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Innovation System and Efficiency: A Bibliometric Review

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Abstract: Doing a bibliometric analysis of published literature using data from Scopus, this study seeks to provide light on the present status of research in the area of innovation systems and efficiency. The study finds possible areas of collaboration among researchers, organisations, and institutions by examining authors, research institutions, published articles, and research trends. The results of this study have important practical and policy ramifications, especially for decision-makers who want to develop and put into practice regulations that encourage innovation and boost productivity. The study's findings can help businesses and organization's by pointing them in the direction of best practices and methods for enhancing the effectiveness of their innovation systems. The study can also help programs for education and training that aim to improve innovative systems and efficiency by fostering knowledge and skill development. Finally, the study can offer insightful information on potential future research directions in the area of innovation systems and efficiency, enabling scientists to spot areas that still require more research. In conclusion, this study offers a thorough and current evaluation of the body of research on innovation systems and effectiveness. In especially for politicians, corporations, organization's, and educators striving to improve innovation systems and efficiency, the practical and policy implications of the findings show the potential impact of this study on the outcomes in terms of innovation and efficiency.

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1. Introduction

Innovation and efficiency are the core competitiveness of economic development (Wu, Song, & Zhao, 2018). The concept of innovation was first put forward by Schumpeter in 1912. Schumpeter believed that innovation was “establishing a new production function”, and summarized innovation into five new combinations (Schumpeter, 1990). Innovation has different system levels from the level of technological innovation. At the national level, it is the national innovation system, at the regional level, it is the regional innovation system, and at the industrial level, it is the industrial innovation system. Jan (2022) highlighted the irreplaceability of innovation in optimizing solutions for energy-efficient systems, a characteristic deeply intertwined with the structure of such systems. The key to the operation of the innovation system is to establish a cooperative innovation network (Liu, 2000). Doloreux and Gomez (2020) stated that National Systems of Innovation (NSI) highlights the essentially systemic nature of innovation, involving both organisations and state in the innovation process within a nation. The efficiency of innovation system is directly related to the efficiency of national innovation system and the country’s comprehensive national strength and competitiveness (Li, 2013). This essay attempts to make a summary of the research on innovation system and efficiency, and better use the theory of innovation system to guide the practice of national development of countries.

1.1 Problem statement

Despite the growing interest in understanding the relationship between innovation systems and efficiency, there is a lack of a comprehensive and up-to-date analysis of the existing literature. Many studies have focused on specific aspects of the innovation system, such as R&D or technology transfer, without providing a holistic view of the system and its impact on efficiency. Moreover, there is a need to identify the main trends and research gaps in this field, which can guide future research and policy-making efforts. Therefore, the main problem addressed by this study is the lack of a systematic and comprehensive bibliometric review of the literature on innovation systems and efficiency, which can provide insights into the current state of research and help identify areas for further investigation.

2. Research design

2.1. Data sources

In order to ensure the integrity and accuracy of the obtained data, Scopus database is used, which has the most literature and the general subject range. The search

time was 1st August 2022, and 567 valid documents were obtained by keyword search focusing on “innovation system” and “efficiency”.

2.2. Methodology of the study

This essay focuses on the theme of innovation system and efficiency. Vosview and Citespace software are used for visual analysis of knowledge maps. Knowledge map is developed on the basis of citation analysis theory and information technology visualization. Citespace and Vosview software systems are two information visualization software used to measure and analyze scientific literature data, showing the internal mechanism of scientific evolution in the research field and the development trends in the research field. This essay uses the information visualization analysis technology of these software to conduct information visualization analysis on the annual trend, authors and institutions, keyword co-occurrence and topic clustering of selected literature, so as to analyze the internal relationship of literature, identify current research hot issues, summarize the characteristics of research and predict its possible development trend.

3. Research results and analysis

3.1. Trend of relevant document issuance

Through the annual distribution, the relationship between the number of papers in the efficiency research field of the innovation system and the change of time can be presented, and then the development speed and research status of this field can be understood, so the development trend of the past prediction can be sorted out. According to the collected data, 567 papers related to the efficiency of the innovation system were published internationally in the 26 years from 1996 to 2022. The distribution trend chart was obtained through statistics on the number of each year.

It can be clearly observed from the figure that the research related to innovation system and efficiency shows an upward distribution, and the overall number of documents issued increases every year. At the same time, it can be seen from the Figure 1 that the number of research articles in this field has increased from 1 in 1996 to 44 in 2022, and the number of articles published during this period has increased relatively evenly year by year. It can be observed from the figure that the number of articles issued in the 15 years from 2008 to 2022 has increased rapidly, and reached the peak of 64 articles in 2021. A total of 526 articles were published in the past 15 years, with an annual average of about 35 articles, accounting for 92.7% of the total. This indicates that international research in this field has a research boom period from 2008 to 2022.

