A Visualization Analysis of the Research Status Quo of High-Tech Industry Research Based on Mapping Knowledge Domains

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Abstract. This paper regarded the 12385 related to high technology industry 's research literatures which were from Web of Science database during the 2008-2017 as the research object, using bibliometrics method, based on citespace to analyze high technology industry research from the keywords, co-citation analysis, and obtained the following results:High technology industry research field focused mainly on industry, technology, innovation, performance and so forth;Laursen K, Cassiman B, Perkmann M, Podsakoff PM, Hall BH and their papers have high influence in high technology industry research field. "*Bioresoure Technology*", "*Strategic Management Journal*", "*Research Policy*", "*American Economic Review*" etc. were the most important publication journals for the high cited reference.

Introduction

With the change of the world economic pattern, innovation and industrial transformation are in the gestation period. High - tech industries are increasingly becoming the focus of competition among countries. Cultivating and developing high-tech industries is an effective way and an important means for the country to promote economic growth and technological transformation and upgrading. Countries around the world have continuously issued policies and measures to support the development of high-tech industries. The United States first put forward the concept of high technology, while China equates high technology with high and new technology .The definition of high-tech industry is similar both abroad and at home. As Nelson, an American scholar, said, " The so-called high-tech industry refers to an industry that relies on a large number of researchers and research and development funds to achieve technological progress". Chinese researchers define it as: high-tech industry is composed of enterprises or groups of enterprises engaged in research and development, production, promotion and application of high and new technology.

The current research on high-tech industry has been going through more than 30 years since the early 1980s, but there is no systematic literature review and sorting out. It is of theoretical value and practical significance to sort out the core theoretical evolution path, research focus and frontier of high-tech industry.Therefore, based on co-word analysis, citation analysis and knowledge mapping, this paper shows the discipline distribution and knowledge base of research and development of high-tech industry through knowledge mapping, and reveals the evolution process and path, research hotspot and research trend of high-tech industry to make up for the lack of quantitative and dynamic analysis of the overall situation of high-tech industry in relevant literature, with a view to providing reference for later research.

Data Sources and Research Methods

Research Methods

There are two kinds of methods to analyze documents in this paper: bibliometrics and scientific knowledge mapping. Bibliometrics is to study the development history of a certain field by means of statistical description, analyze the law of document growth in the research field, with a view to

showing the current development status of the field and predicting the future development trend and research prospect Error: Reference source not found. The research method of scientific knowledge atlas is to visualize a certain research field through the form of atlas, including mining relevant data, analyzing text information, and scientifically measuring documents, etc. It can not only reveal the frame diagram of knowledge structure in a certain research field from a static point of view, but also dynamically show the development track and flow direction of knowledge [1].Citespace V, a visualization tool used in this paper, is a software developed by Dr. Chen Chaomei for scientific metrology and document information visualization.

Data Sources

The literature analyzed in this paper comes from the Web of Science database, which includes three citation databases of ISI, namely Science Citation Index Expanded, Social Sciences Citation Index and Arts&Humanities Citation Index. Set the time range to 2008 - 2017.We used " subject =High Technology Industry" or " subject =Hi-Tech Industry" as the search criteria to retrieve 12471 articles. The document type is limited to Article, Proceeding Paper and Review, and 12385 valid documents are screened out, and the data download method is set to " Full Record Contains Referenced References and Abstracts".

Keyword Co-Occurrence and Research Focus Analysis

This paper uses keyword analysis to determine the research focus and development trend of high-tech industry. The key word is the "eye" of an academic article, which intuitively shows the research object and method of the article. Through the key analysis, we can analyze the research hotspots of a certain research topic at various stages. In Citespace, the node is selected as the keyword, the threshold is selected as top50, the time segment is selected as 1, the cropping method is selected as "MST", and the keyword co-occurrence map is obtained by running Citespace, with 138 nodes and 680 connections. We selected high-frequency keywords with frequency equal to or greater than 140 and listed their respective centrality, as shown in Table 1.

From Table 1, we can see that "Technology", " Industry" and " Performance" are the three most critical nodes in the research field of high-tech industries. According to the research object, the research of high-tech Industry can be divided into three aspects: (1) taking industry as the object, high-frequency keywords include industry, Innovation, System, Management, China, Perspective and Energy;(2) For enterprises, the high-frequency keywords are Performance, Firm, Growth, Impact, Productivity, Strategy and Behavior.(3) It is aimed at products / technologies. The high-frequency keywords are Technology, Model, Research and development, Design, Information technology, Optimization, knowledge, Quality, etc. It is generally believed that nodes with mediation centrality greater than 0. 1 play an important role in the network structure.

