International Journal of Forecasting 1985-2018: A retrospective based on bibliometric and knowledge diffusion analysis

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Abstract

As one of the leading journals in the forecasting field, International Journal of Forecasting (IJF) has continually contributed to the field over 30 years. In this study, a retrospective analysis is conducted to evaluate the merits of IJF from 1985 to 2018 based on the raw data harvested from Scopus. The retrospective analysis consists of two parts. One is a bibliometric analysis of IJF based on a science mapping technique which focuses on the level of paper, author and country. The citation network, co-citation network, co-author network and country collaboration network are mapped based on IJF's publications. Multiple relationships between different scientific entities can be explored from these networks. The other is a knowledge diffusion analysis based on the forecasting papers and their citing papers. The discipline distribution of citing papers can be obtained with the citation relationship between forecasting papers and their citing papers. Besides, a dynamic analysis of citing disciplines over time uncovers the changes of knowledge diffusion starting from forecasting papers. A deeper investigation about the knowledge diffusion outside of the forecasting journals is conducted for better elaborating the performance of IJF in knowledge diffusion outside the forecasting field. These two kinds of analyses directly depict a landscape about the development track of IJF based on the endorsements it obtained and the knowledge it spread abroad.

Key words: Forecasting research, Bibliometrics, Science mapping, Knowledge diffusion

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1. Introduction

International journal of forecasting (IJF), one of the leading journals in the forecasting field, was issued by International Institute of Forecasters (IIF) in 1985, and then continued to contribute the forecasting field up to now. According to its website, the main purpose of the journal is to "make forecasting useful and relevant for decision and policy makers", and all kinds of forecasting methods are welcomed by the journal for better bridging the gap between theory and practice. Many of the IJF papers involved the topics in the fields of business, economics, and management (BEM) for promoting the forecasting research in these fields. An existing overview about the forecasting journals which consist of IJF and Journal of Forecasting (JF) was conducted based on citation analysis and expert opinion, and an important part of the overview was elaborated under a background of BEM applications (Fildes 2006). The overview was and remains a valuable conclusion about the evaluation of the IJF and JF through examining how they have met their initial objectives successfully, and the content of the overview is informative. However, the bibliometric techniques which are used by the overview are sort of simple and not effective enough. The overview only used one bibliometric technique (i.e., citation analysis) to analyze the data of IJF, which has left a wide space for the performance of other bibliometric techniques. Many other overviews are conducted for evaluating the merits of a certain journal based on various bibliometric techniques, and a brief summary is provided as below.

Merigó et al. (2015) conducted an overview of the Journal of Business Research based on some basic bibliometric techniques, for example, identifying citation structure, highly cited papers, the most prolific authors, institutions, and countries. All of them were regarded as the main factors that affect the performance of the journal, and measured by the number of publications and citations. Calma and Davies (2016) provided an overview of Academy of Management Journal using some similar bibliometric techniques. According to the number of publications the journal published and citations the journal received, the most prolific author, countries, organizations, years and highly cited papers, authors were obtained. Moreover, based on the data of journal papers and their references, science mapping technique was used to construct the networks of most prolific authors and most cited authors. Due to the advantage of delineating relationships between scientific entities, science mapping has become a frequently-used bibliometric technique for visualizing different kinds of academic relationships. Wichaisri and Sopadang (2018) used the data of Sustainable Development to extract the co-citation relationship between the cited papers, and then determined four main clusters from the co-citation relationships based on the science mapping technique.

As stated above, many of the existing overviews have proven the effectiveness of bibliometric techniques, especially the combination of basic bibliometric indicators and the science mapping techniques. In our previous work, this combination has been used in many bibliometric studies. Our first try of the combination is the study to analyze the development of Atanassov intuitionistic fuzzy set (Yu and Shi 2015). Then, this research pattern was successfully applied in aggregation operator research (Yu 2015). Moreover, an overview of Information Science (INS) was conducted based on this research pattern to explore the structures and trends of the INS publications (Yu et al. 2017). Basically, the majority of the most important factors which affect the performance of journal can be identified under this research pattern. Further, some internal relationships between different kinds of scientific entities can be recognized and expressed by science mapping techniques. Highly cited paper, author, countries, and prolific author, country are common factors that can affect the performance of the journal. Co-citation relationship, co-author relationship, country collaboration relationship are some common internal relationships embedded in the journal. The status quo of journal can be elaborated by these factors and relationships. Moreover, the development track of journal can be delineated based on a dynamic bibliometric analysis. However, under this research pattern, the researchis limited inside the journal, which means the academic activities outside but related to the journal are difficult to recognize. To settle this problem, the knowledge diffusion analysis is a good choice.

In bibliometrics, knowledge flow can be constructed based on the citing and cited behaviors which correspond to the knowledge integration and knowledge diffusion (Shi et al. 2018), respectively. Knowledge integration means the knowledge transfer from the cited papers to the given papers, while knowledge diffusion is from the given papers to the citing papers. In this study, the raw data of IJF is harvested from Scopus. However, information about cited papers of IJF publications is largely missing in Scopus. Therefore, the knowledge integration cannot be conducted in this study, and we select the knowledge diffusion analysis as the primary content.

Porter and Chubin (1985) first defined the proportion of citations falling outside the category as a cross-discipline indicator to delineate how the knowledge diffuses from the target category to the outside categories. In Web of Science, the journals are classified based on the predefined categories, while in Scopus, subject area is used to replace the concept of category. Therefore, in this study, we use subject area equaling to the concept of category in the knowledge diffusion research. IJF and JF are two leading and authoritative journals in the forecasting field, therefore, IJF papers and JF papers are all included in the knowledge diffusion analysis. The raw data of IJF papers, JF papers and their citing papers are harvested from Scopus. The citation relationships between the IJF papers and their citing papers are extracted to explore what subject areas are most interested in the forecasting researches. The same work will be conducted between JF papers and their citing papers. Then, a rough result about the knowledge diffusion can be obtained at the level of subject area. Moreover, to better explore the subject areas that are royal to the forecasting researches, a dynamic analysis is conducted based on time slicing. The whole publication time of IJF and JF is divided into three periods, respectively, and in each period, some typical citing subject areas which have a special performance in citation behavior are identified. These typical citing subject areas are selected in a further investigation and the journal citation relationships between IJF/JF and their citing journals are extracted. Therefore, more detailed findings can be obtained at the level of journal. In addition, an overlapping work is conducted in the typical citing subject areas of IJF and JF. The derived overlapping subject areas are regarded as the most typical admirers to the forecasting field. In each subject area, we extract IJF papers that are cited by more journals belonging to the subject area, and these papers are most welcomed by the researches outside the forecasting field. The more journals cite the IJF papers, the more widely the knowledge of IJF papers spread.

The remainder of this paper is organized as follows. Section 2 presents a bibliometric analysis of IJF to identify the publication/citation structure of IJF and the most contributing papers, authors and countries. Section 3 offers a knowledge diffusion analysis of the forecasting journals. Section 4 states some discussion and conclusion of this study.

2. Bibliometric analysis of IJF

In this section, some frequently-used bibliometric techniques are applied into analyzing the IJF papers. First, a basic statistics of IJF papers is provided from the angle of output and citation. Some interesting findings can be obtained through exploring the relationships between the curves of annual output and annual citation. Then, paper, author, and country are selected as the three factors influencing the performance of the journal. The most cited, co-cited papers, the most prolific authors, the most cited authors, the most prolific countries, the most cited countries are all identified. Further, the citation, co-citation relationships, the co-author relationship, and the country collaboration relationship are depicted based on science mapping techniques.

2.1. Basic statistics of IJF

Annual evolutions of papers and citations are depicted in Fig 1, and the detailed data is stated in the table 1. The Panel A of Fig 1 provides a view of the overall trend to analyze the dynamic of papers and citations. Observing from the paper curve, there is a decrease of the yearly output from 1996 to 2001, but, by the large, the yearly output increased over time. The most prolific year is 2016 with 105 papers, and the least productive year is the initial year with 27 papers. As for the annual evolution of citations, the situation is similar to that of paper. By the large, the number of citations increased over time, but with a little drop in the period of 1996-2001. The number of citations in the year of 2006 is the highest, which largely owes to a highly cited paper (i.e., received 1198 citations) written by (Hyndman and Koehler 2006). After the year of 2006, the number of citations had a wavy decrease. In addition, the shape of citation curve is quite similar to that of paper curve, especially the periods of 1984-1994 and 2010-2018.

To deeply investigate the relation between the citation curve and the paper curve, these two curves are divided into four pieces in the Panel B, C, D, and E. In the Panel B and E, the trends of paper and citation are quite similar, which is reflected in every peak point and valley point. However, the interspace between the paper curve and citation curve is bigger in the Panel E than in the Panel B, which indicates the ratio of citations per paper is dropping from the initial years to the latest years. This phenomenon may result from two reasons. One is the increased academic output around the world. Another is the shorter citation

time window, which means the papers published in the latest years do not have enough time to accumulate their citations.

In the Panel C, the shapes of paper curve and citation curve are still kind of similar, but the ratio of citations per paper from 1997 to 2000 is much higher than the remaining years, which indicates the papers published in 1997, 1998, 1999 and 2000 attracted more citations than others. To better investigate why these papers can attract more citations, we have a closer look at the raw data of these papers, and we find each year has one or two highly cited papers. A highly cited paper with 564 citations was published in 1997, and focused on testing the equality of prediction mean squared errors (D. Harvey, Leybourne, and Newbold 1997). In 1998, Zhang et al. proposed to investigate the effect of key factor on forecasting performance of artificial neural network (Zhang, Patuwo, and Hu 1998), and this research has accumulated 2007 citations. In 1999, a research analyzing the Delphi technique as a forecasting tool was conducted (Rowe and Wright 1999), and received 941 citations. In 2000, Makridakis and Hibon (2000) describes a M3-Competition, and compare the results of the latest M3-Competition with previous M-Competitions. The research of Makridakis and Hibon received 669 citations. Based on the raw data from 1985 to 2018 harvested from Scopus, only eight papers have more 500 citations, and four of eight occurred in the period of the Panel C. In the Panel D, there is a peak point during the whole citation curve which is the year of 2006, and there are eight papers received more 100 citations in 2006. Among these papers, the study conducted by Hyndman and Koehler (2006) is the most highly cited with 1198 citations, which contributes to one fourth of the total citations in 2006.

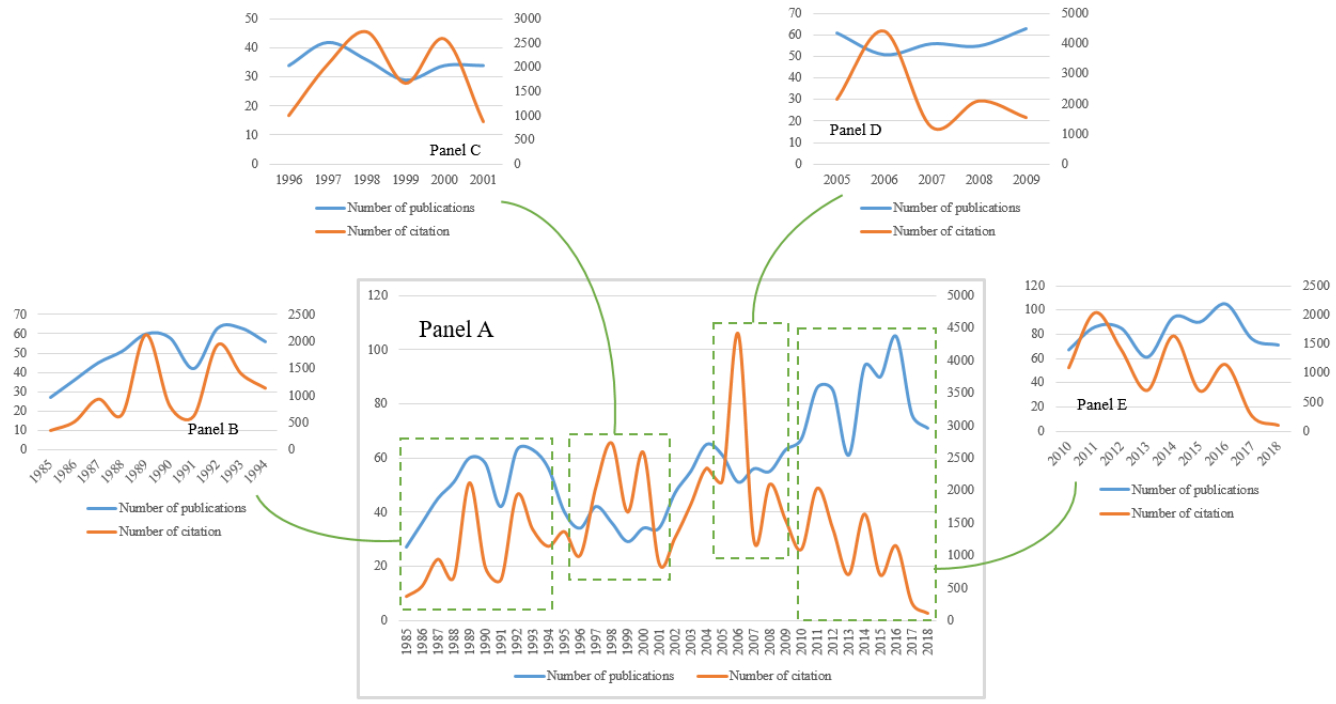


Figure 1: Annual evolutions of IJF papers and citations from 1985 to 2018

2.2. Citation network and co-citation network

After an overall review about the total IJF papers from 1985 to 2018, we focus on evaluating the performance of single IJF paper. The top 20 most cited IJF papers are listed in table 1 with the information about the citation number, author names, publication year, etc. Note that the country in table 1 refers to the country of first author and UK contains England, Scotland, Walsh, and North Ireland. The top three most cited papers all receive over 1000 citations, and the first one even possesses over 2000 citations. These three papers already appear in the subsection 2.1 as the important contributors for promoting the citations of their publication years. The first one is the paper written by Zhang, Patuwo, and Hu (1998) which investigated the research on forecasting with artificial neural networks. The second is the work of Hyndman and Koehler (2006) which considered the mean absolute scaled error as the standard measure based on comparing the accuracy of multiple forecasting methods. The third is Clemen (1989) which provided a review about the research on forecast combination and suggestions for the future work.

Table 1: Information about top 20 most cited IJF papers

Rank	Paper	TC	TC/Year	Country	Nau	Nin
1	Zhang et al. (1998)	2007	95.57	USA	3	1
2	Hyndman and Koehler (2006)	1198	92.15	Australia	2	2
3	Clemen (1989)	1105	36.83	USA	1	1
4	Rowe and Wright (1999)	941	47.05	UK	2	2
5	Makridakis and Hibon (2000)	669	35.21	France	2	1
6	De Gooijer and Hyndman (2006)	612	47.08	Netherlands	2	2
7	Armstrong and Collopy (1992)	573	21.22	USA	2	2
8	Harvey et al. (1997)	564	25.64	UK	3	1
9	Witt and Witt (1995)	468	19.50	UK	2	2
10	Thomas (2000)	390	20.53	UK	1	1
11	Meade and Islam (2006)	381	29.31	UK	2	2
12	Gardner (2006)	377	29.00	USA	1	1
13	Diebold and Yilmaz (2012)	375	53.57	USA	2	3
14	Holt (2004)	372	24.80	USA	1	1
15	Weron (2014)	345	69.00	Poland	1	1
16	Hyndman et al. (2002)	310	18.24	Australia	4	2
17	Conejo et al, (2005)	282	20.14	Spain	4	2
18	Taylor et al., (2006)	265	20.38	UK	3	3
19	Brown (1993)	221	8.50	USA	1	1
20	Lawrence (2006)	212	16.31	Australia	4	4

Besides, a citation network is mapped based on the citation relationship between IJF papers. The citation network consists of nodes and links, where some nodes are connected with links and some are isolated. A node represents a paper and a link represents the citation relationship between any two connected papers. The size of node is denoted as the number of citations a paper received. Through this citation network, the citation relationships between any connected IJF papers can be visually obtained and deeper investigations like highly cited publications are cited by what papers can be conducted easily. The number of citations no less than 80 is set as the limitation, then 111 qualified IJF papers are derived. 29 of the 111 papers are discarded because they are isolated. Finally, 82 IJF papers are used to construct this citation map, as shown in Fig. 2. Distance between any pair of papers denotes their similarity calculated by the association strength method (Eck and Waltman 2009) The longer distance is the more dissimilar the two connected papers are. Papers with high similarity values are clustered and represented as the same color. Among the 82 IJF papers, 70 of them have citations, while the remaining 12 papers have no citations, but cite to some of the 70 papers. From Fig. 2, Zhang, Patuwo, and Hu (1998) is the biggest node because it is the most cited paper among the total IJF papers, but among these 82 IJF papers, it is not the paper that has the most citations from the 82 IJF papers. The 82 IJF papers in Fig. 2 are all highly cited papers, so their endorsements are pretty authoritative. Winning an endorsement from these 82 papers helps a lot to promote the prestige of the paper, so a further investigation is conducted to derive the highly cited papers, where their citations are from these 82 papers. We define the citation from the IJF papers as the local citation (LC). The papers having no less than 5 local citations are extracted, as shown in table 2. Paper written

by Gooijer and Hyndman (2006) is the most cited among these 82 IJF papers, and the paper is about a 25 review on time series forecasting based on the papers of JIF and Journal of Forecasting (JF). According to the local citation percentage (LC/TC), the research of Crone, Hibon, and Nikolopoulos (2011) ranks the first, which indicates the high quality of its citations. Zhang, Patuwo, and Hu (1998) is top one highly cited in the total IJF papers, but its performance in local citation percentage is not that remarkable.