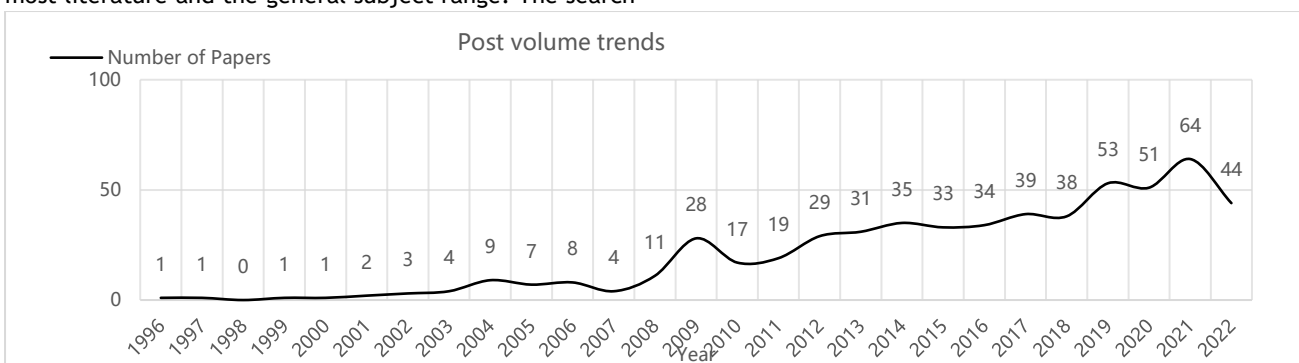


Figure 1. Number of Articles Published from 1996 to 2022

By using the moving average method to predict the issuance, the future research potential and research space value of this field can be explored (Tsujiimoto et al., 2016). According to calculation formula of moving average method $M_t = \frac{1}{N}(x_t + x_{t-1} + \dots + x_{t-N})$, assuming that the observation sequence (number of documents) is $X_1, X_2,$

$X_3 \dots X_T$, taking the moving average number $n < T$, and set the moving average number to 3, the predicted results of the international number of documents are shown in the Table 1. Since the literature of 2022 is incomplete, the forecast year starts from 2021. The predicted results are as follows.

Table 1. Forecast of the number of articles issued

Year	Number of Papers	Predicted Trends (Number of Papers)	Confidence higher limit (Number of Papers)	Confidence Upper Limit (Number of Papers)
1996	1			
1997	1			
1998	0			
1999	1			
2000	1			
2001	2			
2002	3			
2003	4			
2004	9			
2005	7			
2006	8			
2007	4			
2008	11			
2009	28			
2010	17			
2011	19			
2012	29			
2013	31			
2014	35			
2015	33			
2016	34			
2017	39			
2018	38			
2019	53			
2020	51			
2021	64	64	64	64
2022		62.74	51.35	74.13
2023		70.14	57.41	82.87
2024		77.55	62.23	92.86
2025		84.95	65.88	104.02
2026		92.36	68.59	116.13
2027		99.76	70.52	129.00
2028		107.17	71.82	142.52
2029		114.57	72.56	156.58
2030		121.98	72.81	171.14

According to the prediction results of the number of articles, the research on the efficiency of innovation system by international scholars in the future is on the rise, which conforms to the linear growth law. In order to ensure the accuracy of the analysis, the confidence interval was set at 95% in the study, and the prediction curve obtained is shown in the Table 1. It is expected

that by 2030, the output of research results of international scholars will fluctuate between the lower and upper confidence limits, and the number of papers will increase year by year as shown in the Figure 2. The results show that there is a large research space and potential research value in the field of innovation system and efficiency.

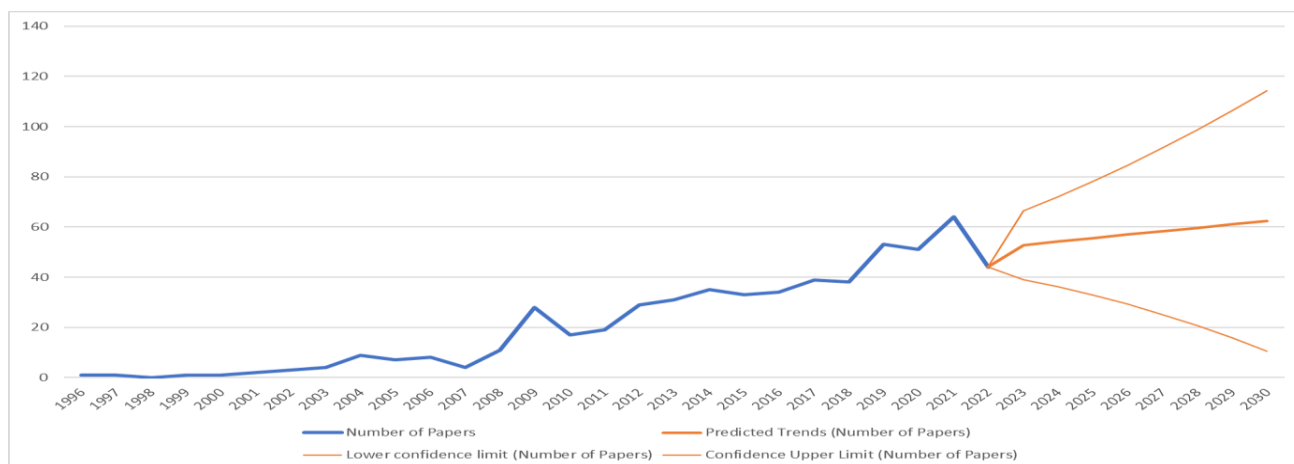


Figure 2. Forecast of document distribution

3.2. Author and their cooperative relationship

Analyzing the authors and the cooperative relationship among the authors of the literature will help to understand the efficient authors and research groups in the field of innovation system and efficiency. After standardization, the data provided by the sample study are processed through Citespace. The time period is selected from 1996 to 2022 (Top N = 50). The analysis project is selected as the “author”, and the author co-occurrence related to the

