong (2002) researched the economic value of the knowledge generated at universities and argued that academic science exerts a substantial impact on the success of firms in the biotechnology field. They found that firms whose scientists collaborated with top university scientists produced more patents and more highly cited patents.

Based on the data of 134 firms founded to commercialize technologies licensed from Massachusetts Institute of Technology during the 1980–1996 period, Shane and Stuart (2002) studied how resource endowments, in particular, founders' social capital endowments, affect the incidence of early-life performance milestones. The results show that new ventures with founders that have direct and indirect relationships with venture investors prior to firm founding are the most likely to receive venture funding and thus less likely to fail. In addition, receiving venture funding is the single most important event leading to a successful IPO. Agrawal and Henderson (2002) also studied the technology transfer activities at the Massachusetts Institute of Technology and found that patenting plays a relatively small role in the technology transfer in the Mechanical and Electrical Engineering departments. Most faculty members there estimated that patents only account for less than 10 percent of the knowledge that is transferred from their labs. However, the evidence shows that the number of patents may be a valid indicator of research impact because the numbers of patents and paper citations are positively correlated.

Studying the channels through which UK university researchers interact with industry, D'Este and Patel (2007) found that the individual characteristics of researchers are more important in shaping university-industry linkages than are the characteristics of departments and universities. Lockett and Wright (2005) studied data from two surveys conducted in 2002 and 2003 on UK universities' commercialization activities and found that both the number of spin-off companies created and the number of spin-off companies attracting external equity investment are positively associated with universities' expenditures on intellectual property protection, the business development capabilities of technology transfer offices and universities' royalty regimes.

Conclusion

This chapter reviews the recent advances in the literature on IP and innovation management. Following the methodology used in Ziedonis (2008), we use a set of keywords closely related to IP and innovation management to search for relevant publications in 29 leading academic journals. We retrieve 2,081 articles from these journals published between 1986 and March 2018. Based on a bibliometric analysis of these articles, we demonstrate growing interest in academic community on the topics of IP and innovation management, as reflected by the rapid growth in the number of publications and citations to these publications in the observation period. In particular, the growth of both numbers seems to accelerate in the 2000s. We then rank the retrieved articles by the annual average citations they received and obtain a list of most-cited articles. As the articles highlighted by Ziedonis (2008) were mostly published in the 1980s and 1990s, we focus on reviewing the highly cited articles published after 2000 and regard our effort as an extension of Ziedonis's (2008) work.

Examining these 48 highly cited articles, we group them into five themes, namely, intangible assets and innovation; alliance, network and innovation; patenting as a proxy for innovation

activities; IP management and innovation; and university technology transfer. In the streams of literature on intangible assets, alliances, networks and innovation, we observe that scholars investigate how firms can invest, obtain and leverage their intangible assets or alliance networks to boost their innovation activities and firm performance. In particular, scholars often use patent data to construct variables to measure network and firm linkages. The availability of fine-grained patent data in electronic format and innovations in methods of using these data enable scholars to advance in their use of patenting as a proxy for innovation activities and generate novel insights on how to protect and leverage IP in an open innovation environment and how to protect and promote innovation to enhance firm performance. Finally, we identify a set of highly cited articles focusing on the topic of university technology transfer, thereby demonstrating the importance of universities as knowledge generators and transmitters in a national innovation system.

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References

Acs, Z. J., Anselin, L. and Varga, A. (2002). Patents and innovation counts as measures of regional production of new knowledge. *Research Policy*, 31, 1069–1085.

Agrawal, A. and Henderson, R. (2002). Putting patents in context: exploring knowledge transfer from MIT. *Management Science*, 48, 44–60.

Ahuja, G. (2000a). Collaboration networks, structural holes, and innovation: a longitudinal study. *Administrative Science Quarterly*, 45, 425–455.

Ahuja, G. (2000b). The duality of collaboration: inducements and opportunities in the formation of interfirm linkages. *Strategic Management Journal*, 21, 317–343.

Ahuja, G. and Katila, R. (2001). Technological acquisitions and the innovation performance of acquiring firms: a longitudinal study. *Strategic Management Journal*, 22, 197–220.

AL-Aali, A. Y. and Teece, D. J. (2013). Towards the (strategic) management of intellectual property: retrospective and prospective. *California Management Review*, 55, 15–30.