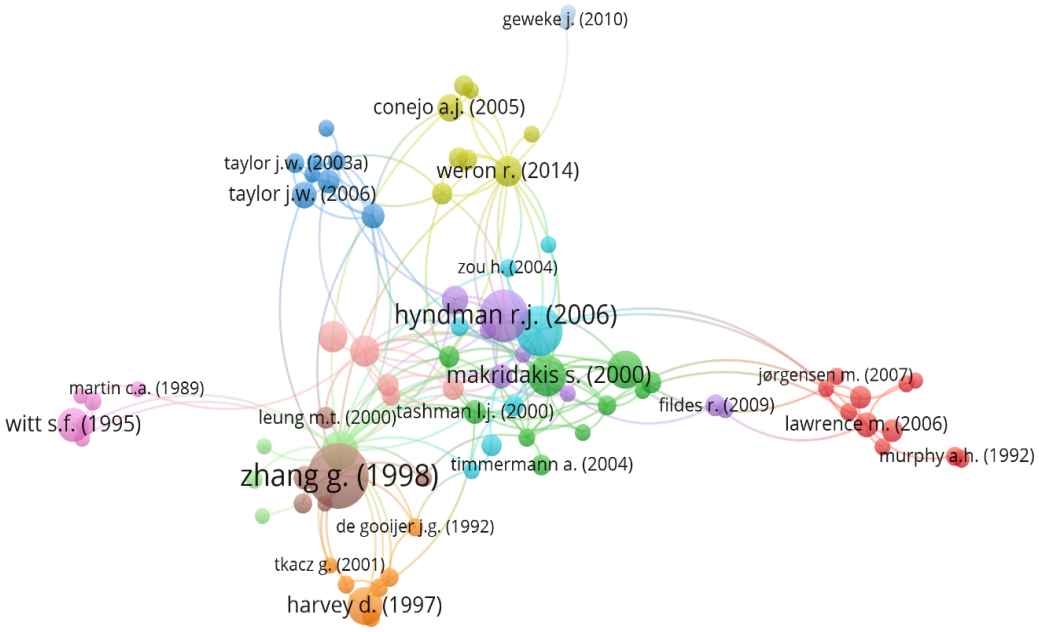


Figure 2: Citation network of 82 most cited IJF papers

Table 2: Information about the most local cited IJF papers

Rank	Paper	LC	TC	LC/ TC
1	De Gooijer and Hyndman (2006)	33	612	5.39%
2	Weron (2014)	17	345	4.93%
3	Gardner (2006)	16	377	4.24%
4	Makridakis and Hibon (2000)	16	669	2.39%
5	Zhang et al. (1998)	12	2007	0.60%
6	Clemen (1989)	11	1105	1.00%
7	Crone et al. (2011)	10	108	9.26%
8	Taylor et al. (2008)	10	124	8.06%
9	Lawrence et al. (2006)	10	212	4.72%
10	Darbellay and Slama (2000)	10	207	4.83%
11	Makridakis (1993)	10	133	7.52%

Co-citation analysis is one of the useful bibliometric methods. As the name suggested, the co-citation relationship describes the relations between any two co-cited papers, and the co-cited papers means papers that are cited by the same paper. If two papers are cited by one same paper, then these two papers are in a co-citation relationship and the co-citation strength they possess is one. Based on the IJF papers harvested from Scopus, the co-citation relationships between them and citing papers are extracted. Note that 122 IJF papers are excluded because of the missing data and format errors. Finally, 1816 IJF papers and 33204 references are included in this co-citation network, shown in Fig. 3. IJF papers published in the same year are divided into one group to better straighten out their co-citation evolution trajectory. Moreover, three groups of thresholding are used to control the filtration of the qualified papers. Each group of thresholding has three criterion which are the minimum citations, minimum co-citations, and minimum normalized co-citations. The first thresholding is set in the year of 1985, the second in 2002, and the last is in 2018. After some trail runs, the first thresholding is set with 50, 3, 15, the second is 3, 3, 20, and the third is 3, 3, 20.

The color in the Fig. 3 denotes the publication year of papers, and the warm color represents the latest

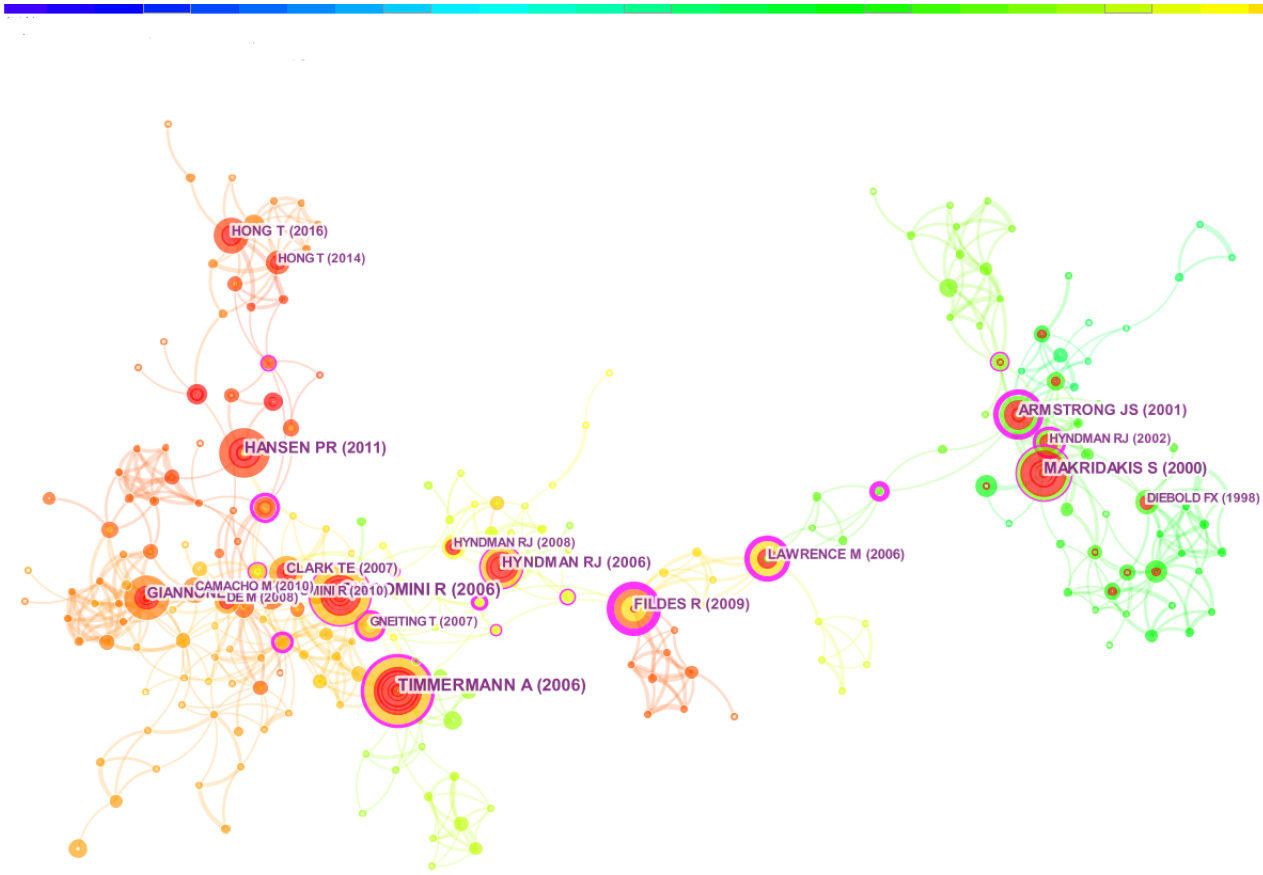
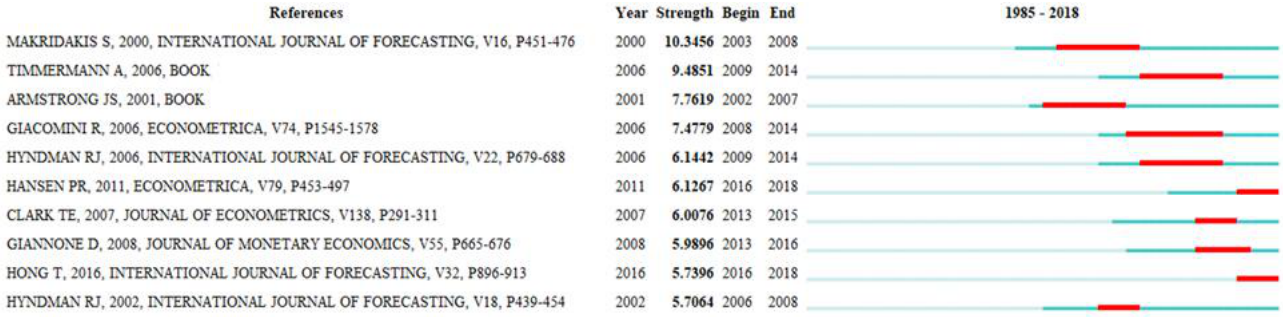


Figure 3: Co-citation network of IJF papers and their citing papers

year, while the cold color represents the old year. The size of node denotes the co-cited times of each paper, and the bigger the size is the more the co-cited times are. From Fig. 3, we can see that the coldest color is green (i.e., approximately corresponds to the year of 1998), which means the papers published earlier are excluded according to the thresholding. The top 10 most co-cited papers which have the biggest nodes are extracted and listed in table 3. The most co-cited research conducted by Timmermann (2006) elaborated on the advantages of forecast combination, and analyzed the factors that can determine the advantages. The second most co-cited work (Giannone, Reichlin, and Small 2008) provided a framework which was useful for the real-time forecast selection based on conditional expectations of forecasts, and applied this framework into a testing problem. The third most co-cited work is an IJF paper written by Makridakis and Hibon (2000) which described a M3-Competition. This IJF paper also is the main contributor for the high citations in the year of 2000. Including the work of Makridakis and Hibon (2000), we find that four of the ten most co-cited papers are IJF papers, which means these four IJF papers possess the most co-endorsements from IJF papers. In table 3, except for the co-citation, the information about the first co-cited year, the last co-cited year, the whole co-cited duration, and the average co-citation per year about each top ten co-cited papers are provided. Among these four IJF papers, we find the research conducted by Hong et al. (2016) has the shortest co-cited duration, but the highest average co-citation per year, which denotes the research (Hong et al. 2016) is very frequently co-cited by others in recent years. From the Fig. 3, we can see the study (Hong et al. 2016) is in a co-citation relationship with his another research (Hong, Pinson, and Fan 2014), and these two researches are both related to the energy forecasting. Another two IJF papers are the work of Hyndman and Koehler (2006) and the work of Fildes et al. (2009) which both possess relatively low average co-citation per year, and it denotes they are behind Hong's work (Hong et al. 2016) in co-cited activity. One thing is interesting that the node of Fildes et al. (2009) is wrapped with a purple ring in Fig. 3, where the purple ring means the node enjoys a high between-ness centrality. The between-ness was proposed by Freeman (1977) and depicts the structural property of communication of nodes between connected networks. A node with high between-ness centrality denotes it is more inclined to be positioned between some connected networks. In Fig. 3, the node of Fildes et al. (2009) is between a red cluster and a yellow cluster, which means the node of Fildes et al. (2009) linked the researches published earlier than 2009 and later than 2009. Fildes et al. (2009) plays an important role in expressing the connected co-

citation relationships between these two clusters of researches. Besides, another work called burst detection is conducted to identify papers with abrupt change (Kleinberg 2003), as shown in Fig. 4. The papers with abrupt change usually are the milestone papers of the science mapping research. From Fig. 4, we can find that the same four IJF papers having high co-citations are also remarkable in this burst detection, especially, the work of Makridakis (Makridakis and Hibon 2000) has the strongest burst power, which means it is the most important milestone in this co-citation mapping.



References	Year	Strength	Begin	End	1985 - 2018
MAKRIDAKIS S, 2000, INTERNATIONAL JOURNAL OF FORECASTING, V16, P451-476	2000	**10.3456**	2003	2008	
TIMMERMANN A, 2006, BOOK	2006	**9.4851**	2009	2014	
ARMSTRONG JS, 2001, BOOK	2001	**7.7619**	2002	2007	
GIACOMINI R, 2006, ECONOMETRICA, V74, P1545-1578	2006	**7.4779**	2008	2014	
HYNDMAN RJ, 2006, INTERNATIONAL JOURNAL OF FORECASTING, V22, P679-688	2006	**6.1442**	2009	2014	
HANSEN PR, 2011, ECONOMETRICA, V79, P453-497	2011	**6.1267**	2016	2018	
CLARK TE, 2007, JOURNAL OF ECONOMETRICS, V138, P291-311	2007	**6.0076**	2013	2015	
GIANNONE D, 2008, JOURNAL OF MONETARY ECONOMICS, V55, P665-676	2008	**5.9896**	2013	2016	
HONG T, 2016, INTERNATIONAL JOURNAL OF FORECASTING, V32, P896-913	2016	**5.7396**	2016	2018	
HYNDMAN RJ, 2002, INTERNATIONAL JOURNAL OF FORECASTING, V18, P439-454	2002	**5.7064**	2006	2008	

Figure 4: Papers with the strongest power in the burst detection.

Table 3: Information about the most co-cited papers in the co-citation network

Rank	Co	Paper	Source	FY	LY	Y	best year (number)	Ave-Co	Citation
1	26	Timmermann (2006)	Handbook of economic forecasting	2009	2014	6	2009(9)	4.33	1247
2	24	Giacomini and White (2006)	Econometrica	2007	2014	8	2009/2011/2013(5)	3.00	1231
3	22	Makridakis and Hibon (2000)	International journal of forecasting	2003	2008	6	2006(7)	3.67	1325
4	20	Hansen et al. (2011)	Econometrica	2012	2018	7	2018(7)	2.86	1036
5	18	Giannone et al. (2008)	Journal of Monetary Economics	2013	2018	6	2016(8)	3.00	793
6	17	Hyndman and Koehler (2006)	International journal of forecasting	2009	2014	6	2011(6)	2.83	2338
7	16	Armstrong (2001)	Principles of Forecasting: A Handbook for Researchers and Practitioners	2001	2007	7	2002/2006(6)	2.28	1740
8	15	Fildes et al. (2009)	International journal of forecasting	2011	2017	7	2013(7)	2.14	299
9	14	Hong et al. (2016)	International journal of forecasting	2016	2018	3	2016(8)	4.67	251
10	14	Lawrence (2006)	Journal of the American College of Cardiology	2007	2013	7	2013(6)	2.00	379

2.3. Authors analysis in IJF and co-author network

Prolific authors can be regarded as the experts of the field or the important contributors of the journal. After a preliminary review, some prolific associate editors who published in IJF are excluded because the researches of associate editors are more inclined to be highly cited than those of normal IJF authors. The top ten prolific authors in IJF are selected from the remaining IJF authors, as shown in table 4. The information about their first paper year, and last paper year is stated in table 4. We find that most of the ten prolific authors possess a long academic career, especially Koehler and Ord whose papers covering at least 30 years. Five of the ten authors affiliated in USA, which indicates the USA scholars form a leading and active community in IJF. Generally speaking, first author is the main contributor of a paper, and corresponding author is responsible for a paper. Therefore, we calculate the number of papers that the authors are responsible for the first authors or the corresponding authors. From table 4, Chatfield's first author percentage is 86.67% which is the highest among the ten authors, followed by Taylor and Lahiri. O'Connor and Ord are two authors who have relatively weak performance in first author percentage and corresponding author percentage. It means that they are prolific authors in IJF, but in most cases, they acted as a collaborator of the papers, rather than the main contributor.

Table 4: Information about the top ten prolific authors in IJF

Rank	Author	TP	Country	FY	LY	Y	1st	1st %	Cor	Cor %
1	Franses, P. H.	26	Netherlands	1991	2017	27	12	46%	13	50%
2	Stekler, H. O.	24	USA	1988	2015	28	10	42%	12	50%
3	Goodwin, P.	22	UK	1993	2017	25	10	45%	13	59%
4	Koehler, A.B.	19	USA	1985	2017	33	6	32%	10	53%
5	O'Connor, M.	18	Australia	1989	2007	19	5	28%	7	39%
6	Taylor J.W.	16	UK	1999	2018	20	13	81.25%	14	87.50%
7	Lawrence M.	15	Australia	1992	2011	20	7	46.67%	6	40.00%
8	Ord	15	USA	1988	2017	30	4	26.67%	5	33.33%
9	Chatfield C.	15	USA	1986	1995	10	13	86.67%	10	66.67%
10	Lahiri K.	15	USA	1987	2015	29	12	80.00%	9	60.00%

The number of citations an author received is a useful indicator to evaluate the prestige of authors, therefore, the top ten most cited authors are selected in table 5. Similar to the table 4, the associate editors are excluded in table 5. Koehler is the most cited author due to his relatively high output. Wright has the highest TC/TP value, which is largely due to his highly cited paper, "The Delphi technique as a forecasting tool: Issues and analysis" (Rowe and Wright 1999). Franses is the most prolific author, but ranks the last in TC, which indicates his researches are not as attractive as those of the other nine authors. Besides, the number of citations from the IJF and outside the IJF are calculated. Goodwin, Collopy, Hibon and O'Connor receive higher local citation percentage, which means the IJF endorsements their researches obtained are more than those of the remaining authors.

Table 5: Information about the top ten most cited IJF authors

Rank	Author	TC	TP	RTP	TC/TP	LC	%	OC	%
1	Koehler, A.B.	1634	19	3	86	79	4.83%	1555	95.17%
2	Wright, G.	1180	9	8	131.11	47	3.98%	1133	96.02%
3	Hibon, M.	1016	11	6	92.36	131	12.89%	885	87.11%
4	Taylor J.W.	750	16	5	46.88	33	4.40%	717	95.60%
5	De Gooijer, J.G.	738	9	9	82.00	31	4.20%	707	95.80%
6	Collopy, F.	675	12	10	56.25	96	14.22%	579	85.78%
7	Franses, P. H.	665	26	1	25.58	57	8.57%	608	91.43%
8	Goodwin, P.	656	22	2	29.82	95	14.48%	561	85.52%
9	O'Connor, M.	653	18	4	36.28	84	12.86%	569	87.14%
10	Meade, N.	598	10	7	59.80	31	5.18%	567	94.82%

A co-author network is constructed based on the co-author relationship between IJF authors. Authors who publish less than eight papers are discarded, then 38 qualified authors are derived. Among the 38

authors, 6 authors are isolated, so finally 32 authors are mapped into the co-author network, as shown in Fig.5.