efficiency study of the international innovation system from 1996 to 2022 is drawn, as shown in the following Figure 3. The node size of the graph is related to the number of articles published by the author (the more articles, the larger the nodes). The connection between nodes reflects the cooperative relationship among different authors. The Figure 3 shows N = 509 (number of network nodes: 509), E = 352 (number of connections: 352), Density = 0.0027 (network density: 0.0027).

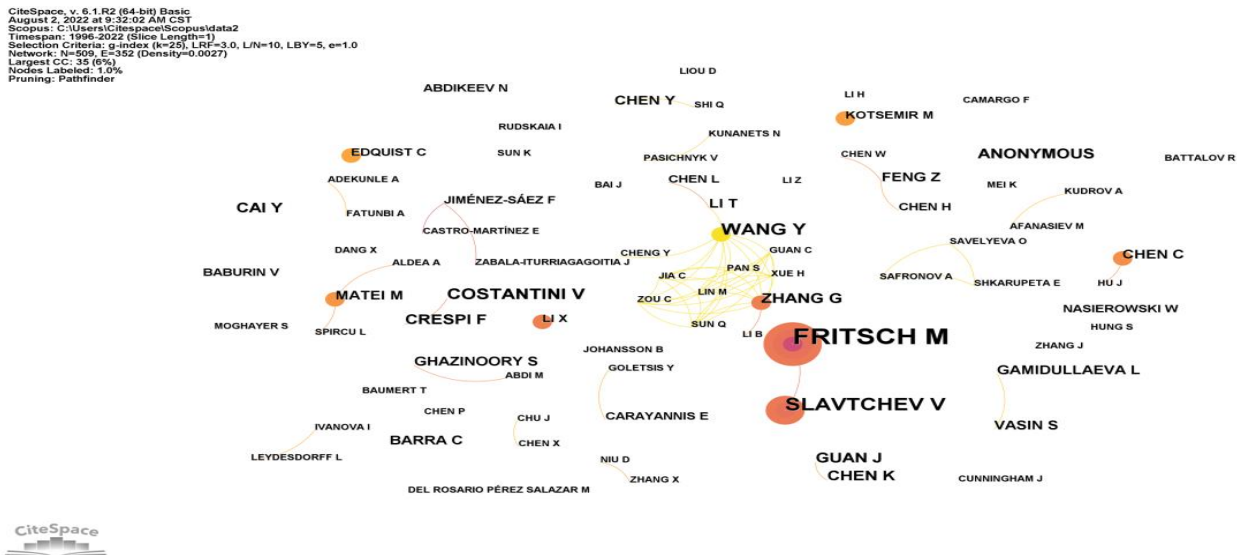


Figure 3. Author co-occurrence and cooperation Atlas

The cooperation relationship among the authors of the current research on the efficiency of innovation system is mainly shown in the following aspects:

First, in terms of the number of papers published by the authors, the efficiency of innovation systems has attracted much attention, and some scholars have played a mainstay role. Fritsch has published the largest number of papers which is a total of 17 papers, occupying the largest node position in the graph, followed by Slavtchev, who published 9 papers.

According to the statistics, the number of published papers of the top 10 authors (see Table 2), and the number of published papers of the top 10 research scholars is more than 5. These scholars have played an important role in promoting the research of innovation system and efficiency.

Table 2. Information of the top ten contributors

No.	Frequency	Year of first publication	Author
1	17	2001	FRITSCH
2	9	2006	SLAVTCHEV
3	7	2020	WANG
4	6	2008	COSTANTINI
5	5	2011	ANONYMOU
6	5	2012	CHEN
7	5	2008	CRESPI
8	5	2011	CAI
9	5	2003	GUAN
10	5	2009	ZHANG

Second, from the perspective of the cluster effect of cooperation, it has the characteristics of independence. As shown in the Table 2 and Figure 3, there are relatively many authors dedicated to the research of innovation system and efficiency, but the number of nodes is larger than the number of connections, and many nodes are

independent, indicating that there is no cooperative relationship among them. From the perspective of independence, scholars such as Anonymous, Cai, etc, have published similar amounts of articles and they are all independent authors. Although there are many scholars who publish articles independently, there are cooperative relationships among some scholars. From the perspective of cooperation, it is generally the cooperation among authors with high publication rates and authors with low publication rates, as authors with low publication rates need the resource advantages of those with high publication rates to drive research.

It can be concluded that the researchers in this field should gradually develop from individuals to groups, and accelerate the formation of a number of scientific research leaders and stable scientific research teams. This will be one of the important ways to improve the research level and the quality of results in the future.