Almeida, P. and Phene, A. (2004). Subsidiaries and knowledge creation: the influence of the MNC and host country on innovation. *Strategic Management Journal*, 25, 847–864.

Benner, M. J. (2002). Process management and technological innovation: a longitudinal study of the photography and paint industries. *Administrative Science Quarterly*, 47, 676–706.

Bouty, I. (2000). Interpersonal and interaction influences on informal resource exchanges between R&D researchers across organizational boundaries. *Academy of Management Journal*, 43, 50–65.

Bozeman, B. (2000). Technology transfer and public policy: a review of research and theory. *Research Policy*, 29, 627–655.

Cohen, W. M., Goto, A., Nagata, A., Nelson, R. R. and Walsh, J. R. (2002). R&D spillovers, patents and the incentives to innovate in Japan and the United States. *Research Policy*, 31, 1349–1367.

D'este, P. and Patel, P. (2007). University-industry linkages in the UK: what are the factors underlying the variety of interactions with industry? *Research Policy*, 36, 1295–1313.

Delios, A. and Beamish, P. W. (2001). Survival and profitability: the roles of experience and intangible assets in foreign subsidiary performance. *Academy of Management Journal*, 44, 1028–1038.

Di Gregorio, D. and Shane, S. (2003). Why do some universities generate more start-ups than others? *Research Policy*, 32, 209–227.

Fisher, W. W., III. and Oberholzer-Gee, F. (2013). Strategic management of intellectual property: an integrated approach. *California Management Review*, 55, 157–183.

Fleming, L. (2001). Recombinant uncertainty in technological search. *Management Science*, 47, 117–132.

Fleming, L., Mingo, S. and Chen, D. (2007). Collaborative brokerage, generative creativity, and creative success. *Administrative Science Quarterly*, 52, 443–475.

Fleming, L. and Sorenson, O. (2004). Science as a map in technological search. *Strategic Management Journal*, 25, 909–928.

Frost, T. S. (2001). The geographic sources of foreign subsidiaries' innovations. *Strategic Management Journal*, 22, 101–123.

Furman, J. L., Porter, M. E. and Stern, S. (2002). The determinants of national innovative capacity. *Research Policy*, 31, 899–933.

Gans, J. S. and Stern, S. (2003). The product market and the market for 'ideas': commercialization strategies for technology entrepreneurs. *Research Policy*, 32, 333–350.

Hagedoorn, J. and Cloodt, M. (2003). Measuring innovative performance: is there an advantage in using multiple indicators? *Research Policy*, 32, 1365–1379.

Harhoff, D., Scherer, F. M. and Vopel, K. (2003). Citations, family size, opposition and the value of patent rights. *Research Policy*, 32, 1343–1363.

Hitt, M. A., Dacin, M. T., Levitas, E., Arregle, J. L. and Borza, A. (2000). Partner selection in emerging and developed market contexts: resource-based and organizational learning perspectives. *Academy of Management Journal*, 43, 449–467.

Hoang, H. and Rothaermel, F. T. (2005). The effect of general and partner-specific alliance experience on joint R&D project performance. *The Academy of Management Journal*, 48, 332–345.

Huizingh, E. K. R. E. (2011). Open innovation: state of the art and future perspectives. *Technovation*, 31, 2–9.

Jaffe, A. B., Trajtenberg, M. and Henderson, R. (1993). Geographic localization of knowledge spillovers as evidenced by Patent citations. *The Quarterly Journal of Economics*, 108, 577–598.

Krishnan, R., Martin, X. and Noorderhaven, N. G. (2006). When does trust matter to alliance performance? *Academy of Management Journal*, 49, 894–917.

Levin, R. C., Klevorick, A. K., Nelson, R. R. and Winter, S. G. (1987). Appropriating the returns from industrial research and development. *Brookings Papers on Economic Activity*, 783.

Lockett, A. and Wright, M. (2005). Resources, capabilities, risk capital and the creation of university spin-out companies. *Research Policy*, 34, 1043–1057.

Lu, J. W. and Beamish, P. W. (2004). International diversification and firm performance: the S-CURVE hypothesis. *Academy of Management Journal*, 47, 598–609.