Table 1 Statistics of high frequency keywords in high - tech industry

Serial number	Keywords	Frequency	Centrality	Serial number	Keywords	Frequency	Centrality
1	Technology	965	0.18	12	Impact	213	0.14
2	Industry	806	0.18	13	China	208	0.08
3	Performance	659	0.05	14	Knowledge	187	0.03
4	Innovation	539	0.08	15	Quality	175	0.09
5	System	480	0.1	16	Productivity	173	0.05
6	Model	391	0.09	17	Strategy	168	0.04
7	Research and development	291	0.04	18	Perspective	165	0.05
8	Firm	286	0.08	19	Information technology	165	0.11
9	Management	273	0.03	20	Optimization	165	0.04
10	Design	262	0.07	21	Energy	149	0.17
11	Growth	230	0.08	22	Behavior	147	0.16

Research hotspot refers to a topic or perspective that has been studied by more documents in a certain period of time. Therefore, through co-occurrence analysis of research hotspots in the field of high-tech industries, we can grasp the hot issues in the development of this field. In CiteSpace node type, select "Keyword" and " top50" as the threshold, run CiteSpace Ⅴ and draw a keyword co-occurrence network. In order to better show the time distribution and mutual relationship in the research of high-tech industries, this paper selects the " Time Zone" time zone network view to get the keyword network time zone view (as shown in fig. 1).
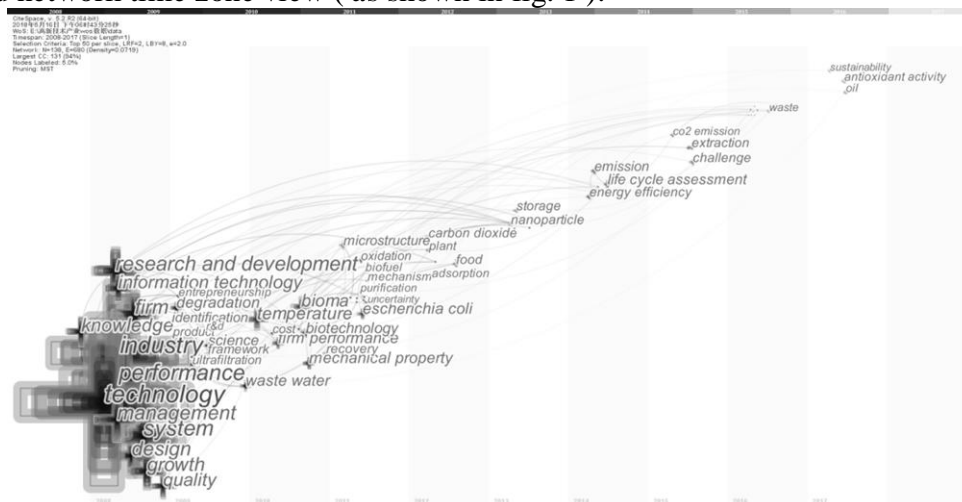

Fig.1 Research on knowledge map of hot spot evolution

As can be seen from Figure 1, the node of " Technology" is the largest, followed by " Industry" and has dense and continuous links with keywords at other time points, which also shows that from 2008 to the present, research related to the high-tech industry has been linked. In 2008 - 2009, It mainly focuses on Technology, Industry, Performance, Innovation, System, Model, Research and development, Firm, Management and other high-frequency keywords. on the surface, the research focus at this stage mainly focuses on research and development investment, technological innovation and enterprise performance in high-tech industries. Dai and others discussed the relationship between knowledge, network and performance of high-tech enterprises based on the view of knowledge foundation and social network [2].From 2010 to 2013, some key words such as Bioma, Biotechnology, Biofuel, Purification and Nanoparticle appeared, which indicated that biotechnology and new material technology were the focus of research at this stage. From 2014 to 2017, many key words also emerged in this stage, such as Life cycle assessment, CO2 emission, Waste, Sustainability and so on. The frequency is not high, indicating that the research focus in this stage of the high-tech industry is scattered and has not yet formed a relatively focused research problem, but it is obvious that the relationship between the high-tech industry and the environment and the issue of sustainable development have become the research focus in this stage. For example, Liao et al take managers and employees of Taiwan's Hsinchu Science and Technology Park as research objects, and the results show that environmental education has a significant positive correlation with green innovation ability and the amount of environmentally friendly product research and development [3].The article hopes to carry out environmental education for high-tech industries, grasp the green business opportunities and get rid of the vicious circle of price competition.