3.3. Research institution

An effective analysis of the issuing institutions and their cooperative relationships is helpful to grasp the core research institutions in the field of innovation system and efficiency as a whole. Running the Cite space software, importing the data after the standardized processing of the sample documents into Cite space, selecting “institution” as the analysis item in the Cite space tool, and selecting 1996-2022 as the time for the analysis of the selected database, so as to draw the co-occurrence figure of the research related institutions. As shown in the Figure 4, each node represents a research institution, and the connection between nodes reflects the cooperative relationship between different institutions. The larger the font, the higher the amount of documents issued by the organization. The operation result is that the number of nodes is N = 409, the number of connections is E = 242, and

the network Density is 0.0029. That is, in the co-occurrence knowledge figure of research institutions in the field of innovation system and efficiency, a total of 409 institutions and 242 connections among institutions were selected. It can be seen from the Figure 4 that there are fewer connections than nodes and the density is relatively low, which indicates that there is a lack of close cooperation among institutions

that have made important contributions to the field and the degree of communication is relatively low. It is not difficult to judge that the cooperation of several institutions led by school of management, department of economics, school of economics and management is relatively close, and has formed a certain scale. Other institutions show the characteristics of independent distribution.

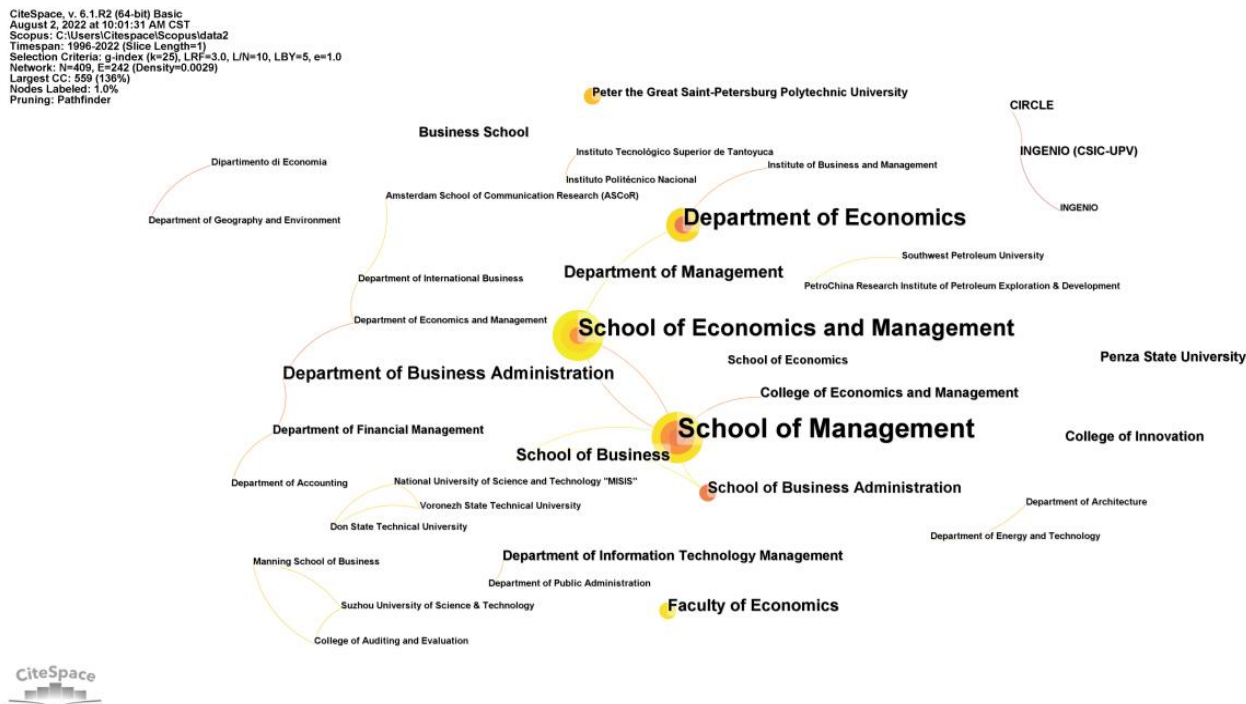


Figure 4. Organization co-occurrence and cooperation

The following table is obtained by statistics on the number of documents issued by different institutions.

Table 3. Top 15 institutions in the number of published articles

No.	Frequency	Institutions
1	23	School of Management
2	15	School of Economics and Management
3	14	Department of Economics
4	7	Department of Business Administration
5	6	Department of Management
6	6	School of Business
7	6	Faculty of Economics
8	5	School of Business Administration
9	4	College of Innovation
10	4	Penza State University
11	4	College of Economics and Management
12	4	Business School
13	4	Department of Information Technology Management
14	3	Peter the Great Saint-Petersburg Polytechnic University
15	3	School of Economics

From the Table 3 and the visual figure, it can be observed that there are many international institutions that conduct research on the efficiency of the innovation system, and the scientific research team is relatively strong. However, the level of document issuance and research strength of these institutions are quite different. There are 3 organizations with 10 or more articles, and the rest are all with 7 or less. On the whole, the international institutions that have research on the efficiency of innovation system

have a large difference in the level of documents issued. Only a few institutions have conducted in-depth discussion and research on the efficiency of innovation system, while most institutions have relatively single research, and have not conducted systematic in-depth discussion and multi-faceted research, and have not invested enough in this field. In addition, through the analysis of graphs and tables, it is found that the research on the efficiency of innovation system has the following conditions: some high-yield institutions cooperate with low-yield institutions, such as Department of business administration, Department of financial management, Department of economics and management. Through the analysis of nodes, it is found that such cooperation is often low-yield institutions that need the resources and knowledge of high-yield institutions for research.