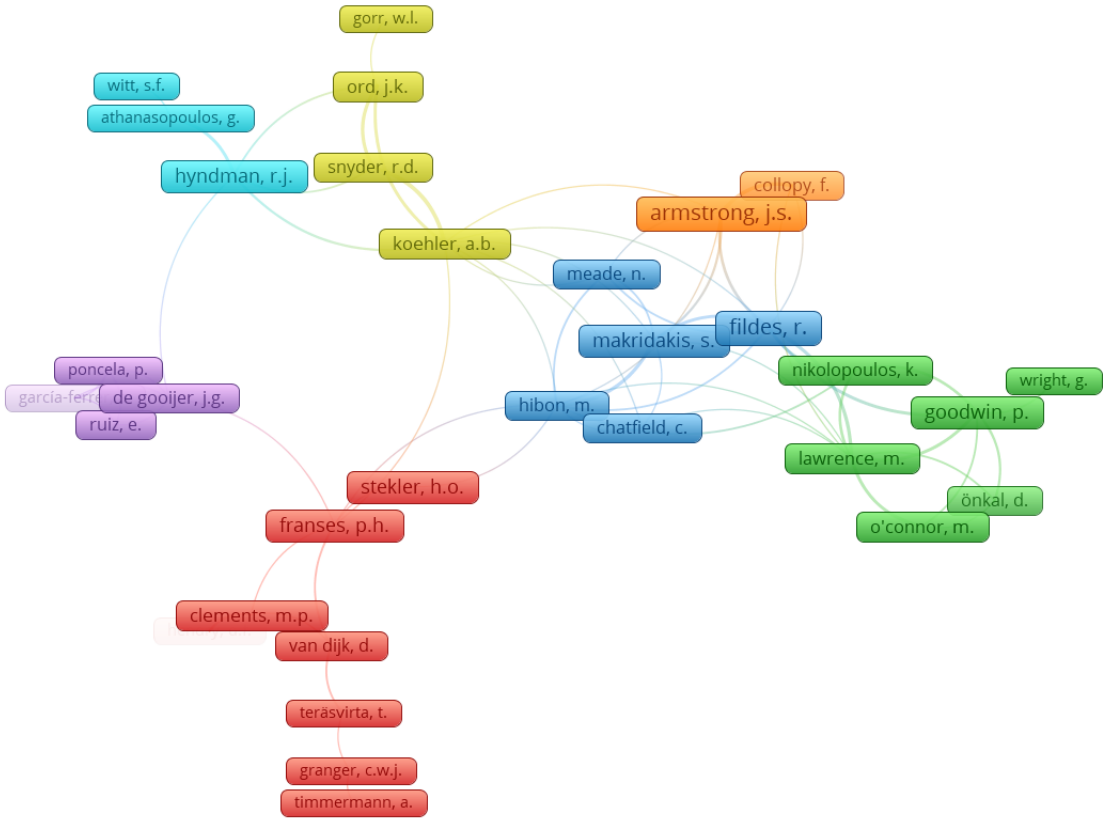


Figure 5: Co-author network of the most prolific IJF authors

2.4. Country analysis and country co-occurrence network

In this subsection, we extract some prolific countries and most attractive countries according to the number of publications and citations. Based on this analysis, we can identify what countries are the biggest providers of IJF and what countries possess the highest authority in IJF. Besides, a country co-occurrence network is provided to express the collaboration relationships among different countries.

Country is a geographical community producing the academic researches, and the large academic output of a country declares the high academic productivity of the country. Therefore, country is selected as the objective of this subsection, and analyzed based on the number of papers each country produced and the number of citations they received. Information about the top ten prolific countries are listed in table 6. USA, UK, and Australia rank the top places, and their durations range the whole issue period of IJF. USA is the dominant country whose papers occupy around 41% of the total IJF papers. Moreover, most of the prolific countries belong to Europe and North America, which indicates the developed countries in Europe and North America are still the main producers of IJF papers. Besides, a dynamic analysis is conducted based on the output of these ten countries, and the whole period (i.e., years from 1985 to 2018) is divided into three slices, as shown in Fig. 6. The left chart of the Fig. 6 depicts the percentage dynamic in the same country based on three time slices, while the right chart of the Fig. 6 provides the dynamic of each prolific country's percentage of the total IJF papers in three time slices. From the left chart, the percentage change of USA is not obvious, and the same as that of Canada. Except for USA and Canada, the percentages of the remaining countries have increased greatly over time, which indicating the forecasting researches is growing fast in these countries. From the right chart, USA is in the dominant position, as the most productive country in IJF. However, the percentage it possess is decreasing over time, which means it is losing its output advantage in IJF as the production rises in other countries. UK, Australia, and Germany are showing signs of active productivity.

The number of citations a country possesses is an important indicator to evaluate the prestige of it, and also is a sign of knowledge spreading from the country. Therefore, the top ten most cited countries are

Table 6: Information about the top ten prolific countries

Rank	Country	TP	FY	LY	Y	TP/Y	% of total
1	USA	798	1985	2018	34	23.47	41.18%
2	UK	420	1985	2018	34	12.35	21.67%
3	Australia	178	1985	2018	34	5.24	9.18%
4	Germany	110	1988	2018	31	3.55	5.68%
5	Netherlands	99	1988	2018	31	3.19	5.11%
6	Spain	93	1986	2018	33	2.82	4.80%
7	Canada	84	1985	2018	34	2.47	4.33%
8	Italy	70	1987	2018	32	2.19	3.61%
9	France	67	1986	2018	33	2.03	3.46%
10	Belgium	36	1989	2018	30	1.20	1.86%

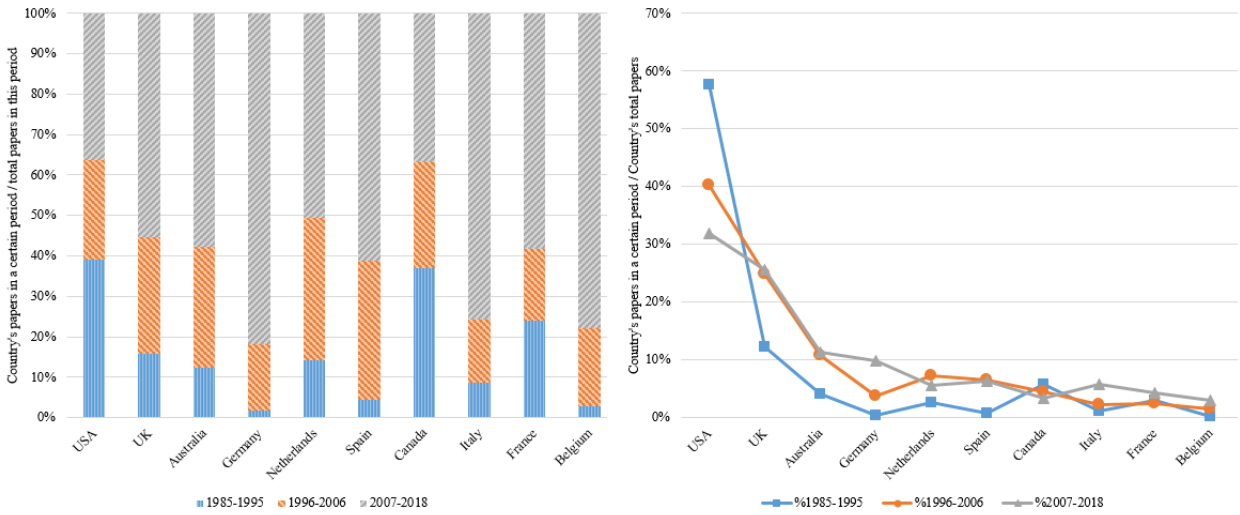


Figure 6: The dynamic of the academic productivity of the prolific countries

selected in table 7. USA is the most highly cited country, and its citations are nearly double of the UK' citations. Compared to the table 6, Belgium drops out of the list of top ten most cited countries, and Turkey replaces Belgium as the member of top most cited countries. Except for the number of citations, the number of citations per paper is provided, and it reveals the attraction of single paper. One thing is interesting that USA dominates the advantage in the total number of citations, but it is behind Australia, France, Turkey and UK in the number of citations per paper. What is more, we calculate the number of citations from the IJF (In-TC) and the number of citations outside the IJF (Out-TC). The former demonstrates how many IJF researches pay attention to the papers of the country, and the latter shows the prestige that the papers of the country possesses outside the IJF. USA is the most prolific country, but its citation percentage from the IJF is the lowest, which means its researches caught more attention from journals outside the IJF. On the contrary, Italy, France, and Germany possess a relatively high citation percentage from the IJF, which means these countries receive more endorsements from the researches in IJF compared with the remaining countries.

What is more, a country collaboration network is mapped in Fig. 7. The size of label denotes the number of papers a country produced, and the links between any connected labels indicates the collaboration relationships between connected countries. 25 countries that collaborate with others no less 15 times are extracted to construct the country collaboration network. The detailed information including Link (the collaboration times a country possesses), CM (the country that collaborate most with the target country), Number (the collaboration times that CM collaborates with the target country) and N/L (the percentage that divides Number by Link) is stated in table 8. USA ranks the first in table 8 with 217 collaboration times, followed by UK with 201 collaboration times. Moreover, USA and UK are the countries that cooperate with each other the most. Besides, 11 countries cooperate with USA the most, and 9 countries cooperate with UK the most. Australia ranks the third in table 8, but it is not the most collaborated country to any of the

Table 7: The information about the top ten most cited countries

Rank	Country	TC	TP	TC/TP	In-TC	In%	Out-TC	Out%
1	USA	22875	798	28.67	901	3.94%	21974	96.06%
2	UK	12899	420	30.71	646	5.01%	12253	94.99%
3	Australia	6540	178	36.74	352	5.38%	6188	94.62%
4	Netherlands	2635	99	26.62	150	5.69%	2485	94.31%
5	France	2417	67	36.07	226	9.35%	2191	90.65%
6	Germany	2023	110	18.39	164	8.11%	1859	91.89%
7	Spain	1876	93	20.17	128	6.82%	1748	93.18%
8	Canada	1850	84	22.02	121	6.54%	1729	93.46%
9	Italy	1122	70	16.03	122	10.87%	1000	89.13%
10	turkey	1061	33	32.15	57	5.37%	1004	94.63%

countries in table 8, while Netherlands is the most collaborated country to Belgium, Denmark, and Austria.

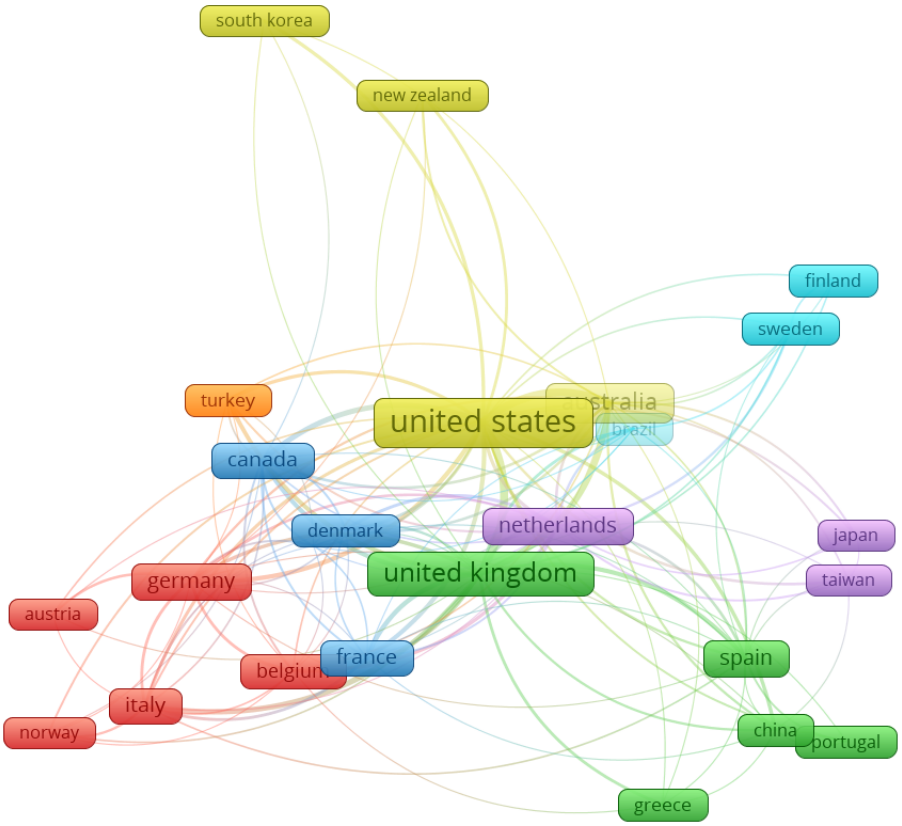


Figure 7: Country collaboration network

Table 8: Information about the countries in the country collaboration network

Rank	Country	Link	CM	Number	N/L
1	USA	217	UK	44	20.28%
2	UK	201	USA	44	21.89%
3	Australia	116	US	42	36.21%
4	Netherlands	69	USA/Belgium	8	11.59%
5	Germany	61	USA	14	22.95%
6	Italy	57	UK	21	36.84%
7	Canada	54	USA	19	35.19%
8	France	49	UK	15	30.61%
9	Spain	39	UK	13	33.33%
10	Belgium	34	Netherlands/UK	8	23.53%
11	Denmark	32	Netherlands	7	21.88%
12	Turkey	30	UK	12	40.00%
13	Switzerland	20	USA	4	20.00%
14	Brazil	19	UK	6	31.58%
15	China	19	USA	9	47.37%
16	Sweden	15	Netherlands	4	26.67%
17	Taiwan	14	USA	5	35.71%
18	Norway	12	Italy	4	33.33%
19	Greece	11	UK	6	54.55%
20	New Zealand	11	USA	6	54.55%
21	South Korea	11	USA	8	72.73%
22	Austria	10	Germany	5	50.00%
23	Japan	10	USA/Japan	3	30.00%
24	Portugal	8	Spain/USA	3	37.50%
25	Finland	7	Sweden/UK/USA	2	28.57%

3. Knowledge diffusion analysis of the forecasting journals

In academics, knowledge diffuses along with the citing behaviors of papers, and papers belong to different subject areas according to their research contents. In Scopus, subject areas are usually considered as the labels to classify the different kinds of knowledge. In this study, subject areas are used for conducting the knowledge diffusion analysis. However, categorizations on subject areas exist deviations because of the informal acquisition (Leydesdorff and Goldstone 2014), therefore, the analysis only relying on the level of subject areas is easily to be subject to a biased result. For this reason, the knowledge diffusion analysis is conducted both at the subject area level and the journal level.

As one of the leading forecasting journal, IJF was launched in 1985 following another authoritative forecasting journal, Journal of Forecasting (JF). These two leading forecasting journals are the important members in the International Institute of Forecasting (IIF). Therefore, in this study, in order to have a broader overview about the knowledge fertilization in the forecasting field, both of IJF and JF are included in the knowledge diffusion analysis.

3.1. Analysis at the level of subject area

In this subsection, papers cited IJF and JF papers are selected, respectively, as the raw data. A static analysis about the subject area distribution is provided to figure out which subject areas pay attention to the forecasting papers. Moreover, a dynamic analysis is supplemented to describe how the subject area distribution evolves over time. Forecasting papers in different periods may attract researches from different subject areas.

3.1.1. Static analysis about the subject area distribution

In Scopus, IJF papers ranging from 1985 to 2018 was retrieved, and then 29464 citing papers ranging from 1985 to 2019 were harvested. Similarly, 16419 citing papers are obtained based on JF papers from 1982 to 2018. The top ten most prolific subject areas among the citing papers are stated in table 9. We find that

IJF citing papers and JF citing papers possess the same prolific subject areas, which denotes both of the journals have very similar audiences. IJF and JF were set with an aim that become an output for the BEM forecasting researches (Fildes 2006). From the angle of knowledge diffusion, this aim has been successfully achieved because Computer Science, Economics, Econometrics and Finance, and Business, Management and Accounting have become the three dominant subject areas based on the forecasting citing papers.

Table 9: Information about the top ten most prolific subject areas

29464 citing papers of IJF				16419 citing papers of JF			
Rank	Subject area	NP1	Percent1	Rank	Subject area	NP2	Percent2
1	Computer Science	7586	25.75%	1	Economics, Econometrics and Finance	5184	31.57%
2	Economics, Econometrics and Finance	7487	25.41%	2	Business, Management and Accounting	4891	29.79%
3	Business, Management and Accounting	7449	25.28%	3	Mathematics	3946	24.03%
4	Engineering	5888	19.98%	4	Computer Science	3791	23.09%
5	Mathematics	5482	18.61%	5	Decision Sciences	2971	18.09%
6	Social Sciences	4277	14.52%	6	Engineering	2305	14.04%
7	Decision Sciences	3665	12.44%	7	Social Sciences	2179	13.27%
8	Energy	2222	7.54%	8	Environmental Science	1109	6.75%
9	Environmental Science	2070	7.03%	9	Energy	641	3.90%
10	Earth and Planetary Sciences	969	3.29%	10	Earth and Planetary Sciences	588	3.58%

3.1.2. Dynamic analysis about the subject area distribution

To better explore the dynamic of the subject area distribution, the IJF citing papers are divided into three slices based on their publishing years. In each period, the top ten prolific subject areas are provided, as shown in table 10. Computer Science and Engineering are two subject areas that keep moving up over three periods, which means the IJF papers attract increasingly researches on both of these subject areas. More and more forecasting papers pay attention to the combination with researches on these two subject areas, and these two subject areas would possibly continue to be the research hotspot in the next few years. The ranking of Psychology keeps declining over three periods from the seventh in 1985-1996 to the tenth in 1997-2008, finally falling out of the list in 2009-2019. Also there has been a marked pullback in the ranking of Decision Sciences from period 1 to period 2.