Co - Citation Analysis

Literature Cited Analysis

Co - cited documents refer to two or more documents cited in one article that have similarities in research content. Generally speaking, the higher the cited frequency of documents, the more important their position in the network and their relevance to other documents will be higher, but

this connection is not black or white. Literature co-citation analysis can find out the literature with higher centrality and frequency of citation in a certain research field, that is, the key literature. Through Citespace's display of high frequency, the eight papers with the highest citation frequency were studied. Set the node type to Cited Reference in Citespace; The threshold is set to Top50; The time interval is set to 1 year; The calculation method is set to Path Finder. Citespace V is run to get a knowledge map of the literature cited in the field of high-tech industries.As shown in fig. 2.
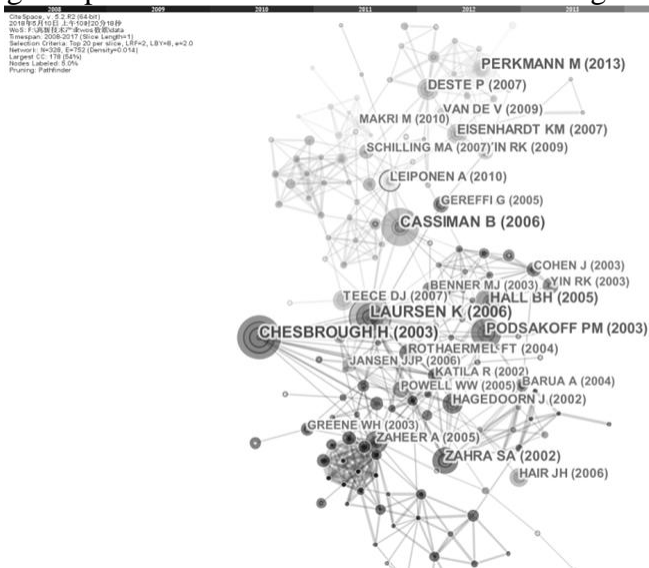

Fig. 2 The cited knowledge map of the literature

The highly cited documents related to the field of high-tech industry can be known through the cited knowledge map of the documents, and eight documents with cited frequency greater than 12 are listed, with information mainly including frequency, centrality, author, year of publication, journal source, etc., as shown in Table 2.This collection of documents constitutes the classic literature on high-tech industry research.

Table 2 Relevant information of highly cited documents

Serial number	Frequency	Centrality	Author	Year	Title
1	24	0.18	Laursen K	2006	Open For Innovation: The Role Of Openness In Explaining Innovation Performance Among U.K. Manufacturing Firms
2	23	0.08	Cassiman B	2006	In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition
3	20	0.01	Perkmann M	2013	Academic engagement and commercialisation: A review of the literature on university–industry relations
4	19	0.01	Podsakoff PM	2003	Common method biases in behavioral research: a critical review of the literature and recommended remedies
5	18	0.05	Hall BH	2005	Market value and patent citations
6	16	0.03	Zahra SA	2002	Absorptive capacity: a review, reconceptualization, and extension
7	13	0.05	Eisenhardt KM	2007	Theory building from cases: opportunities and challenges
8	13	0.05	Deste P	2007	University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry?

Author Co-Citation Analysis

Through author co-citation analysis, we can learn the theory that has the most far-reaching influence on the field of high-tech industry and dig out scholars with strong influence in this field. Set the node type to Cited Author in CiteSpace; The threshold is set to Top50;The time interval is set to one year, and the top 10 authors will be listed for analysis of the authors who have made important contributions to the high-tech industry (see Figure 3).Each node corresponds to an author. The size of the node is positively related to the cited frequency of the author. The larger the node, the more important its position in the co-cited network is.
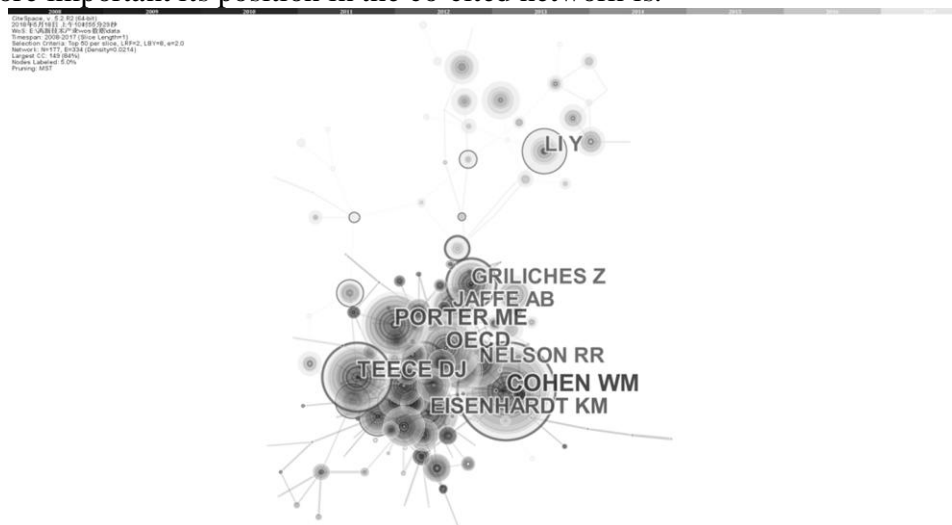