3.4. Country of publication

Through the literature study on the innovation system and efficiency in Scopus database (1996-2022), the contribution of each country in this field can clearly be observed. There are 81 countries involved in the intercepted documents, and the 15 countries with the highest publications are shown in Table 4. According to the distribution of countries in the following Figure 5 and Table 4, China has the largest number of articles in this field, which is reaching 147; The second is Russian Federation, with 86 articles; United States followed closely, with 38 articles, ranking third.

From the perspective of the national co-occurrence figure, the exchanges and cooperation among countries are closer (more connections).

CiteSpace, v. 5.1.R2 (64-bit) Basic
 August 2, 2022 at 9:54:01 AM CST
 Scopus: C:\Users\jcspace\Scopus\data2
 Timespan: 1996-2022 (Slice Length=1)
 Selection Criteria: g-index (k=25), LRF=3.0, L/N=10, LBY=5, e=1.0
 Network: N=82, E=99 (Density=0.0298)
 Largest CC: 65 (79%)
 Nodes Labeled: 1.0%
 Pruning: Pathfinder



CiteSpace

Figure 5. Distribution of countries publishing articles

Table 4. Information table of countries with higher issuance

No.	Frequency	Centrality	Country
1	147	0.04	CHINA
2	86	0.15	RUSSIAN FEDERATION
3	38	0.29	UNITED STATES
4	37	0.42	UNITED KINGDOM
5	32	0.13	GERMANY
6	24	0.26	NETHERLANDS
7	22	0.25	ITALY
8	20	0.07	SWEDEN
9	19	0.26	SPAIN
10	15	0.19	AUSTRALIA
11	14	0.12	CANADA
12	13	0.35	FRANCE
13	13	0	SOUTH KOREA
14	12	0.08	UKRAINE
15	10	0.04	SOUTH AFRICA

3.5. Highly cited papers

The highly cited papers are generally articles with high academic value and great professional influence. The authors of the highly cited papers are usually

experts and scholars with deep attainments in the profession. Through analyzing the highly cited papers, the main research directions and main research contents in this field can be observed which is shown in Table 5.

Table 5. Information table of top ten highly cited documents

Serial Number	Title	Author	Year	Total Citation	View
1	Modeling the relative efficiency of national innovation systems	Guan and Chen (2012)	2012	223	Although the concept of innovation efficiency is a simplification of the innovation process, it may be a useful tool for guiding policy decisions. The second step partial least squares regression (PLSR) is used to examine the impact of the policy based institutional environment on innovation efficiency, taking into account such statistical issues as multicollinearity, small data sets and a small number of distribution assumptions.
2	Systemic instruments for systemic innovation problems	Wieczorek and Hekkert (2012)	2012	125	This paper analyzes that two methods of studying innovation system - structural analysis and functional analysis - can be combined in a systemic policy framework, which is helpful to identify systemic problems first; Secondly, the systematic tools to solve these problems are proposed.
3	Technological innovation systems in contexts	Bergek et al. (2015)	2015	92	The interaction between technology innovation system (TIS) and broader "background structure" is discussed. Although various contextual influences have been considered in tis research, it is suggested that the tis framework can be further strengthened by more detailed conceptualization of the tis context structure and tis context interaction.