Markman, G. D., Espina, M. I. and Phan, P. H. (2004). Patents as surrogates for inimitable and non-substitutable resources. *Journal of Management*, 30, 529–544.

Mazzoleni, R. and Nelson, R. R. (1998). The benefits and costs of strong patent protection: a contribution to the current debate. *Research Policy*, 27, 273–284.

Mowery, D. C., Nelson, R. R., Sampat, B. N. and Ziedonis, A. A. (2001). The growth of patenting and licensing by US universities: an assessment of the effects of the Bayh-Dole act of 1980. *Research Policy*, 30, 99–119.

Ocean Tomo (2015). Annual study of intangible asset market value from Ocean Tomo, LLC, available at http://www.oceantomo.com/2015/03/04/2015-intangible-asset-market-value-study/.

O'Reilly, C. A. and Tushman, M. L. (2004). The ambidextrous organisation. *Harvard Business Review*, 82, 74–81.

Owen-Smith, J. and Powell, W. W. (2004). Knowledge networks as channels and conduits: the effects of spillovers in the Boston biotechnology community. *Organization Science*, 15, 5–21.

Perkmann, M., Tartari, V., Mckelvey, M., Autio, E., Brostr M. A., D'este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A. and Sobrero, M. (2013). Academic engagement and commercialisation: a review of the literature on university – industry relations. *Research Policy*, 42, 423–442.

Roberts, P. W. and Dowling, G. R. (2002). Corporate reputation and sustained superior financial performance. *Strategic Management Journal*, 23, 1077–1093.

Romijn, H. and Albaladejo, M. (2002). Determinants of innovation capability in small electronics and software firms in southeast England. *Research Policy*, 31, 1053–1067.

Rosenkopf, L. and Nerkar, A. (2001). Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, 22, 287–306.

Rothaermel, F. T., Agung, S. D. and Jiang, L. (2007). University entrepreneurship: a taxonomy of the literature. *Industrial and Corporate Change*, 16, 691–791.

Sampson, R. C. (2007). R&D alliances and firm performance: the impact of technological diversity and alliance organization on innovation. *Academy of Management Journal*, 50, 364–386.

Schilling, M. A. and Phelps, C. C. (2007). Interfirm collaboration networks: the impact of large-scale network structure on firm innovation. *Management Science*, 53, 1113–1126.

Shane, S. and Stuart, T. (2002). Organizational endowments and the performance of university start-ups. *Management Science*, 48, 154–170.

Singh, J. (2005). Collaborative networks as determinants of knowledge diffusion patterns. *Management Science*, 51, 756–770.

Song, J., Almeida, P. and Wu, G. (2003). Learning-by-hiring: when is mobility more likely to facilitate interfirm knowledge transfer? *Management Science*, 49, 351–365.

Sorensen, J. B. and Stuart, T. E. (2000). Aging, obsolescence, and organizational innovation. *Administrative Science Quarterly*, 45, 81–112.

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, 791–811.

Subramaniam, M. and Youndt, M. A. (2005). The influence of intellectual capital on the types of innovative capabilities. *Academy of Management Journal*, 48, 450–463.

Teece, D. J. (1986). Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. *Research Policy*, 15, 285–305.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28, 1319–1350.

Thursby, J. G. and Thursby, M. C. (2002). Who is selling the Ivory Tower? Sources of growth in university licensing. *Management Science*, 48, 90–104.

Trajtenberg, M. (1990). A penny for your quotes: patent citations and the value of innovations. *The RAND Journal of Economics*, 21, 172–187.

Von Hippel, E. and von Krogh, G. (2003). Open source software and the 'private-collective' innovation model: issues for organization science. *Organization Science*, 14, 209–223.

Youndt, M. A., Subramaniam, M. and Snell, S. A. (2004). Intellectual capital profiles: an examination of investments and returns. *Journal of Management Studies*, 41, 335–361.

Ziedonis, R. H. (2008). Intellectual property and innovation. In Shane, S. (Ed.), *Handbook of technology and innovation management*. New York: John Wiley & Sons Ltd.

Zucker, L. G., Darby, M. R. and Armstrong, J. S. (2002). Commercializing knowledge: university science, knowledge capture, and firm performance in biotechnology. *Management Science*, 48, 138–153.