Similar work is conducted in the JF citing papers, and the top ten prolific subject areas are provided in table 11. Economics, Econometrics and Finance, Computer Science, and Engineering are three subject areas that keep moving up during three periods, while the rankings of Decision Sciences, and Psychology decline over time. It indicates that the former three subject areas are the research hotspots in the current forecasting field, and the latter two are in a declining position.

Table 10: Change of subject area distribution in IJF citing papers over time

1985-1996			1997-2008			1997-2008		
1046 IJF citing papers			5312 IJF citing papers			23105 IJF citing papers		
Subject area	NP1	Percent1	Subject area	NP2	Percent2	Subject area	NP3	Percent3
Business, Management and Accounting	586	56.02%	Business, Management and Accounting	1708	32.15%	Computer Science	6259	27.09%
Economics, Econometrics and Finance	269	25.72%	Economics, Econometrics and Finance	1485	27.96%	Economics, Econometrics and Finance	5733	24.81%
Decision Sciences	246	23.52%	Computer Science	1185	22.31%	Business, Management and Accounting	5155	22.31%
Mathematics	226	21.61%	Mathematics	1034	19.47%	Engineering	4944	21.40%
Social Sciences	157	15.01%	Engineering	878	16.53%	Mathematics	4222	18.27%
Computer Science	141	13.48%	Social Sciences	869	16.36%	Social Sciences	3251	14.07%
Engineering	65	6.21%	Decision Sciences	835	15.72%	Decision Sciences	2584	11.18%
Psychology	65	6.21%	Environmental Science	311	5.85%	energy	2068	8.95%
Environmental Science	44	4.21%	Earth and Planetary Sciences	190	3.58%	Environmental Science	1715	7.42%
Arts and Humanities	22	2.10%	Psychology	173	3.26%	Earth and Planetary Sciences	765	3.31%

Table 11: Change of subject area distribution in JF citing papers over time

1982-1994			1995-2007			2008-2019		
1272 JF citing papers			4117 JF citing papers			11209 JF citing papers		
Subject area	NP1	Percent1	Subject area	NP2	Percent2	Subject area	NP3	Percent3
Business, Management and Accounting	696	54.72%	Business, Management and Accounting	1290	31.33%	Economics, Econometrics and Finance	3756	34.06%
Decision Sciences	437	34.36%	Economics, Econometrics and Finance	1177	28.59%	Business, Management and Accounting	2905	26.34%
Mathematics	388	30.50%	Mathematics	1114	27.06%	Computer Science	2651	24.04%
Computer Science	262	20.60%	Computer Science	878	21.33%	Mathematics	2444	22.16%
Economics, Econometrics and Finance	250	19.65%	Decision Sciences	866	21.03%	Engineering	17537	159.01%
Social Sciences	198	15.57%	Social Sciences	559	13.58%	Decision Sciences	1668	15.12%
Psychology	134	10.53%	Engineering	472	11.46%	Social Sciences	1422	12.89%
Engineering	80	6.29%	Environmental Science	313	7.60%	Environmental Science	734	6.66%
Environmental Science	62	4.87%	Earth and Planetary Sciences	208	5.05%	Energy	563	5.10%
Arts and Humanities	61	4.80%	Psychology	183	4.44%	Earth and Planetary Sciences	348	3.16%

3.2. Analysis at the level of journal

Based on the subsection 3.1, the knowledge diffusion analysis at the level of subject area has been completed, but the scope of subject area is kind of wide-ranging. Therefore, the research scope is narrowed to the level of journal to conduct a further knowledge diffusion analysis. The subject areas which have a special performance in subsection 3.1 will be analyzed as the primary research objectives, and the citation relationships between different journals within the same subject area will be elaborated and visualized in citation networks. Moreover, all of the analysis is dynamic to better elaborate the evolution progress of the knowledge diffusion among the different journals. Considering the authority of IJF and JF in the forecasting field, the knowledge diffusion processes starting from IJF and JF are both delineated based on their citations relationships. The forecasting-related applications published in the journals outside the forecasting journals are investigated.

3.2.1. Knowledge diffusion within the same subject area starts from IJF

Knowledge diffusion starts from IJF has been investigated in subsection 3.1.2, and four subject areas have a special performance, which are Computer Science, Engineering, Psychology, and Decision Sciences. All of the citing papers belonging to these four subject areas are harvested, respectively, then aggregated into the level of journal, and the journal citation relationships between different journals within the same subject area are extracted and mapped in journal citation networks.

3.2.1.1. Journal citation network in Computer Science

All the citing papers belonging to Computer Science are harvested and divided into three periods. In each period, the journal citation relationships are mapped in Fig. 8-10, and the journal citation structure can be intuitively observed in Fig. 8-10. Given the different scale of journal networks, there are different limiting conditions set for three networks, and then different parameters of each network including clusters (the number of groups containing the same color nodes), local links (the number of links), and link strength (the total strength that each link possesses). The top ten journals that have the most connections with IJF are extracted. Note that the information about the limiting conditions, parameters, and top ten journals is stated in table 12.

Figure 8: IJF Journal citation network in Computer Science from 1985 to 1994

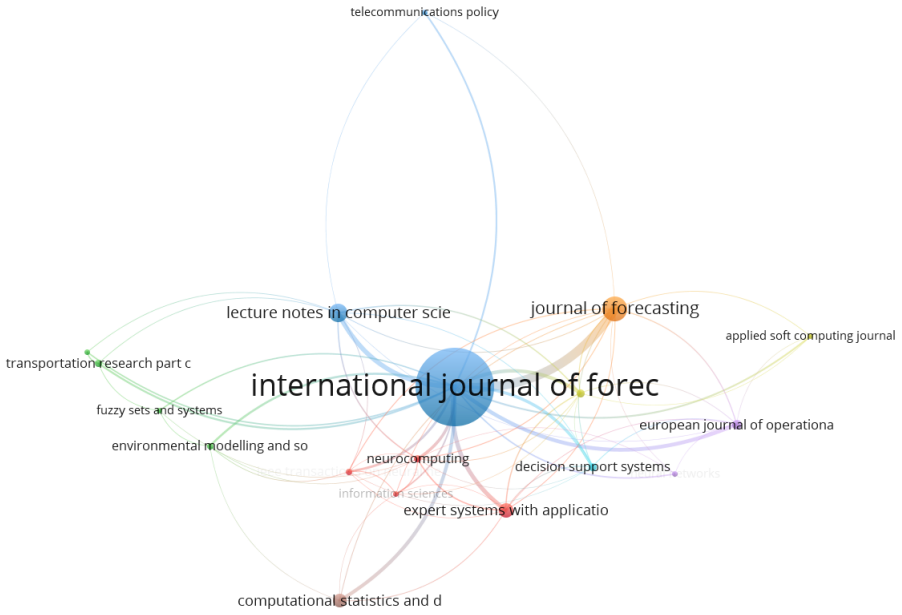


Figure 9: IJF Journal citation network in Computer Science from 1997 to 2008

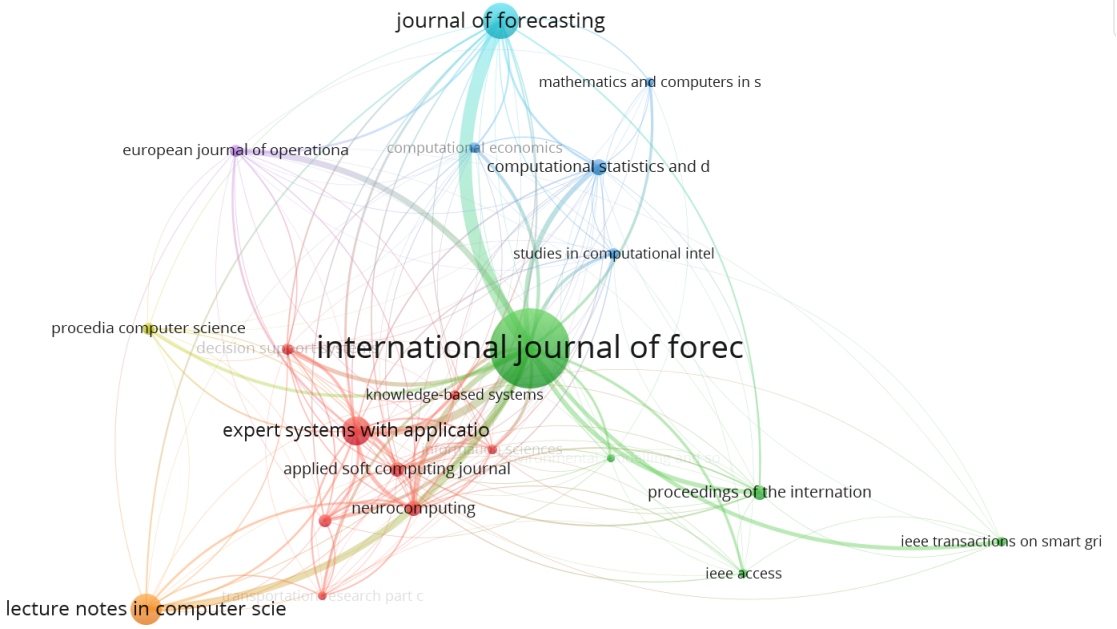


Figure 10: IJF Journal citation network in Computer Science from 2009 to 2019

Table 12: The information about the journal citation networks in Computer Science based on the IJF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	Journal of Forecasting	139	1	Journal of Forecasting	365	1	Journal of Forecasting	1448
2	Decision Support Systems	6	2	Lecture Notes in Computer Science	93	2	Expert Systems with Applications	550
3	Connection Science	5	3	Expert Systems with Applications	76	3	Lecture Notes in Computer Science	429
4	Expert Systems	3	4	European Journal of Operational Research	62	4	European Journal of Operational Research	300
5	Information Systems Research	3	5	Computers and Operations Research	54	5	Neurocomputing	249
6	The International Journal of Advanced Manufacturing Technology	3	6	Computational Statistics and Data Analysis	53	6	Computational Statistics and Data Analysis	214
7	Handbooks in Operations Research and Management Science	2	7	Decision Support Systems	39	7	Proceedings of The International Joint Conference on Neural Networks	173
8	IEEE Transactions on Image Processing	2	8	Neurocomputing	36	8	Applied Soft Computing Journal	156
9	IEEE Transactions on Neural Networks	1	9	IEEE Transactions on Neural Networks	24	9	Decision Support Systems	149
10	The Knowledge Engineering Review	1	10	Environmental Modelling and Software	20	10	IEEE Transactions on Smart Grid	134

Observing from the Fig. 8-10, IJF always occupies a central place in networks with other connected journals around it. JF is the journal that possesses the most connection with IJF, which indicates IJF is most cited by the papers of JF. The structure of the three networks has some little change from period 1 to period 3. Except for JF, Lecture Notes in Computer Science, and Expert Systems with Applications and European Journal of Operational Research are three journals that gradually possess increasingly thicker links with IJF, which means they take an increasingly important position in their journal citation networks. Information in the table 12 also proves the fact that these three journals have the most citation connection with IJF comparing with other journals, and they are the most royal audiences of IJF. Moreover, except for JF and Decision Support Systems, all of the top journals in period 1 fall out of the lists in period 2 and 3. The ranking of Decision Support Systems keeps declining over time. This phenomenon denotes that there is a big change in the audience of IJF from period 1 to period 2 and 3, and it is an interesting finding that is worthy of a deeper investigation in the future work.

3.2.1.2. Journal citation network in Engineering

The journal citation relationships based on the citing papers belonging to Engineering are depicted in the Fig. 11-13, and the detailed information is stated in table 13. From the structure of networks, IJF is a dominating center, and the links connecting IJF and other journals are increasingly thicker over time. From period 1 to 3, International Journal of Production Research (IJPR) is the only one journal that appears in three networks, but its ranking keeps declining over time, which means IJPR is a relatively royal audience of IJF but IJF is becoming more attractive to other journals than to IJPR over time. Moreover, except for IJPR, all of the journals in the list of period 1 disappear in the lists of period 2 and 3, which means there exists a big change in the top journals of Engineering from period 1 to period 2 and 3. Expert Systems with Applications, International Journal of Production Economics, and IEEE Transactions on Power Systems are journals that have a good performance both in period 2 and 3, which means they are interested in the IJF papers and become the main citing journals of IJF for a relatively long time. One thing is interesting that unlike the leading position occupies in Computer Science, JF only appears in the list of period 2 in table 13, which demonstrates JF performs less well in Engineering than in Computer Science. The citation connection between IJF and JF in Engineering is much weaker than in Computer Science. Besides, observing from Fig. 13, there is an emerging cluster containing some red nodes in the left side of the figure, which has not appeared in both Fig. 11 and 12. According to the table 13, they are some energy-related journals which are Energy, Energies, Applied Energy, and International Journal of Electrical Power and Energy Systems. It is an important signal that some energy-related journals in Engineering are becoming more and more interested in the IJF researches.