4	Evaluation of multi-period regional r&d efficiency	Chen, Kou, and Fu (2018)	2018	64	Through the novel application of China's Regional R & D system, a solution to this problem in the multi period regional R & D efficiency measurement is provided.
5	A review of (almost) 20 years of regional innovation systems research	Doloreux and Gomez (2018)	2017	53	Let researchers understand the empirical results obtained so far and highlight areas requiring further work. This review describes the development history of RIS (regional innovation system), draws a chart of current RIS research subjects, and discusses suggestions to promote the development of RIS.
6	Regional r&d efficiency in Korea from static and dynamic perspectives	Han, Asmild, and Kunc (2016)	2016	18	Looking at the regional R&D efficiency and regional research of South Korea from the static and dynamic perspectives. Research and development (R&D) efficiency is highly concerned in regional innovation research. This study examines the R&D efficiency patterns in 15 regions of South Korea from 2005 to 2009. It uses data envelopment analysis to determine the R&D performance of the region relative to the best practices from a static perspective, and uses Malmquist productivity index to evaluate its performance changes within a given time range, providing a dynamic perspective.
7	A multilevel and multistage efficiency evaluation of innovation systems	Carayannis, Grigoroudis, and Goletsis (2016)	2016	16	Assessing the efficiency of innovation systems can serve as an important support tool for decision-making, identifying best practices and developing potential improvements in actions and strategies. It also helps to provide valuable insights into the nature and dynamics of the innovation process at different stages and levels. To propose a comprehensive evaluation and classification framework for national and regional innovation efficiency. The proposed model is based on Data Envelopment Analysis and is formulated as a multi-objective mathematical program to consider the objectives and constraints at different stages and levels of the innovation process.
8	Measuring efficiencies of multi-period and multi-division systems associated with DEA	Kou et al. (2016)	2016	16	A new formulation method of dynamic network DEA (DN-DEA) model based on system thinking is proposed to measure and decompose the overall efficiency of MPMDS. The proposed method is universal and maintains the objective attribute of DEA evaluation. It not only does not need a pre specified weight to subjectively integrate the component efficiency into the overall efficiency, but also applies to radial and non radial measurements.
9	Staged efficiency and its Determinants of regional innovation systems	Kaihua and Mingting (2014)	2014	15	A coherent two-step analysis procedure is proposed to model the efficiency performance and its determinants of regional innovation system. The efficiency oriented regional innovation system analysis will improve the public's understanding of the "quality" of its operation, help policymakers benchmark innovation performance, and thus improve policy formulation.
10	A typology of European countries based on innovation efficiency and technology gaps	Kontolaimou, Giotopoulos, and Tsakanikas (2016)	2016	11	The innovation efficiency of European countries is analyzed, and the role of early entrepreneurship is considered. The potential technology gap, i.e. the technology gap, is calculated in the meta frontier framework, taking into account that developed countries may use different technologies from developing countries / transition countries to produce innovation. Using bootstrap DEA, it is found that the average technology gap of developing countries / transition countries is twice that of developed economies. Based on the measurement of innovation efficiency and technology gap, European country typology is introduced to reveal the characteristics related to national strategic positioning, national absorptive capacity and knowledge spillover effect.

3.6. Keywords co-occurrence and statistics

Keywords are the words refined by the author to summarize the theme of the article. They are the high generalization and refinement of the author's academic thought, research theme and research content of a specific research. Therefore, keywords can also become the way

and method to analyze the research theme. At the same time, the research hotspots in this field by investigating the occurrence frequency of keywords can be understood and mastered, the update speed of the research content in this field and the vitality of discipline research can be judged. In the analysis of knowledge figure, the research topics and research hotspots of a certain field can be

obtained through the analysis of keywords. In the keyword co-occurrence network picture constructed by Vos viewer software, each node represents a keyword, and the node size represents the frequency of keyword occurrence. The keyword co-occurrence figure obtained by the “keyword” function of Vos viewer is shown in the Figure 6.

A total of 596 keywords were extracted from the collected literature, and the cumulative total frequency of keywords reached 2067 times. There were 6 high-frequency keywords with a frequency greater than 50, with a total frequency of 577. The cumulative frequency of these six high-frequency keywords accounted for 27.91% of the total frequency of all keywords.

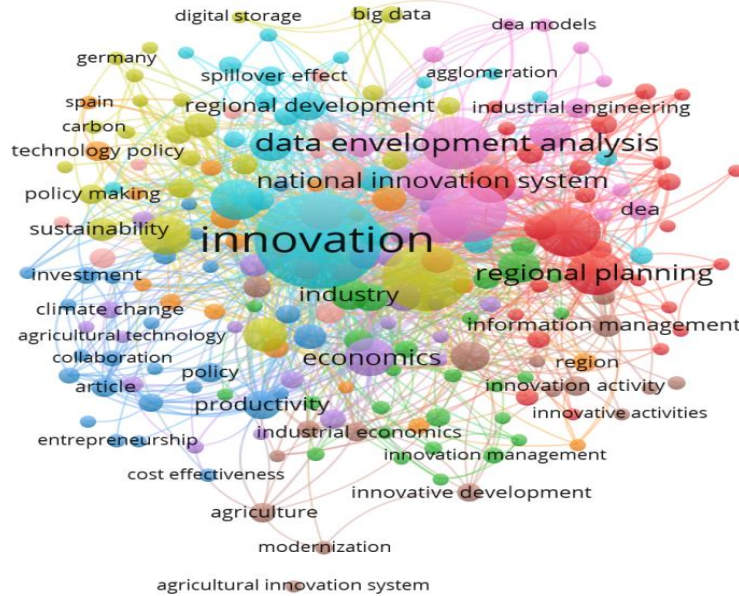


Figure 6. Keyword co-occurrence

The top 50 keywords are summarized by the literature data in Scopus database, as shown in the following Table 6.

Wherein the centrality can show its heat degree from the side.

Table 6. Statistics of some high-frequency keyword information

No.	Frequency	Centrality	Year	Keyword
1	199	0.08		innovation
2	114	0.13		innovation system
3	76	0.21		efficiency
4	71	0.05		regional innovation system
5	60	0.15		data envelopment analysis
6	57	0.06		national innovation system
7	39	0.25		regional planning
8	35	0.16		China
9	31	0.14		energy efficiency
10	27	0.05		economics
11	27	0.04		research and development
12	20	0.02		technological innovation
13	19	0.17		competition
14	19	0.04		innovation efficiency
15	18	0.02		economic and social effect
16	18	0.13		sustainable development
17	18	0.19		technological development
18	14	0.14		industry
19	13	0.08		decision making
20	13	0.02		innovation policy
21	13	0.01		productivity
22	13	0.01		technology transfer
23	11	0.04		regional development
24	11	0.01		technical efficiency
25	10	0.05		competitiveness
26	10	0.02		DEA
27	10	0.13		engineering research
28	10	0.24		Europe
29	10	0		technological innovation system
30	9	0.08		agriculture