Fig. 3 Graph of co-cited knowledge of authors

As can be seen from fig. 3, influential scholars in this field include Cohen WM [4,5] explaining how to solve the problems of research and development, knowledge spillovers and competition among enterprises with asymmetric technological capabilities and the motivation of innovation of different subjects. Poter ME's main research direction is enterprise strategy and competition, and it puts forward five-force model, three strategies and value chain theory. Teece DJ put forward the theory of dynamic capability and dynamic capability. Eisenhardt's contribution is reflected in methodology. Case study is the main method to construct subversive innovation theory. Jaffe AB [6,7] explored the relationship between technological change and environmental policy, and provided environmental economists with research guidelines and analysis tools for technological change. Nelson RR put forward the evolution theory of economic change, holding that the growth of enterprises is similar to biological evolution, that is, enterprises grow through diversity, heredity and natural selectivity, and organization, innovation and path dependence have a profound impact on the growth of enterprises.

Analysis of the Co-Citation of Periodicals

By generating a network map of journal co-citation (see fig. 4), we can identify the major journals that disseminate knowledge in the research field of high-tech industries, that is, important carriers.
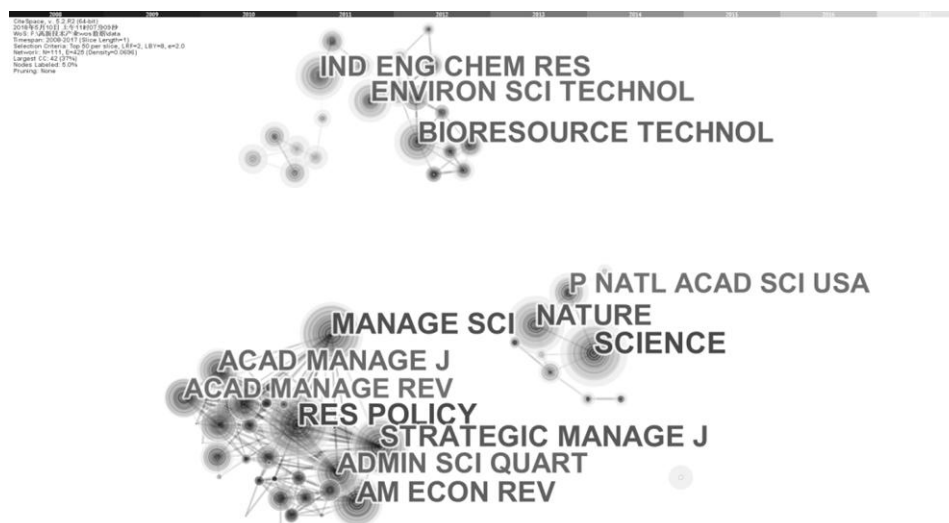
Fig. 4 Web map of journal co - citation

From the perspective of the centrality of the knowledge map cited by journals, the centrality of journals such as Bioresource Technology, Strategic Management Journal, Research Policy and American Economic Review is higher than that of other journals, with the four journals being 0.09, 0.07, 0.05 and 0.04 respectively. According to the centrality of the knowledge map cited by the journals, the above journals have great influence and authority in the field of high-tech industry, and are an important carrier of knowledge in the field of high-tech industry from the perspective of scientific quantitative analysis. At the same time, Bioresource Technology, Strategic Management Journal, Research Policy and American Economic Review are both highly cited and centered, indicating that these four journals are important core journals in the field of high-tech industry and are an important source of reference journals for follow-up scholars.

Conclusion

Based on the methods of bibliometrics and knowledge mapping, this paper takes 12385 papers in the field of High Technology Industry included in the Web of Science database as the research object, shows the research focus and frontier of the papers published in the past 10 years, and deeply analyzes the knowledge base, high-impact research population and communication carrier on which the development of this field depends, and draws the following conclusions:

(1)In the past 10 years, research hotspots in the field of high-tech industry have also been different in different time periods. Specifically, it can be divided into three stages: from 2008 to 2009, the research focus of this stage mainly focused on R & D investment, technological innovation and enterprise management in high-tech industries. From 2010 to 2013, biotechnology and new material technology were the research hotspots at this stage. From 2014 to 2017, the research focus at this stage was scattered and no more focused research issues were formed, including life cycle assessment, carbon dioxide emissions, waste materials, sustainability, etc.

(2)Hall BH, Zahra SA, Eisenhardt KM and Teece DJ are authors with high cited frequency and centrality, and their papers are also highly cited documents, which are important knowledge bases and sources of research in the field of high-tech industries. The main carriers of highly cited documents are periodicals, and the periodicals with double-high citation and centrality are: Bioresource Technology, Strategic Management Journal, Research Policy and American Economic Review, etc.

Acknowledgement

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