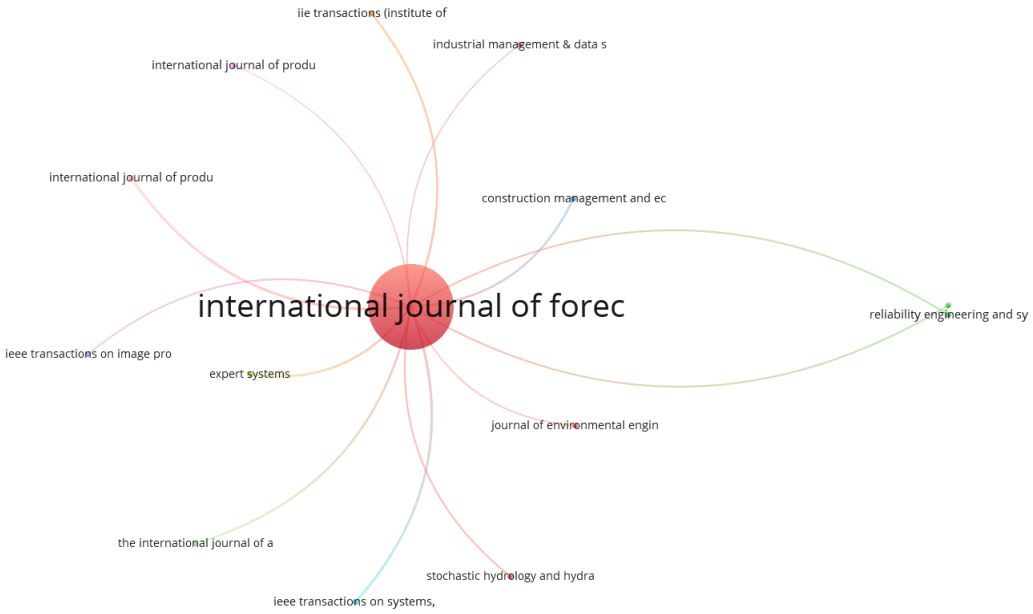


Figure 11: IJF Journal citation network in Engineering from 1985 to 1996

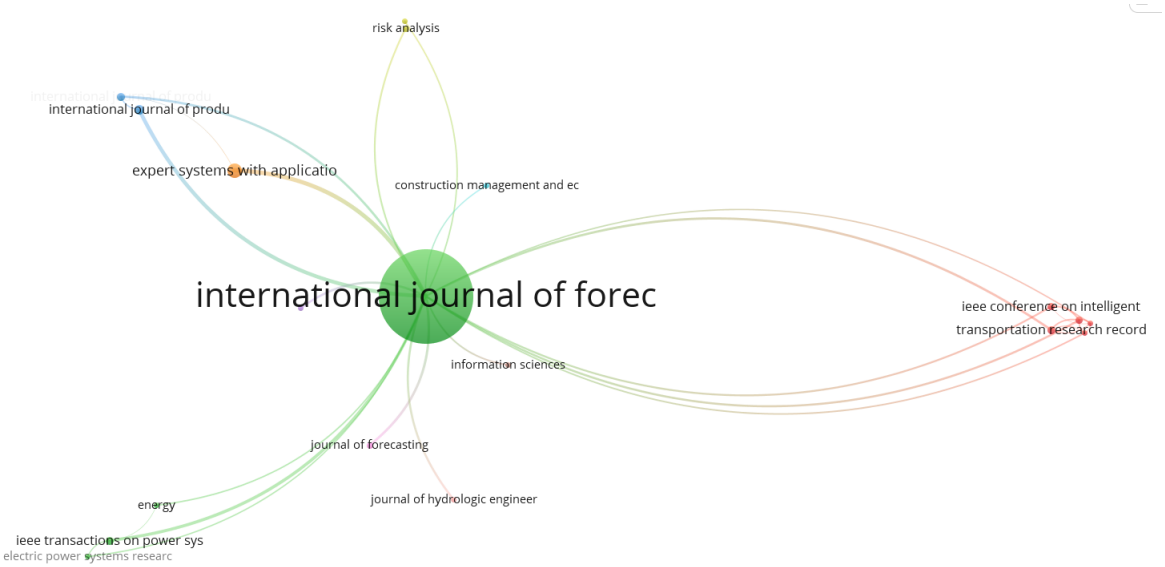


Figure 12: IJF Journal citation network in Engineering from 1997 to 2008

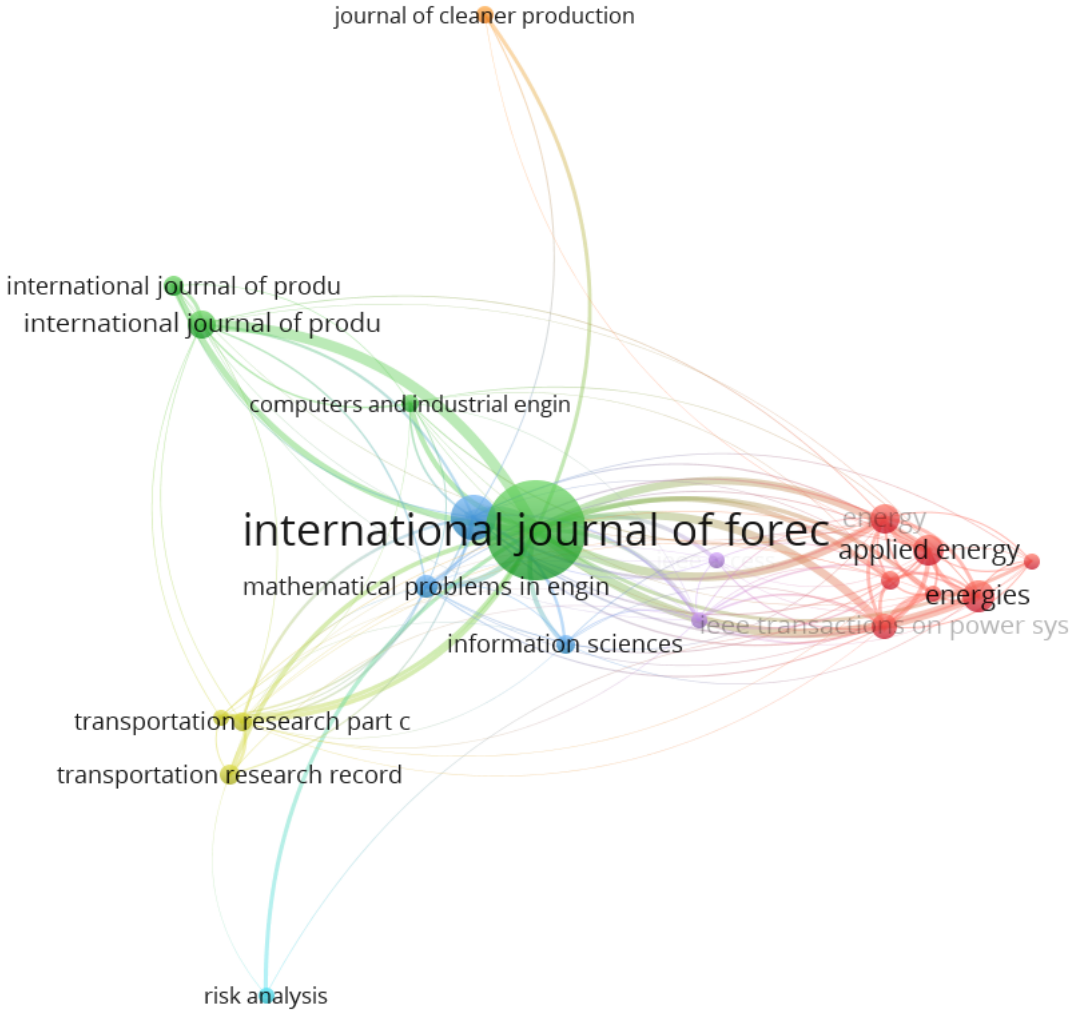


Figure 13: IJF Journal citation network in Engineering from 2009 to 2019

Table 13: The information about the journal citation networks in Engineering based on the IJF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	IEEE Transactions on Systems, Man and Cybernetics	4	1	Expert Systems with Applications	65	1	Expert Systems with Applications	520
2	International Journal of Production Research	4	2	International Journal of Production Economics	53	2	International Journal of Production Economics	326
3	Construction Management and Economics	3	3	IEEE Transactions on Power Systems	35	3	Energies	241
4	Expert Systems	3	4	Journal of Forecasting	22	4	Energy	207
5	IIE Transactions	3	5	International Journal of Production Research	20	5	IEEE Transactions on Power Systems	190
6	The International Journal of Advanced Manufacturing Technology	3	6	Transportation Research Record	20	6	Applied Energy	167
7	IEEE Transactions on Engineering Management	2	7	Computers and Industrial Engineering	18	7	International Journal of Production Research	106
8	IEEE Transactions on Image Processing	2	8	Journal of Hydrologic Engineering	17	8	Mathematical Problems in Engineering	101
9	Reliability Engineering and System Safety	2	9	Transportation Research Part C: Emerging Technologies	16	9	International Journal of Electrical Power And Energy Systems	81
10	Stochastic Hydrology and Hydraulics	2	10	IEEE Conference on Intelligent Transportation Systems	13	10	Computers and Industrial Engineering	74

3.2.1.3. Journal citation network in Decision Science

The journal citation relationships based on the IJF papers and citing papers belonging to Decision Science are depicted in the Fig. 14-16, and the detailed information is stated in table 14. IJF is an absolute center in three networks, and JF is always the most citing journal. In Decision Science, almost all of the top journals in period 1 appear in period 2 or 3, which means the compositions of three journal citation networks are much stable over time. Observing from Fig. 16, there are three main clusters connected to IJF in the last ten years, which are operational research related journals, statistics related journals, and decision making related journals. Naturally, in the range of Decision Science, these three kinds of journals are the most royal audiences to the IJF researches in recent time.

Figure 14: IJF Journal citation network in Decision Science from 1985 to 1996

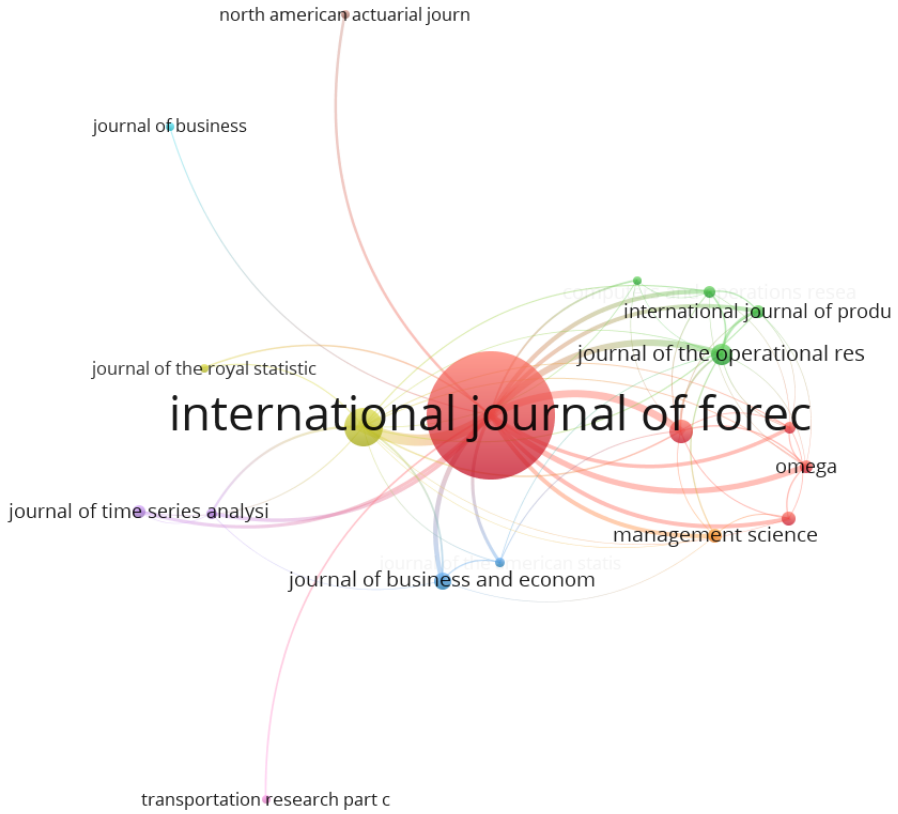


Figure 15: IJF Journal citation network in Decision Science from 1997 to 2008

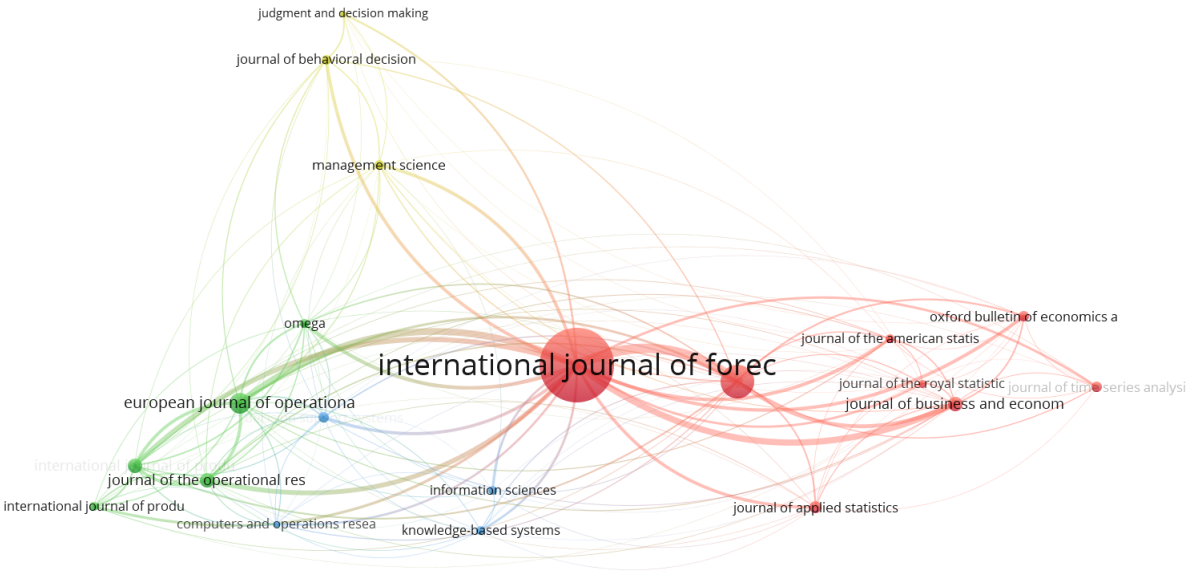


Figure 16: IJF Journal citation network in Decision Science from 2009 to 2019

Table 14: The information about the journal citation networks in Decision Science based on the IJF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	Journal of Forecasting	139	1	Journal of Forecasting	365	1	Journal of Forecasting	1448
2	Journal of Behavioral Decision Making	24	2	European Journal of Operational Research	152	2	European Journal of Operational Research	721
3	Journal of Business and Economic Statistics	23	3	Journal of the Operational Research Society	117	3	Journal of Business and Economic Statistics	625
4	Journal of The Operational Research Society	15	4	Omega	88	4	International Journal of Production Economics	394
5	Journal of the American Statistical Association	14	5	Journal of Business and Economic Statistics	64	5	Journal of the Operational Research Society	353
6	Omega	13	6	Computers and Operations Research	54	6	Omega	205
7	Journal of Applied Statistics	10	7	Management Science	49	7	Journal of the American Statistical Association	182
8	Decision Sciences	9	8	Journal of Behavioral Decision Making	48	8	Oxford Bulletin of Economics And Statistics	179
9	European Journal of Operational Research	8	9	International Journal of Production Economics	47	9	Journal of Behavioral Decision Making	162
10	Decision Support Systems	6	10	Decision Support Systems	39	10	Management Science	159

3.2.1.4. Journal citation network in Psychology

Citing papers belonging to Psychology are much less than those belonging to other three subject areas, but the compositions of top four journals in Psychology over time are the most stable comparing with other three subject areas. Organizational Behavior and Human Decision Processes, Journal of Behavioral Decision Making, Decision Support Systems, and Technological Forecasting and Social Change are top four journals in period 1, 2 and 3, which means in Psychology they are most interested in IJF researches than other journals. However, except for the top four journals, the remaining journals changed a lot over time, which demonstrates in Psychology, IJF attracts different non-primary journals in different periods.

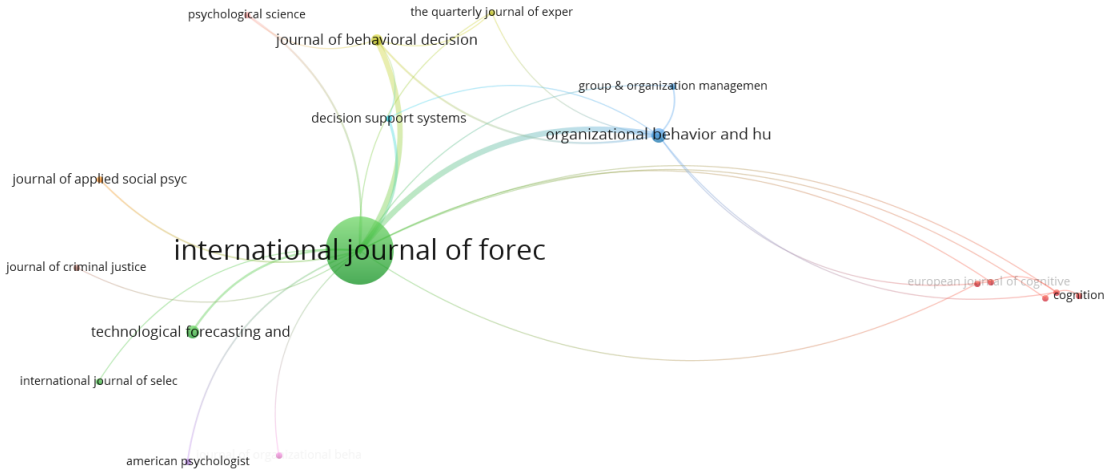


Figure 17: IJF Journal citation network in Psychology from 1985 to 1996

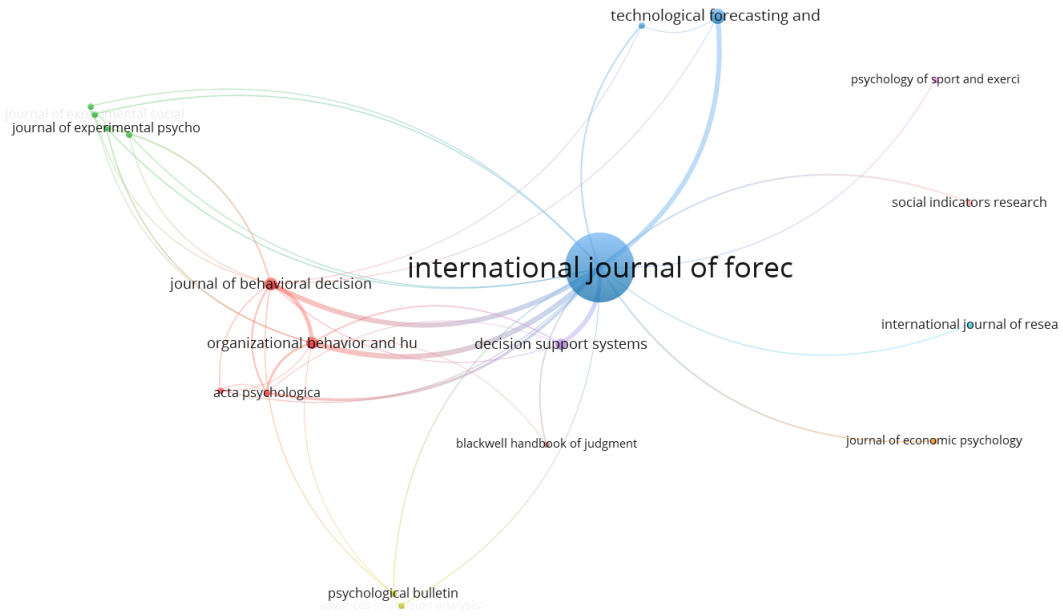


Figure 18: IJF Journal citation network in Psychology from 1997 to 2008

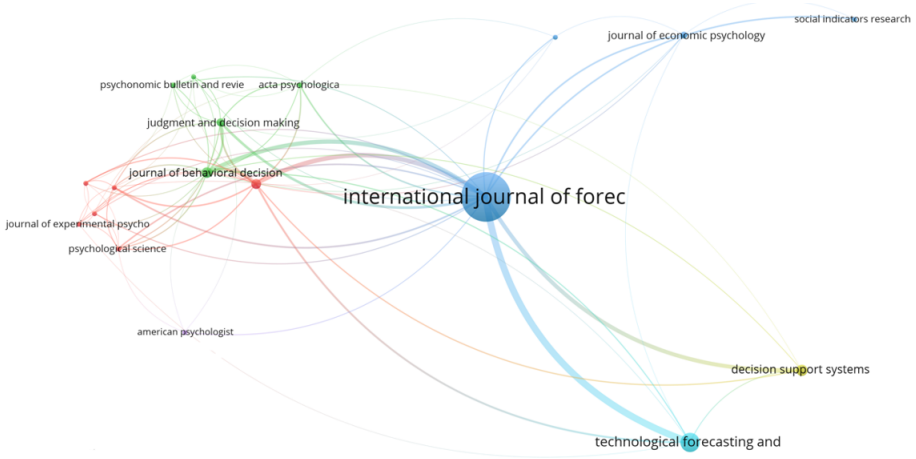


Figure 19: IJF Journal citation network in Psychology from 2009 to 2019

Table 15: The information about the journal citation networks in Psychology based on the IJF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	Organizational Behavior and Human Decision Processes	27	1	Organizational Behavior and Human Decision Processes	54	1	Technological Forecasting and Social Change	425
2	Journal of Behavioral Decision Making	24	2	Journal of Behavioral Decision Making	48	2	Organizational Behavior and Human Decision Processes	192
3	Decision Support Systems	6	3	Technological Forecasting and Social Change	45	3	Journal of Behavioral Decision Making	162
4	Technological Forecasting and Social Change	4	4	Decision Support Systems	39	4	Decision Support Systems	149
5	Psychological Science	3	5	Acta Psychologica	14	5	Judgment and Decision Making	61
6	American Psychologist	2	6	Applied Cognitive Psychology	5	6	Journal of Economic Psychology	27
7	Journal of Applied Social Psychology	2	7	Journal of Economic Psychology	5	7	Journal of Experimental Psychology: Learning Memory and Cognition	27
8	European Journal of Cognitive Psychology	1	8	Social Indicators Research	5	8	Social Indicators Research	25
9	Group & Organization Management	1	9	Blackwell Handbook of Judgment and Decision Making	3	9	Acta Psychologica	22
10	International Journal of Selection and Assessment	1	10	Journal of Experimental Psychology: Applied	3	10	Psychological Science	22

3.2.2. Knowledge diffusion within the same subject area starts from JF

Knowledge diffusion starting from JF is investigated, and five subject areas have a special performance, which are Computer Science, Economics, Econometrics and Finance, Engineering, Psychology, and Decision Sciences. All of the citing papers belonging to these five subject areas are harvested, respectively, then are aggregate them into the level of journal, and the journal citation relationships between different journals within the same subject area are extracted and mapped in journal citation networks.