31	9	0.09	article
32	9	0.06	artificial intelligence
33	9	0.01	developing country
34	9	0.12	Eurasia
35	9	0.02	information management
36	9	0.02	investment
37	9	0.02	patents and invention
38	8	0.01	industrial engineering
39	8	0.03	innovation activity
40	8	0.05	science and technology
41	7	0.02	agricultural innovation system
42	7	0.02	big data
43	7	0.06	environmental regulation
44	7	0.08	industrial research
45	7	0.05	knowledge management
46	7	0.11	sustainability
47	6	0.1	data envelopment analysis (dea)
48	6	0.03	economic development
49	6	0.01	efficiency measurement
50	6	0.01	energy policy

According to the keyword co-occurrence figure and the high-frequency keyword table, the keywords with high frequency in this field include innovation, innovation system, efficiency, regional innovation system, data development analysis, national innovation system, regional planning, etc. Among which, regional innovation system appears the most frequently, which reflects the distinct centrality of the research in this field, and indicates that this keyword is the core keyword of all research results in the efficiency field of the innovation system.

3.7. Keyword time zone analysis

The time zone figure is composed of a series of vertical zones as time zones. It mainly shows the evolving knowledge figure from the time dimension. It can not only clearly show the relationship between documents, but also

show the update of documents. Time zones are listed from left to right in chronological order, which makes the research frontier point to its knowledge base.

Figure 7 clearly shows the evolution process of research hotspots and frontiers in this field, which is important for understanding the dynamic development of this research field. Through the analysis of the Figure 7, the following conclusions can be drawn: from 1996 to 2010, universities mainly carried out research on innovation system, industry, innovation, energy efficiency, Eurasia, efficiency, technology development, etc; Since 2011, scholars have carried out new directions and conducted deeper research on the innovation system and efficiency. With the development of the times, agriculture, financial intelligence and innovation infrastructure have become the research frontier trend.



Figure 7. Time zone of research hotspot

3.8. Keyword emergence

By further processing the above keyword co-occurrence map, 25 high sudden value keywords were obtained from the study of the innovation system and efficiency in 1996-2022. The 25 high emergence keywords are

arranged from far to near according to the age of emergence, which can be seen in Figure 8. In the figure, “Strength” indicates the burst intensity, “Begin” and “End” are the start and end times of the burst, and the red line segment represents the start and end time periods of the burst.

Top 25 Keywords with the Strongest Citation Bursts



Figure 8. Keywords: highlighted Atlas

According to the Figure 8, the keywords with high emergence intensity include “Eurasia (4.52)”, “industry engineering (4.28)”, “efficiency (4.18)”, “technical efficiency (4.15)”, “Europe (4.14)”, etc., which indicates that these keywords are the frontier topics that researchers pay more attention to in their corresponding time periods. From the perspective of the duration of emergence, the ones with longer duration are “Europe (11 years)”, “Science and Technology (5 years)”, “Eurasia (6 years)”, “Research and Development Management (5 years)”, which shows that these keywords have been the focus of scholars’ attention for a long time, and some are even hot topics. According to the time sequence, it can be found that the leading-edge keywords are constantly changing with the passage of time, and the whole shows a phased evolution. Therefore, the research frontiers in the efficiency field of the innovation system will be divided according to the time stage. Among which, the period from 1996 to 2009 was the early stage, and the leading-edge keywords with high emergence intensity were “Europe (4.14)”; The period from 2010 to 2017 is the middle period, and the leading-edge keywords with high emergence

intensity include “technical efficiency (4.15)”; 2018-2022 is the recent period, and the leading-edge keywords with high intensity of emergence include “efficiency (4.18)”.

3.9. Research hotspot evolution trend

Using the Cite space software to draw the time line figure of the keywords in the efficiency field of the innovation system, the duration and evolution trend of the research hotspot can be obtained, as shown in the Figure 9. The keyword evolution figure is arranged from left to right in chronological order. The size of square nodes in the figure is proportional to the frequency of occurrence of corresponding keywords. Through the Cite space software, the selected documents are analyzed for the evolution of the research hotspots in the subject field. Setting the time parameter as 1996-2022, setting year per slice = 1, and set node type = keyword. The running results of the cluster evolution of the subject words are shown in the figure. The obtained figure has a total of 596 nodes and 1626 lines. At this time, Q = 0.8148, indicating that the divided structure is obvious.