3.2.2.1. Journal citation network in Computer Science

JF papers and their citing papers belonging to Computer Science are selected and their journal citation networks are extracted in Fig. 20-22. The citation connection between IJF and JF is very strong in the journal citation networks of IJF, however, in the journal citation networks of JF, their citation connection becomes much weaker, which denotes that the knowledge diffusing strength starting from JF to IJF is weaker than from IJF to JF. Besides, from the angle of time evolution, the most citing journals in the period 1 disappear in the period 2 and 3, and it means there is a change in the knowledge diffusion direction in JF. The journals which are most attracted by JF in the period 1 are no longer most attracted in the period 2 and 3. Observing from the period 2 and 3, Computational Statistics and Data Analysis, Lecture Notes in Computer Science, European Journal of Operational Research, Computational Economics, and Neurocomputing are both most citing journals, which means the knowledge diffusion from JF to these five journals is strong and stable. Expert Systems with Applications first emerged and became the top one most citing journal in the period 3. The number of citation links between JF and Expert Systems with Applications is 154 which far surpasses the number of citation links between JF and second most citing journals.

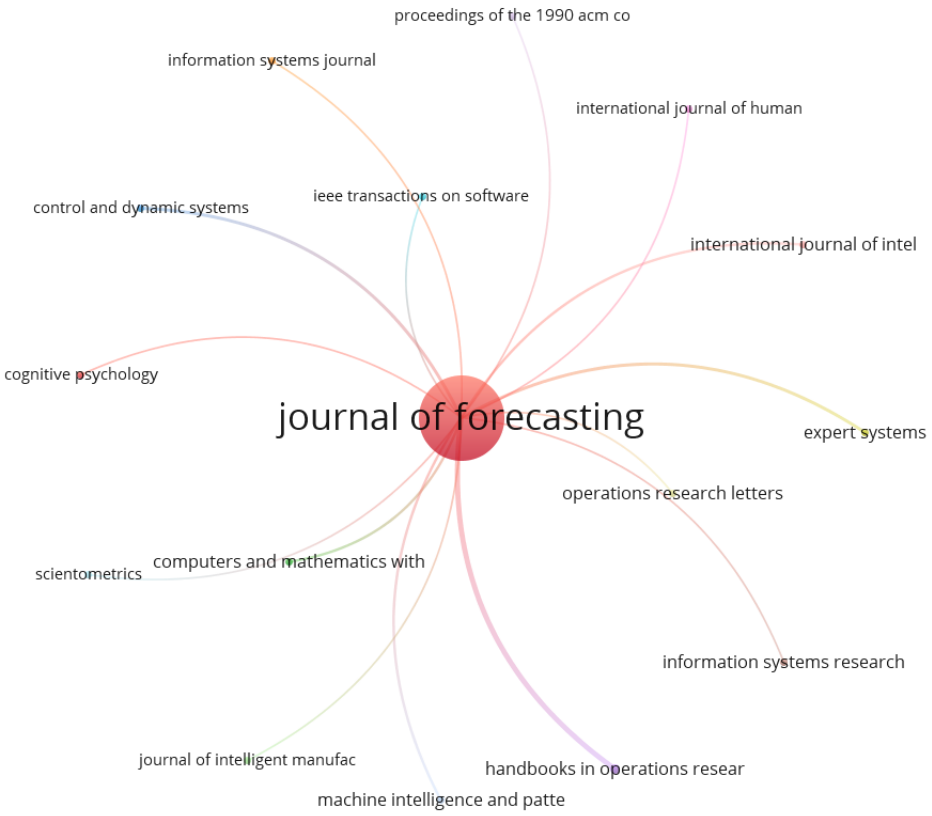


Figure 20: JF Journal citation network in Computer Science from 1982 to 1994

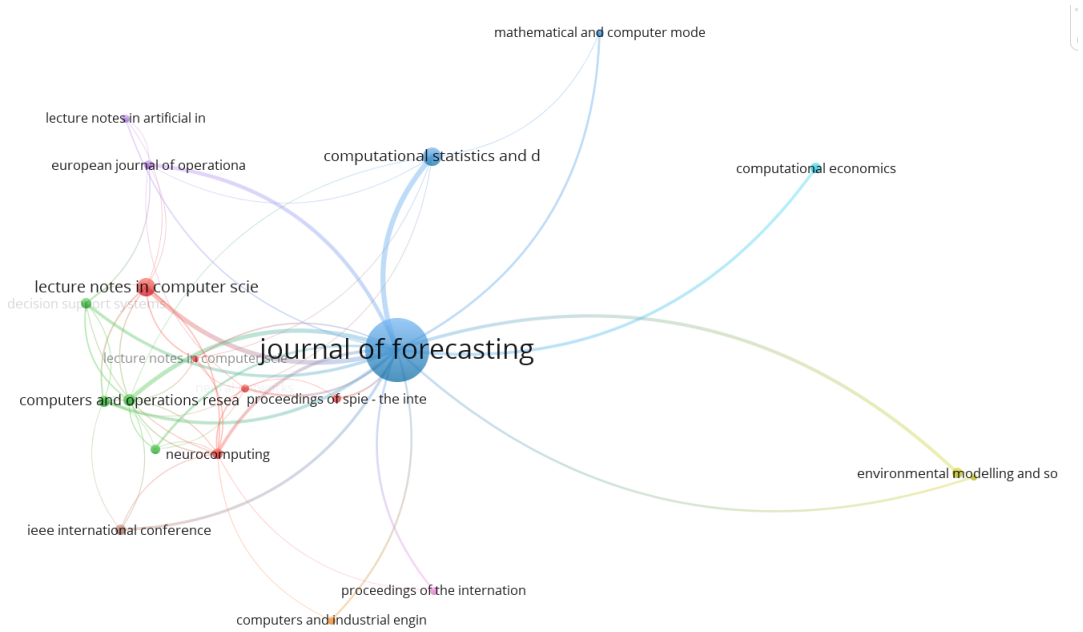


Figure 21: JF Journal citation network in Computer Science from 1995 to 2009

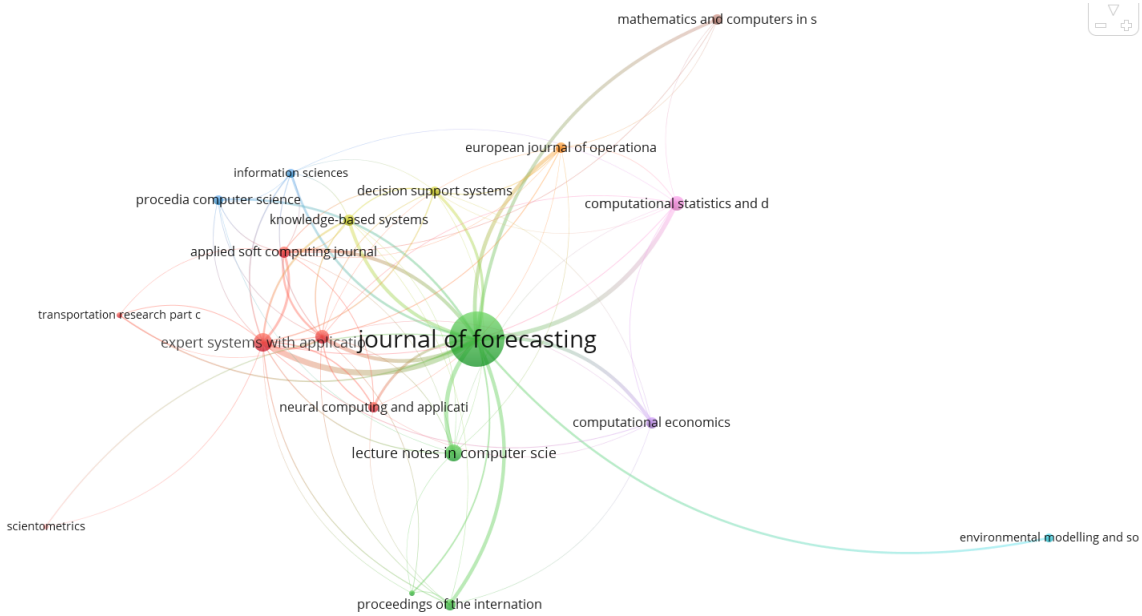


Figure 22: JF Journal citation network in Computer Science from 2008 to 2019

Table 16: The information about the journal citation networks in Computer Science based on the JF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	Handbooks in Operations Research and Management Science	8	1	Computational Statistics and Data Analysis	60	1	Expert Systems with Applications	154
2	Control and Dynamic Systems	3	2	Lecture Notes in Computer Science	49	2	Computational Statistics and Data Analysis	85
3	Expert Systems	3	3	Computers and Operations Research	41	3	Lecture Notes in Computer Science	80
4	Computers and Mathematics with Applications	2	4	European Journal of Operational Research	31	4	Neurocomputing	66
5	International Journal of Intelligent Systems	2	5	Environmental Modelling and Software	24	5	European Journal of Operational Research	63
6	Machine Intelligence and Pattern Recognition	2	6	IEEE Transactions on Neural Networks	23	6	Proceedings of The International Joint Conference on Neural Networks	56
7	Cognitive Psychology	1	7	Neurocomputing	22	7	Computational Economics	55
8	IEEE Transactions on Software Engineering	1	8	Decision Support Systems	20	8	Applied Soft Computing Journal	53
9	Information Systems Journal	1	9	Computational Economics	19	9	Knowledge-Based Systems	50
10	Information Systems Research	1	10	IEEE International Conference on Neural Networks	17	10	Mathematics and Computers in Simulation	47

3.2.2.2. Journal citation network in Economics, Econometrics and Finance

The citation networks based on the IJF papers and their citing papers belonging to Economics, Econometrics and Finance are depicted in Fig. 23-25. The citation network structure of this subject area is kind of stable because four citing journals appear in the list of top ten most citing journals in three periods, which are Journal of Business and Economic Statistics, Applied Economics, Journal of Econometrics, and Journal of Applied Econometrics. Moreover, except for the four journals mentioned above, another three journals also appears in both period 2 and 3, which are Oxford Bulletin of Economics and Statistics, Economic Modelling, and International Journal of Production Economics. There are seven of the ten journals both appear in period 2 and 3, and it means the most royal audiences of this subject area are very stable during the past 25 years. Besides, the network structures of Fig. 24 and Fig. 25 are very similar where the most journals are located in the left side of the figures and leaving one or two journals in the right side. International Journal of Production Economics is a journal that locates in the right side of the Fig. 24 and 25, which indicates it is a prolific citing journal of JF but its content similarity with JF is much weaker than that of journals in the left side.

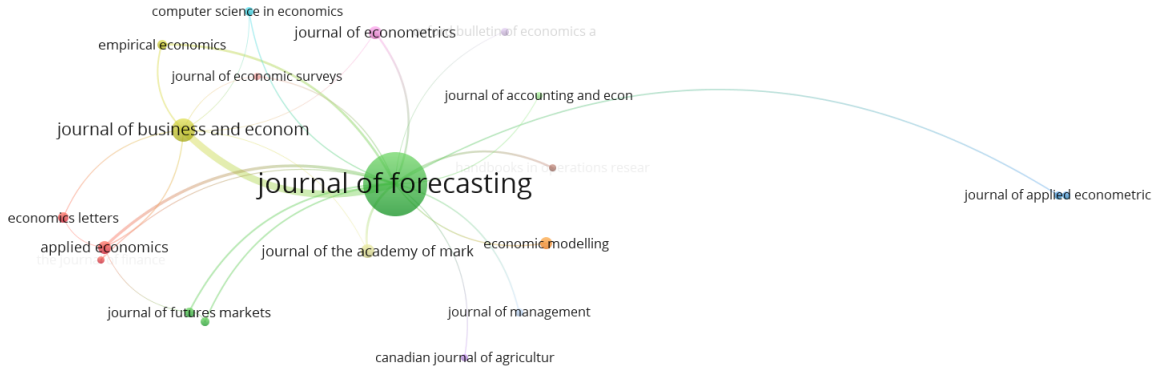


Figure 23: JF Journal citation network in Economics, Econometrics and Finance from 1982 to 1994

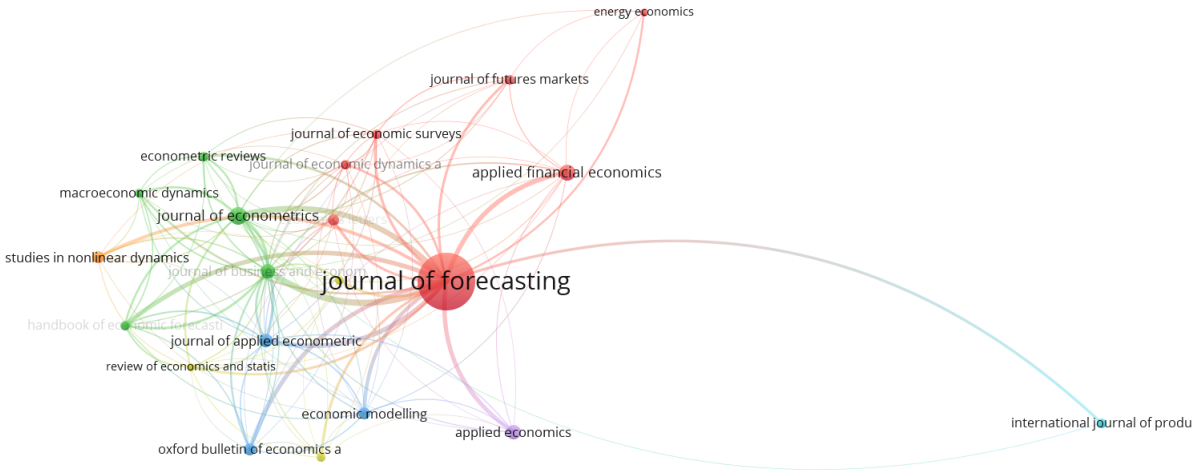


Figure 24: JF Journal citation network in Economics, Econometrics and Finance from 1995 to 2007

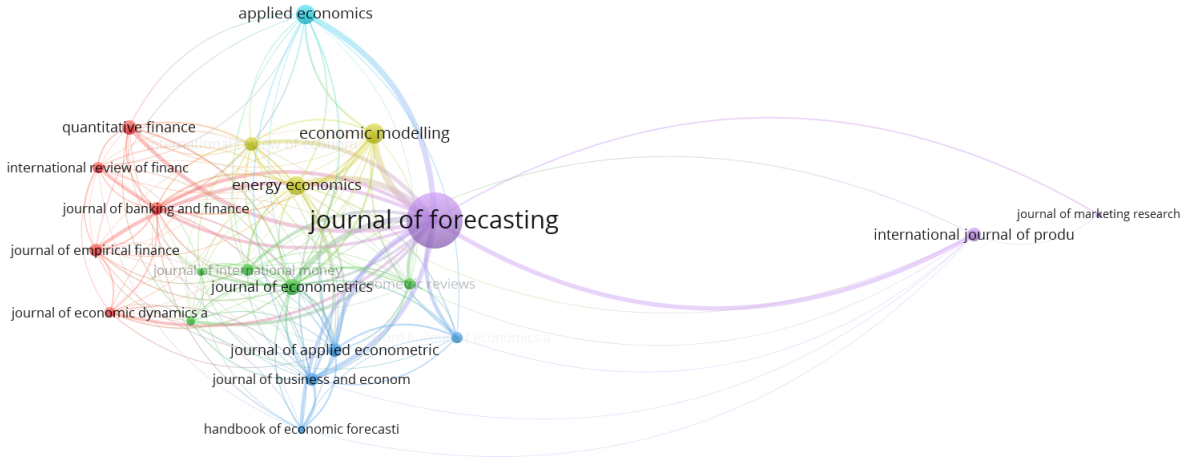


Figure 25: JF Journal citation network in Economics, Econometrics and Finance from 2008 to 2019

Table 17: The information about the journal citation networks in Economics, Econometrics and Finance based on the JF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	Journal of Business and Economic Statistics	98	1	Journal of Business and Economic Statistics	124	1	Economic Modelling	199
2	Applied Economics	16	2	Journal of Econometrics	90	2	Energy Economics	165
3	Empirical Economics	10	3	Journal of Applied Econometrics	70	3	Journal of Econometrics	154
4	Journal of the Academy of Marketing Science	10	4	Applied Financial Economics	66	4	Applied Economics	149
5	Handbooks in Operations Research and Management Science	8	5	Handbook of Economic Forecasting	63	5	Journal of Business and Economic Statistics	104
6	Journal of Econometrics	8	6	Applied Economics	57	6	Journal of Applied Econometrics	101
7	Journal of Futures Markets	6	7	Oxford Bulletin of Economics and Statistics	56	7	International Journal of Production Economics	90
8	American Journal of Agricultural Economics	5	8	Economic Modelling	41	8	International Review of Economics and Finance	75
9	Journal of Applied Econometrics	4	9	Studies in Nonlinear Dynamics And Econometrics	33	9	Quantitative Finance	72
10	Journal of Management	4	10	International Journal of Production Economics	24	10	Oxford Bulletin of Economics and Statistics	62

3.2.2.3. Journal citation network in Engineering

As shown in Fig. 26-28, the journal citation relationships between JF papers and their citing papers in Engineering are described based on the citation networks. In Engineering, the total link strength in period 3 is 632, which is much weaker than the above two subject areas. Therefore, the journal citation strength between JF and other related journals is weak in Engineering. In table 18, one citing journal appears in the period 1 and 2, and another citing journal appears in the period 1 and 3. Further, three citing journals in the period 2 also appears in the period 3. This journal overlapping phenomenon indicates that in Engineering, the citing journals keep a limited continuity in knowledge diffusion starting from JF. Expert Systems with Applications first appears and becomes the top one citing journal in the period 3, moreover, the number of citation links it possesses is much more than that of International Journal of Production Economics (i.e., the second most citing journals in the period 3). In addition, similar to the situation of the knowledge diffusion from IJF in Engineering, there is a new cluster containing some energy-related journals emerging in the period 3, as shown in the right side of the Fig. 28. Therefore, it proves that JF attracts some energy-related journals in the past ten years, which is the same as IJF.

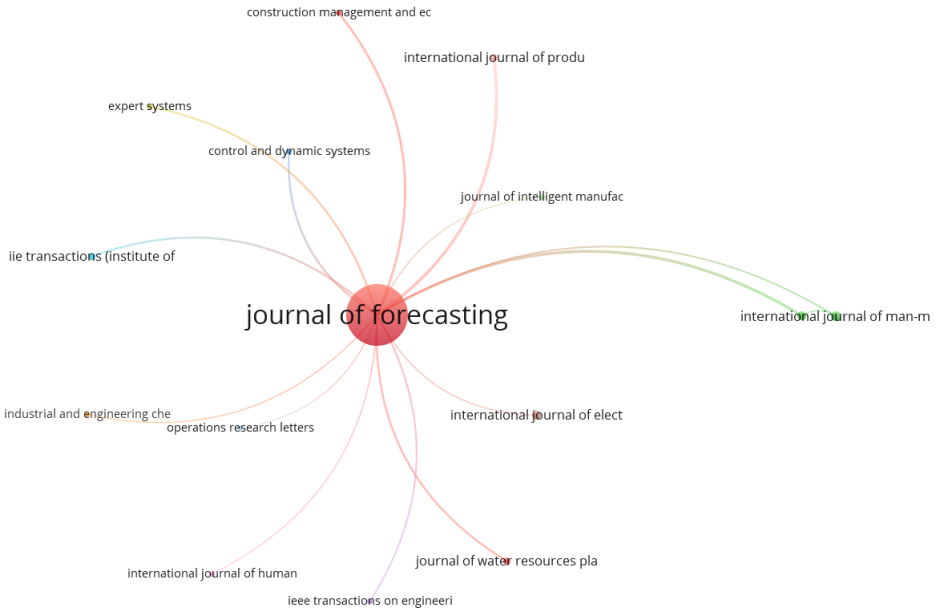


Figure 26: JF Journal citation network in Engineering from 1982 to 1994

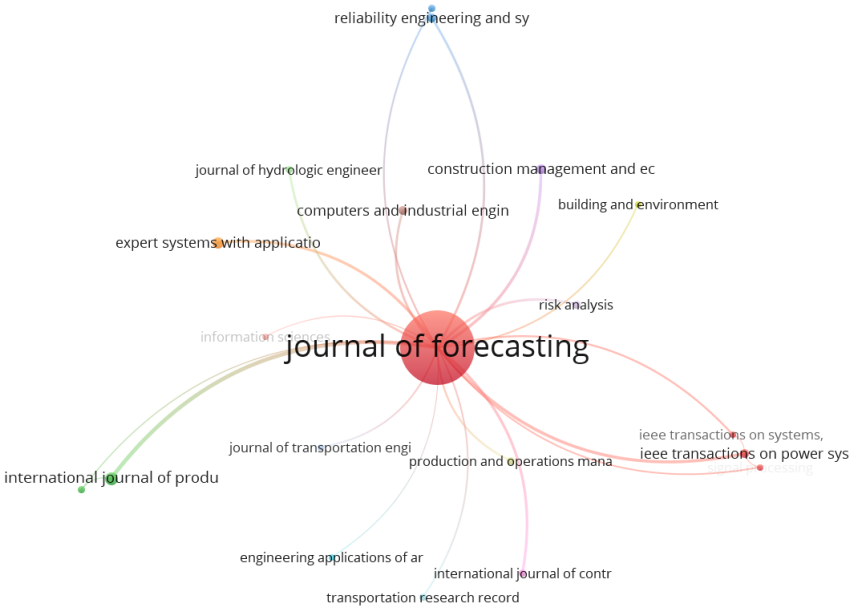


Figure 27: JF Journal citation network in Engineering from 1995 to 2007

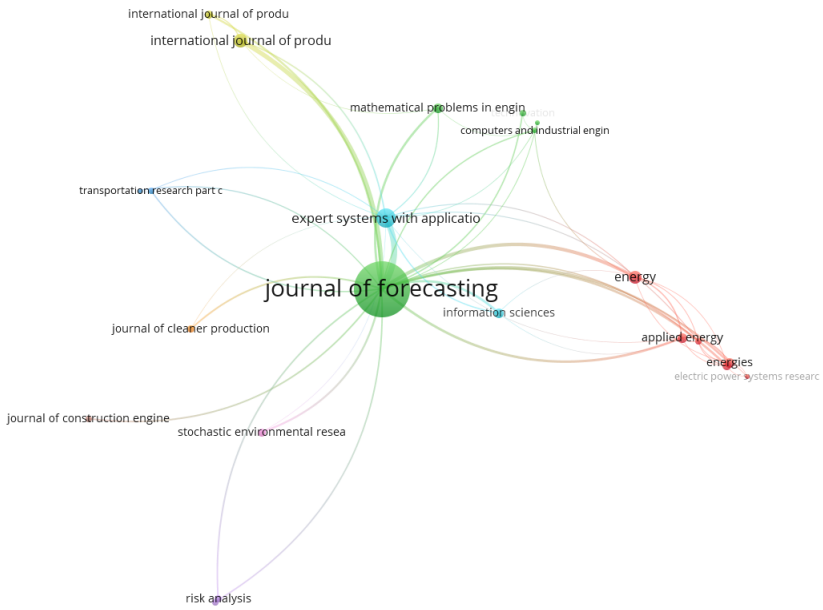


Figure 28: JF Journal citation network in Engineering from 2008 to 2019

Table 18: The information about the journal citation networks in Engineering based on the JF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	IEEE Transactions on Systems, Man and Cybernetics	6	1	International Journal of Production Economics	24	1	Expert Systems with Applications	154
2	International Journal of Production Research	6	2	IEEE Transactions on Power Systems	14	2	International Journal of Production Economics	90
3	Construction Management and Economics	4	3	Construction Management and Economics	13	3	Energy	54
4	Control and Dynamic Systems	3	4	Expert Systems with Applications	11	4	Applied Energy	27
5	Expert Systems	3	5	International Journal of Control	11	5	Information Sciences	24
6	IIE Transactions	3	6	Risk Analysis	10	6	IEEE Transactions on Power Systems	23
7	Journal of Water Resources Planning and Management	3	7	Computers and Industrial Engineering	8	7	Mathematical Problems in Engineering	23
8	IEEE Transactions on Engineering Management	2	8	Journal of Hydrologic Engineering	8	8	Energies	20
9	International Journal of Man-Machine Studies	2	9	Reliability Engineering and System Safety	8	9	International Journal of Production Research	19
10	Industrial and Engineering Chemistry Research	1	10	IEEE Transactions on Systems, Man and Cybernetics Part C: Applications and Reviews	6	10	Stochastic Environmental Research and Risk Assessment	17

3.2.2.4. Journal citation network in Decision Science

The citing papers belonging to Decision Science are selected to construct the journal citation networks with the JF papers, as shown in Fig. 29-31. Journal of Business and Economic Statistics is the most royal citing journal which ranks first in the period 1-2 and second in the period 3. The top three citing journals in the period 1 still appear in the period 2 and 3. Two citing journals in the period 1 are in the list of period 2 (Journal of Applied Statistics, Journal of Time Series Analysis), and another two citing journals in the period 2 appear in the period 3 (European Journal of Operational Research, Oxford Bulletin of Economics and Statistics). Therefore, the citing journals in Decision Science keep a continuity in knowledge diffusion starting from JF.

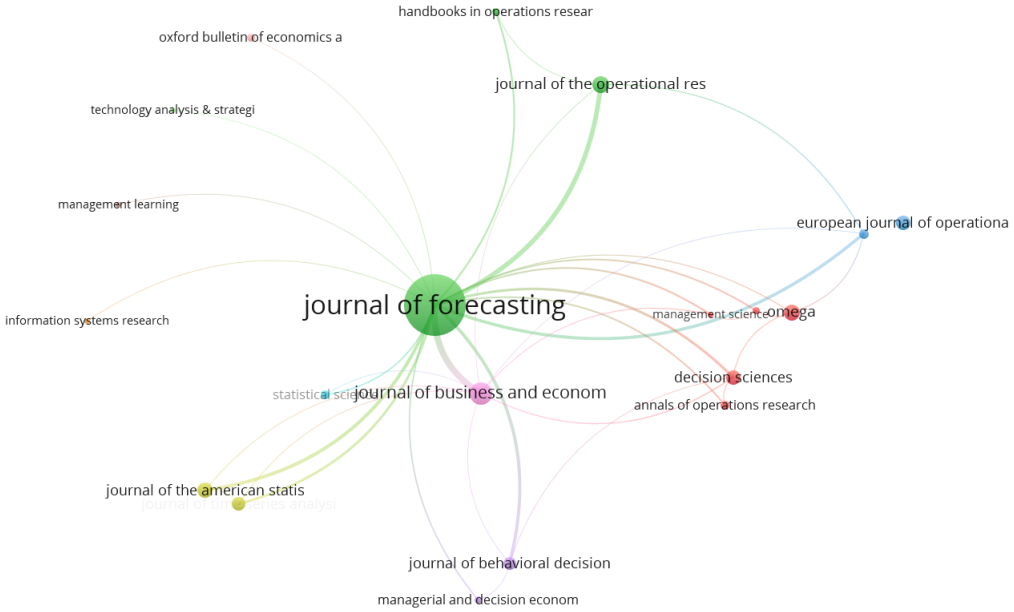


Figure 29: JF Journal citation network in Decision Science from 1982 to 1994

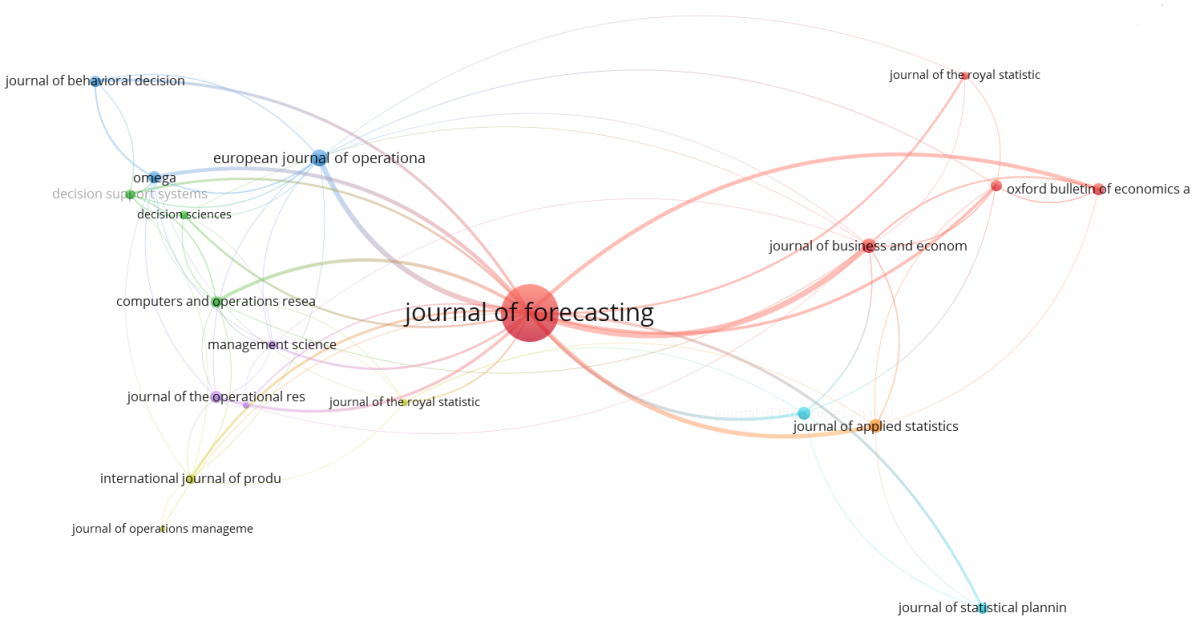


Figure 30: JF Journal citation network in Decision Science from 1995 to 2007

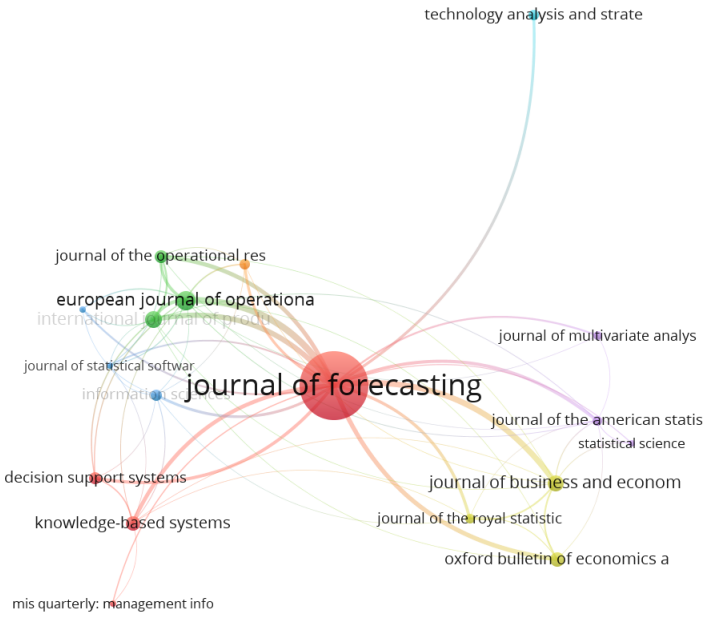


Figure 31: JF Journal citation network in Decision Science from 2008 to 2019

Table 19: The information about the journal citation networks in Decision Science based on the JF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	Journal of Business and Economic Statistics	98	1	Journal of Business and Economic Statistics	124	1	European Journal of Operational Research	139
2	Journal of The Operational Research Society	53	2	European Journal of Operational Research	96	2	Journal of Business and Economic Statistics	109
3	Journal of the American Statistical Association	27	3	Journal of Applied Statistics	74	3	International Journal of Production Economics	89
4	Journal of Applied Statistics	24	4	Oxford Bulletin of Economics and Statistics	56	4	Oxford Bulletin of Economics and Statistics	64
5	Journal of Behavioral Decision Making	24	5	Omega	53	5	Journal of The Operational Research Society	55
6	Decision Sciences	16	6	Computers and Operations Research	41	6	Knowledge-Based Systems	50
7	Journal of Time Series Analysis	15	7	Journal of Time Series Analysis	35	7	Decision Support Systems	33
8	Handbooks in Operations Research and Management Science	8	8	Journal of the American Statistical Association	33	8	Journal of the American Statistical Association	33
9	Management Science	7	9	Journal of Behavioral Decision Making	31	9	Journal of the Royal Statistical Society. Series A: Statistics In Society	30
10	Annals of Operations Research	6	10	Journal of the Operational Research Society	30	10	Technology Analysis and Strategic Management	25

3.2.2.5. Journal citation network in Psychology

The journal citation relationships between JF papers and their citing papers belonging to Psychology are depicted in Fig. 32-34. The total link strength of journal citation network in the period 3 is 218, which is the weakest in all of the networks in the period 3 across the five selected subject areas. It denotes that the density of the citation network in Psychology is the lowest, and the citing journals are not very closely related. From table 20, we find only two citing journals (Journal of Behavioral Decision Making, Organizational Behavior and Human Decision Processes) in the period 1 keep showing in the period 2 and 3. However, another four citing journals (Technological Forecasting and Social Change, Decision Support Systems, Acta Psychologica, Journal of Experimental Psychology: Learning Memory and Cognition) in the period 2 are in the list of the period 3, which indicates the knowledge diffusion starting from JF keeps a continuity ranging from period 2 to period 3. However, observing from the Fig. 34, a new cluster is emerging including some cognitive-related journal and decision making-related journal. These new emerging citing journals are in the citation relationship with JF, but the distance between them and JF is longer than others, which demonstrates the content similarity between them and JF is much lower than other citing journals. The emergence of these journals denotes the JF researches in the past ten years have attracted increasing cognitive-related journals and decision making-related journals, and maybe it is a hot research direction in the forecasting application in Psychology.