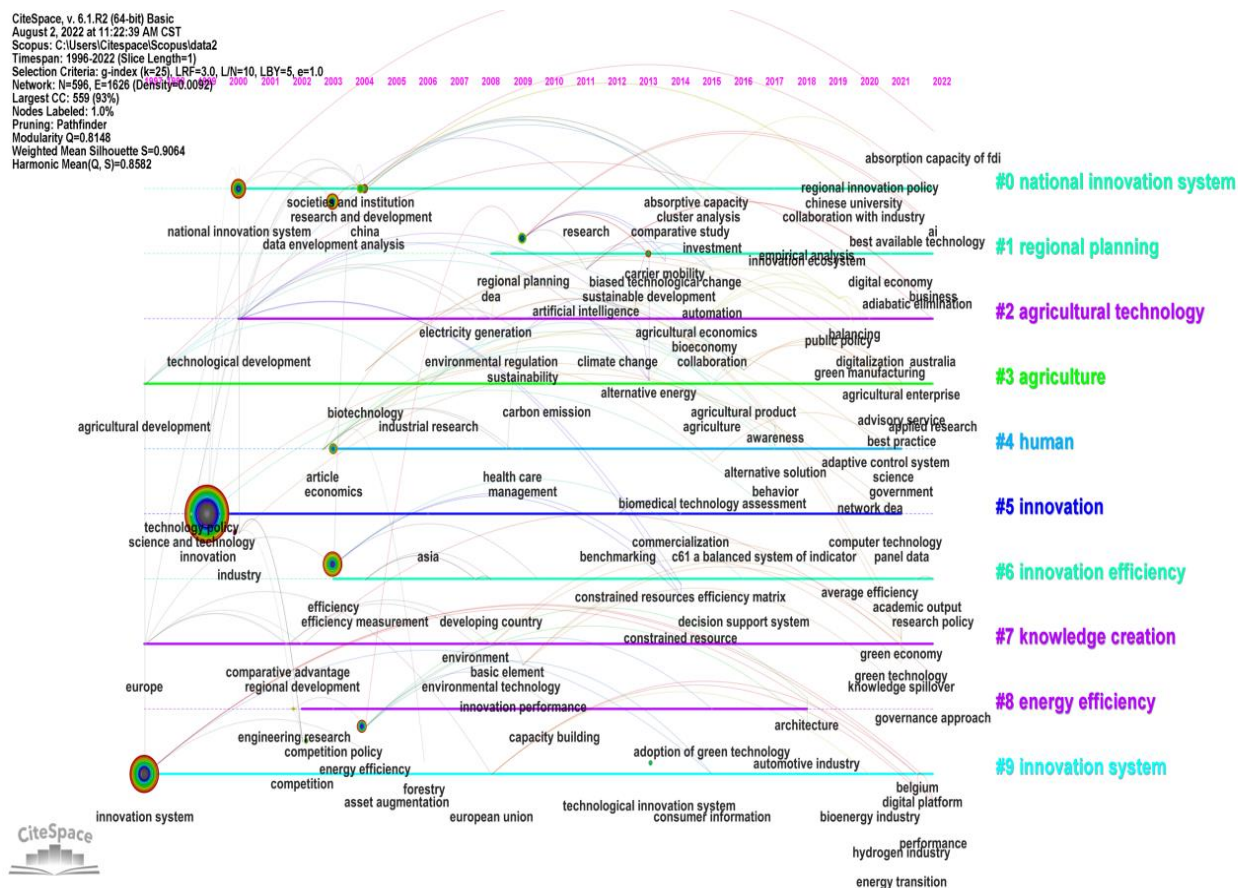


Figure 9. Time distribution of research hotspots and trends

The highlights of key words on this time axis are basically more in each year, indicating that the development of research about innovation system and efficiency shows a trend of stable rise, with little fluctuation. The “innovation system” in the figure is located at the front end of the time axis, which indicates that the field starts to explore based on this keyword. The essence of this keyword also determines that it is studied by scholars as a central keyword. Since then, relevant research on the efficiency of innovation system has been associated with this keyword. The right side of the figure is a keyword cluster label, which is divided into ten clusters in the evolution process: national innovation system, regional planning, agricultural technology, agriculture, human, innovation, innovation efficiency, knowledge creation, energy efficiency and innovation system.

4. Conclusion

This paper figures out 567 literature collected by Scopus since 1996, and draws the following conclusions by analyzing their time distribution, author cooperation, research highlights, research themes and research evolution trend. The number of papers issued in the 15 years from 2008 to 2022 grew rapidly and reached the peak in 2021. According to the author’s knowledge mapping relationship, there is less cooperation between the high-yield authors of the efficiency of the innovation system, and most of the cooperation is limited to the same university or unit, lacking cross sectoral and cross institutional cooperation. In terms of research institutions, there is a lack of close cooperation between institutions that have made important contributions to this field. Only several institutions led by School of Management,

Department of Economics, School of Economics and Management have cooperated closely and formed a certain scale. Other institutions are characterized by independent distribution. Among the countries studying this field, Chinese scholars have published the most papers in this field, followed by Russia and the United States. The keywords with high frequency in this research field include innovation, regional innovation system, data evolution analysis, national innovation system, etc. Except for the subject words, regional innovation system is the most frequently used.

Although scholars have made some achievements in this field, there are still some problems in this research field. First of all, the research is usually not specific enough, there is no in-depth analysis and discussion about the efficiency of the innovation system of related industries. Secondly, it fails to pay full attention to how the relationship between innovation subjects affects the efficiency of the innovation system. Therefore, the efficiency of innovation system can be measured based on the relationship among the innovation subjects, the connection among these subjects can be grasped, and how the intensity of participation of relevant participants affects the efficiency of the innovation system can be further analyzed.

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