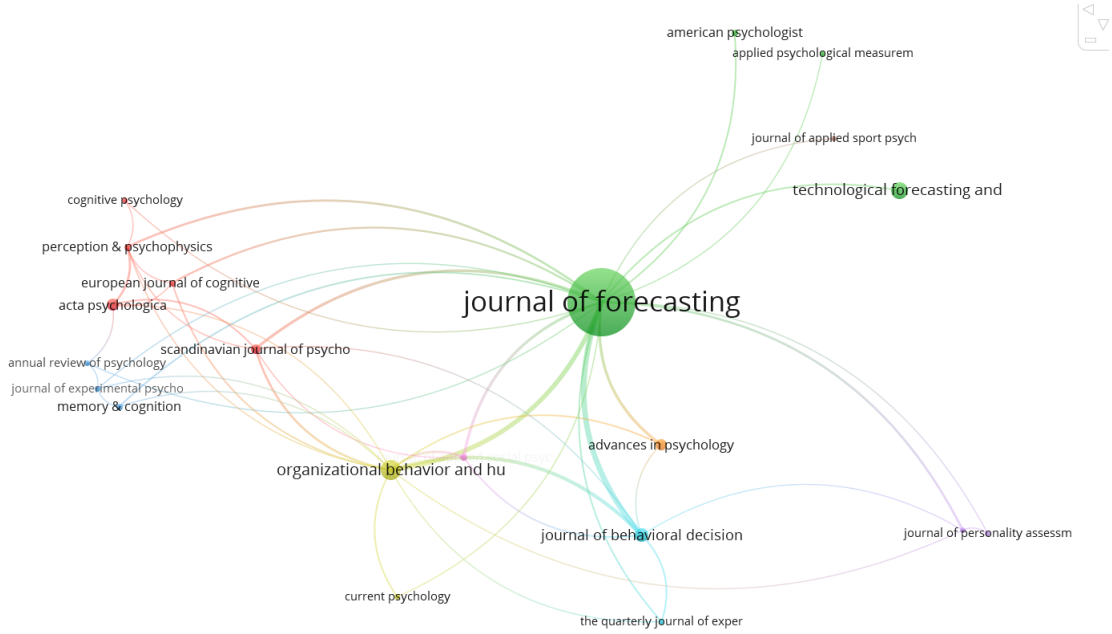


Figure 32: JF Journal citation network in Psychology from 1982 to 1994

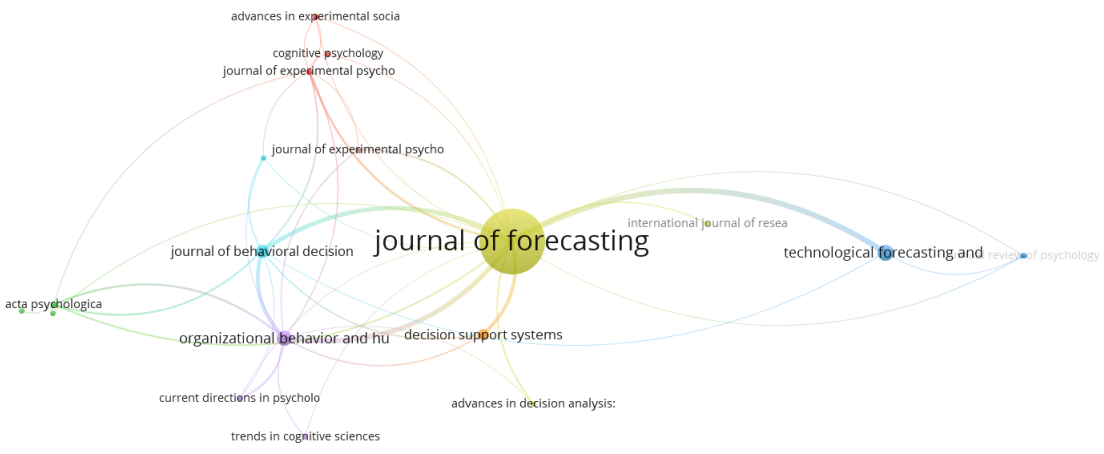


Figure 33: JF Journal citation network in Psychology from 1995 to 2007

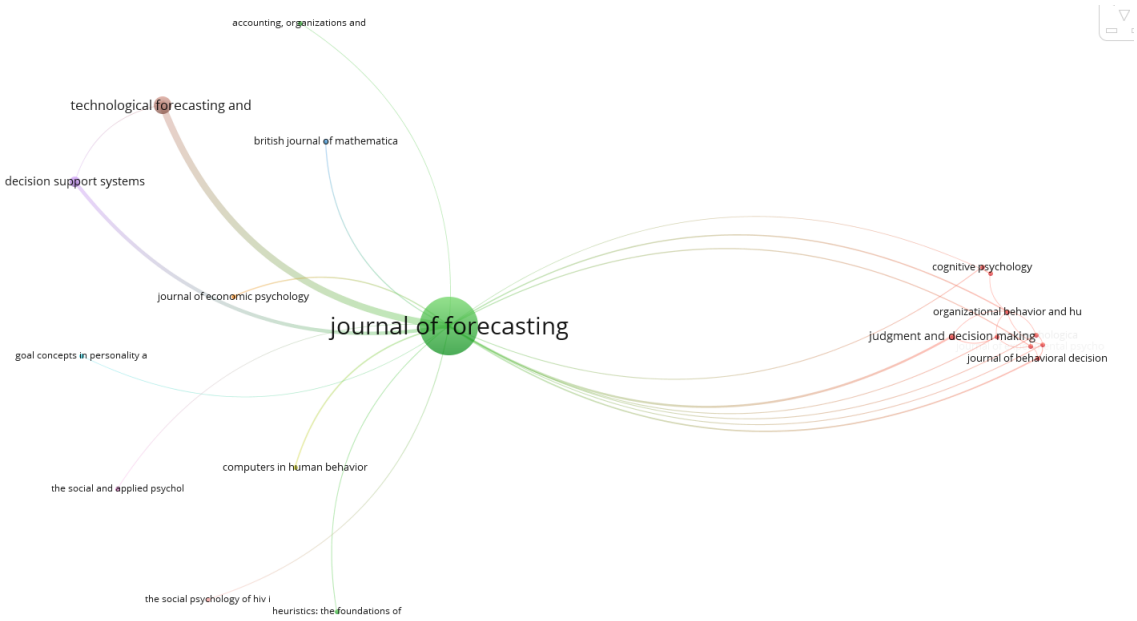


Figure 34: JF Journal citation network in Psychology from 2008 to 2019

Table 20: The information about the journal citation networks in Psychology based on the JF citing papers

1985-1996			1997-2008			2009-2019		
Limiting condition								
Number>=1 Citation>=10			Number>=5 Citation>=200			Number>=40 Citation>=200		
Parameters								
Clusters	Local links	Link strength	Clusters	Local links	Link strength	Clusters	Local links	Link strength
9	18	173	8	66	1025	7	168	6146
R	Journal	Links	R	Journal	Links	R	Journal	Links
1	Journal of Behavioral Decision Making	24	1	Technological Forecasting and Social Change	49	1	Technological Forecasting and Social Change	118
2	Organizational Behavior and Human Decision Processes	17	2	Organizational Behavior and Human Decision Processes	37	2	Decision Support Systems	33
3	Advances in Psychology	6	3	Journal of Behavioral Decision Making	31	3	Judgment and Decision Making	11
4	Journal of Applied Social Psychology	6	4	Decision Support Systems	20	4	Computers in Human Behavior	5
5	Scandinavian Journal of Psychology	6	5	Journal of Experimental Psychology: Applied	9	5	Journal of Behavioral Decision Making	5
6	Perception & Psychophysics	4	6	Acta Psychologica	4	6	Journal of Economic Psychology	4
7	Psychological Bulletin	4	7	Advances in Decision Analysis: From Foundations to Applications	4	7	Organizational Behavior and Human Decision Processes	4
8	European Journal of Cognitive Psychology	3	8	Journal of Experimental Psychology: Learning Memory and Cognition	4	8	British Journal of Mathematical and Statistical Psychology	3
9	American Psychologist	2	9	international Journal of Research in Marketing	2	9	Journal of Experimental Psychology: Learning Memory and Cognition	3
10	Memory & Cognition	2	10	Advances in Experimental Social Psychology	1	10	Acta Psychologica	2

3.2.3. Knowledge diffusion of IJF outside the forecasting field

Knowledge diffusion of the forecasting field has been investigated via constructing journal citation networks of IJF papers, JF papers, and their citing papers. Predefined subject areas are used to categorize papers. Four subject areas in IJF and five subject areas in JF, which have a remarkable performance in knowledge diffusion has been further investigated through analyzing journal citation relationships. Based on the results in subsection 3.2.2, some contributing journals can be obtained, but important papers that have a significant impact on these journals are still undetermined. Therefore, in this subsection, the top ten IJF citing journals and JF citing journals in each subject area are crossed to derive the citing journals both appear in the list of IJF and JF. Then the citing journals of the crossing result are considered to be the most contributing citing journals of forecasting field in each subject area. Note that only citing journals in the period 3 are considered because we focus on the emerging contributing citing journals in the past ten years. Finally, we derive six contributing journals in Computer Science, eight contributing journals in Engineering, six contributing journals in Decision Science, and eight in Psychology. According to the data in different subject areas, different limiting conditions are set. In Computer Science and Engineering, IJF papers that are cited by at least six contributing journals are selected. In Decision Science and Psychology, IJF papers that are cited by at least four contributing journals are selected. All the qualified IJF papers are harvested and listed in table 21-24.

The above four subject areas are involved in the entire development of IJF and JF, therefore, we analyze them as the typical subject areas that integrate the knowledge from the forecasting field. One subject area includes various journals which have different scopes and research focuses. If an IJF paper is cited by more journals within the same subject area, then the knowledge starting from this IJF paper spreads over a wider range within the subject area. Therefore, we extract papers that are cited by more journals within one subject area, and in different subject area, different limiting conditions are set. in table 21, five qualified papers are cited by six journals, and two of five (Taylor, Menezes, and Mcsharry 2006; Darbellay and Slama 2000) are related to the forecasting research on electricity demand, which denotes electricity demand forecasting is a widely-discussed topic in Computer Science. Another popular topic is the research of forecast accuracy because two papers focus on it (Hyndman and Koehler 2006; Makridakis 1993). In Engineering, there are three IJF papers cited by six journals, three IJF papers cited by seven journals, and four IJF papers cited by eight journals. Two of the ten papers focus on the forecasting application in neural networks (Zhang, Patuwo, and Hu 1998; Hippert, Bunn, and Souza 2005). The two papers related to the research of forecast accuracy (Hyndman and Koehler 2006; Makridakis 1993) which are cited by the journals in Computer Science also cited by journals in Engineering. Besides, there are two reviews which research on time series forecasting and forecasting the diffusion of innovation (Gooijer and Hyndman 2006; Meade and Islam 2006). In Decision Science, most IJF papers are cited by four journals. However, one paper is cited by six journals, and it is the serial research about the well-known M-Competitions organized by forecasting experts (Makridakis and Hibon 2000). In Psychology, human judgment which affects the forecasting accuracy is a popular research, and there are three IJF papers focus on judgmental forecasting in table 24. The first one is a review describing the development progress of judgmental forecasting over 25 years (Lawrence et al. 2006). The second one investigates the effects of judges' forecasting based on two experiments, and discusses whether the forecasting results would be impaired if the judges have previously made their own forecasts for the same outcomes (N. Harvey and Harries 2004). The third one is about the judgmental aggregation strategies, and discusses the differences between aggregating opinions and choosing one single judge (Soll and Mannes 2011).

Table 21: Information about the IJF paper cited by the most contributing citing journals in Computer Science

Paper	Author (year)	Cited by contributing journals	TC
Another look at measures of forecast accuracy	Hyndman R.J. and Koehler A.B. (2006)	ASCJ, CSDA, EJOR, LNCS, NC, PIJCNN	1210
Combining forecasts: A review and annotated bibliography	Clemen R.T. (1989)	ASCJ, CSDA, EJOR, LNCS, NC, PIJCNN	1107
A comparison of univariate methods for forecasting electricity demand up to a day ahead	Taylor J.W. et al. (2006)	ASCJ, CSDA, EJOR, LNCS, NC, PIJCNN	267
Accuracy measures: theoretical and practical concerns	Makridakis S. (1993)	ASCJ, CSDA, EJOR, LNCS, NC, PIJCNN	214
Forecasting the short-term demand for electricity: Do neural networks stand a better chance?	Darbellay G.A. and Slama M. (2000)	ASCJ, CSDA, EJOR, LNCS, NC, PIJCNN	208

Table 22: Information about the IJF paper cited by the most contributing citing journals in Engineering

Paper	Author (year)	Cited by contributing journals	TC
Forecasting with artificial neural networks: The state of the art	Zhang G. et al. (1998)	AE, Energies, Energy, ESWA, IEEE-TPS, IJPE, IJPR, MPE	2022
Another look at measures of forecast accuracy	Hyndman R.J. and Koehler A.B. (2006)	AE, Energies, Energy, ESWA, IEEE-TPS, IJPE, IJPR, MPE	1210
Combining forecasts: A review and annotated bibliography	Clemen R.T. (1989)	AE, Energies, Energy, ESWA, IJPE, IJPR, MPE	1107
25 years of time series forecasting	De Gooijer J.G. and Hyndman R.J. (2006)	AE, Energies, Energy, ESWA, IEEE-TPS, IJPE, IJPR, MPE	615
Error measures for generalizing about forecasting methods: Empirical comparisons	Armstrong J.S. and Collopy F. (1992)	AE, Energies, Energy, ESWA, IEEE-TPS, IJPE, IJPR, MPE	573
Modelling and forecasting the diffusion of innovation - A 25-year review	Meade N. and Islam T. (2006)	AE, Energies, Energy, IJPE, IJPR, MPE	381
Exponential smoothing: The state of the art-Part II	Gardner Jr. E.S. (2006)	AE, Energies, Energy, IEEE-TPS, IJPE, IJPR	379
Accuracy measures: theoretical and practical concerns	Makridakis S. (1993)	AE, Energies, Energy, ESWA, IJPE, IJPR, MPE	214
To combine or not to combine: Selecting among forecasts and their combinations	Hibon M. and Evgeniou T. (2005)	AE, Energies, Energy, IEEE-TPS, IJPE, IJPR, MPE	152
Large neural networks for electricity load forecasting: Are they overfitted?	Hippert H.S. et al. (2005)	AE, Energies, Energy, ESWA, IEEE-TPS, MPE	61

Table 23: Information about the IJF paper cited by the most contributing citing journals in Decision Science

Paper	Author (year)	Cited by contributing journals	TC
Another look at measures of forecast accuracy	Hyndman R.J. and Koehler A.B. (2006)	EJOR, IJPE, JASA, JORS	1210
Combining forecasts: A review and annotated bibliography	Clemen R.T. (1989)	EJOR, IJPE, JBES, JORS, OBES	1107
The M3-competition: Results, conclusions and implications	Makridakis S. and Hibon M. (2000)	EJOR, IJPE, JBES, JASA, JORS, OBES	675
Error measures for generalizing about forecasting methods: Empirical comparisons	Armstrong J.S. and Collopy F. (1992)	EJOR, IJPE, JASA, JORS	573
Exponential smoothing: The state of the art-Part II	Gardner Jr. E.S. (2006)	EJOR, IJPE, JBES, JORS	379
A state space framework for automatic forecasting using exponential smoothing methods	Hyndman R.J. et al. (2002)	EJOR, IJPE, JASA, JORS	311
Short-run forecasts of electricity loads and peaks	Ramanathan R. et al. (1997)	EJOR, IJPE, JASA, OBES	206
The evaluation of extrapolative forecasting methods	Fildes R. (1992)	EJOR, IJPE, JASA, JORS	155
Comparing and evaluating Bayesian predictive distributions of asset returns	Geweke J. and Amisano G. (2010)	EJOR, JBES, JASA, OBEA	103
Combining density forecasts	Hall S.G. and Mitchell J. (2007)	EJOR, JBES, JASA, OBEA	93
Combining expert forecasts: Can anything beat the simple average?	Genre V. et al. (2013)	EJOR, IJPR, JBES, OBEA	91

Table 24: Information about the IJF paper cited by the most contributing citing journals in Psychology

Paper	Author (year)	Cited by contributing journals	TC
Another look at measures of forecast accuracy	Hyndman R.J. and Koehler A.B. (2006)	DSS, JBDM, JEPLMC, TFSC	1210
Combining forecasts: A review and annotated bibliography	Clemen R.T. (1989)	DSS, JBDM, JDM, OBHDP, TFSC	1107
Judgmental forecasting: A review of progress over the last 25 years	Lawrence M. et al. (2006)	DSS, JBDM, JEP, JEPLMC, JDM, OBHDP, TFSC	212
Prediction market accuracy in the long run	Berg J.E. et al. (2008)	DSS, JBDM, JEP, TFSC	141
Predicting the World Cup 2002 in soccer: Performance and confidence of experts and non-experts	Andersson P. et al. (2005)	DSS, JEP, JDM, OBHDP	59
Good probabilistic forecasters: The 'consumer's' perspective	Yates J.F. et al. (1996)	AP, JBD, OBHDP, TFSC	55
Effects of judges' forecasting on their later combination of forecasts for the same outcomes	Harvey N., and Harries C. (2004)	JBD, JEP, OBHDP, TFSC	49
Judgmental aggregation strategies depend on whether the self is involved	Soll J.B. and Mannes A.E. (2011)	JBD, JEP, JDM, OBHDP	33

4. Conclusion and discussion

It has been proven that the proposed method combining the basic bibliometric indicators and the science mapping techniques is effective to evaluate the merits of a journal. In this papers, this combination has been used to analyze the state of development of International Journal of Forecasting (IJF) from different angles. Three factors influencing the performance of the journal are identified, and we focus on analyzing the most cited/co-cited papers, the most prolific/cited authors, and the most prolific/cited countries. Moreover, citation/co-citation relationships, co-author relationships, country collaboration relationships between IJF papers and their citing papers are elaborated based on science mapping techniques.

In addition, a knowledge diffusion analysis is conducted to supplement the above proposed method. Based on this knowledge diffusion analysis, the researches outside the forecasting field can be identified through investigating the intellectual radiation impact of the forecasting researches. The analysis supports a valuable direction for the future forecasting researches. As the leading journals in the forecasting field, IJF and Journal of Forecasting (JF) papers are all included. Through investigating the citation relationships between IJF papers and their citing paper, four typical citing subject areas which are Computer Science, Engineering, Psychology, and Decision Sciences have been selected. The journal citation relationships between IJF and the journals belonging to these four citing subject areas are delineated through journal citation networks. Similar work is conducted between JF papers and their citing papers, and we derive five typical citing subject areas which are Computer Science, Economics, Econometrics and Finance, Engineering, Psychology, and Decision Sciences. Also the journal citation networks are constructed to explore the relationships between JF and the journals belonging to the five citing subject areas. Besides, the citing subject areas which have a special performance both in IJF and JF are chosen as the overlapping citing subject areas, and they are Computer Science, Engineering, Psychology, and Decision Science. We investigate the IJF papers which are cited by the most journals within these four subject area, and the derived findings can answer the question how the IJF researches being cited in the papers outside the forecasting field behave and what kind of forecasting knowledge diffuses more widely to the researches outside the forecasting field.

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