Scopus vs WOS as scientific evaluation tools: A comparative analysis based on a testing sample search on the topic of electric vehicles①

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Abstract Based on a bibliometric analysis in combination with other information analysis methods, this paper compares the different evaluation results on the subject of "electric vehicles" drawn from Web of Science (WOS) and from Scopus. We came to the following conclusions after a careful comparison of these two databases. Firstly, both WOS and Scopus would provide some valid and unique evaluation indicators. Secondly, they showed similar results in terms of evaluating research performance of countries and research organizations involved in the targeted subject fields. In fact, both databases are good for discovering the research trend in general at the macroscopic level. Lastly, we ought to take the disciplinary characteristics, the extent of journal inclusion and resource selection criteria as well as inevitable data errors into full account in making recommendations to policy decision-makers.

Keywords WOS, Scopus, Comparative study, Electric vehicles

1 Introduction

The assessment of scientific research output has gained increasing interest in the last decade. It is an important component of scientific and technological activities and also an important means to ensure the healthy development of national scientific and technological undertakings. Therefore, the reasonable and effective utilization of research evaluation tools has vital practical significance for producing fair and acceptable evaluation results.

For a long time, the Science Citation Index (SCI) has been the most commonly used and sometimes the only available multidisciplinary database for the evaluation of publications in the field of science. This monopoly situation came to a close in

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2004 when Reed Elsevier introduced another multidisciplinary database (Scopus) to the market which was soon considered as the most significant competitor with SCI. There are certain controversies concerning using a document database as a tool of evaluation of publications in the field of science. However, people give such databases increasingly more recognition because of their unique pleasant features such as objectivity, measurability, comparability and credibility.

Several authors have compared these two databases from a perspective of information retrieval since 2004. Some researchers compared the features and capabilities of the two databases[1–3]. Others, such as Nisa and Ball compared the differences between these two databases about their citation characteristics including citation tracking and citation rate. As comparisons were getting more than skin-deep, some researchers focused their attention on a comparison of their bibliometric indicators for research evaluation[6–9]. On the basis of previous studies regarding the above mentioned two databases, this paper attempts to compare the different features as reflected in our search exercise onto Web of Science (WOS) and Scopus databases. We took the topic of "electric vehicles" as our search target because electric vehicles is of emerging and promising field of further development under the latest technological advancement environment, especially in the face of our climate change and energy crisis in modern times. We hope our study will help researchers understand better the different characteristics of these two important databases of science and technology in terms of meeting the information needs of scientists and engineers so that the latter can obtain greater achievements in their scientific pursuits.

2 Method

Data used in this study were based on Science Citation Index (SCI), Social Science Citation Index (SSCI) (both of them contained in Web of Science) and Scopus. As electric vehicles (EV) had become a "hot topic" since 1990s, we decided to choose this field as a testing topic for a comparative study[10]. After discussing with EV experts from Beijing University of Technology, we finally fixed on a set of 24 words as retrieval words to search in titles, abstracts, or keywords from 1995 to 2007②. Scopus also contained patents data in its search results in addition to articles while

② WOS Queries: TS=("electric vehicle" or "electric vehicles" or "electric car" or "electric cars" or "hybrid car" or "hybrid cars" or "hybrid vehicle " or "hybrid vehicles" or " battery vehicle" or " battery vehicles" or "battery car" or " battery cars" or "battery powered vehicle" or "battery powered vehicles" or "battery powered car" or "battery powered cars" or " fuel cell vehicle" or " fuel cell vehicles" or "fuel cell car" or "fuel cell cars" or "hybrid powered vehicle" or "hybrid powered vehicles" or "hybrid powered car" or "hybrid powered cars") and Document Type=(Article OR Letter OR Review).
Time span =1995-2007 Database=SCI-EXPANDED, SSCI.

WOS could not give patent data. Such being the case, we decided to take only articles, letters and reviews into consideration among all kinds of document types. Both databases show evidence of limitations with regard to their data constrains. In WOS only 500 records can be downloaded each time and the download upper limit for the total number of records is only 100 thousand. Using same query wording for retrieval in WOS and Scopus, we got a total of 4,665 bibliographic records including 1,665 from WOS and 3,225 from Scopus.

3 Results

3.1 Quantitative comparison

In terms of evaluation exercise, large data pool has absolute advantage to the researchers because they have more options to find generated reliable results and accurate information. With over 15,000 source journal titles, Scopus claims that it covers substantially more journals than Web of Science (almost 9,000 titles)[5]. From Fig. 1, we see that the curve for Scopus data is always above that of WOS.

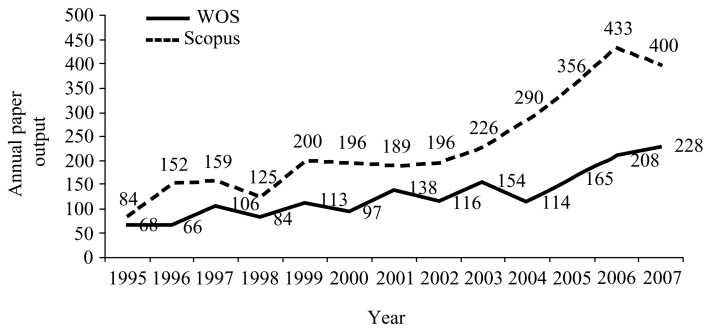

Fig. 1 Annual paper output according to WOS and Scopus (1995–2007).

Scopus Queries: (TITLE-ABS-KEY(“electric vehicle”) OR TITLE-ABS-KEY(“electric vehicles”) OR TITLE-ABS-KEY(“electric car”) OR TITLE-ABS-KEY(“electric cars”) OR TITLE-ABS-KEY(“hybrid car”) OR TITLE-ABS-KEY(“hybrid cars”) OR TITLE-ABS-KEY(“hybrid vehicle”) OR TITLE-ABS-KEY(“hybrid vehicles”) OR TITLE-ABS-KEY(“battery powered vehicle”) OR TITLE-ABS-KEY(“battery powered vehicles”) OR TITLE-ABS-KEY(“fuel cell vehicles”) OR TITLE-ABS-KEY(“battery powered car”) OR TITLE-ABS-KEY(“battery powered cars”) OR TITLE-ABS-KEY(“fuel cell vehicle”) OR TITLE-ABS-KEY(“fuel cell vehicles”) OR TITLE-ABS-KEY(“fuel cell car”) OR TITLE-ABS-KEY(“fuel cell cars”) OR TITLE-ABS-KEY(“hybrid powered vehicle”) OR TITLE-ABS-KEY (“hybrid powered vehicles”) OR TITLE-ABS-KEY(“hybrid powered car”) OR TITLE-ABS-KEY(“hybrid powered cars”) OR TITLE-ABS-KEY(“battery vehicle”) OR TITLE-ABS-KEY(“battery vehicles”) OR TITLE-ABS-KEY(“battery car”) OR TITLE-ABS-KEY(“battery cars”)) AND DOCTYPE (ar OR le OR re) AND PUBYEAR AFT 1994 AND PUBYEAR BEF 2008.

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What is interesting is that Scopus only showed a modest growth rate from 1996 onwards and got a stable quantity advantage in terms of quantitative growth, which was twice as larger than that of WOS from 2004 onwards. During the year 1996 to 2003, however, its quantitative advantage seemed to be not so conspicuous. Therefore, we should pay more attention to the specific data year when we do the evaluation work.

Before conducting statistical analysis, we cleaned up these data results first. Scopus updates its data everyday while WOS usually updates weekly.[4] With slower pace, WOS data has fewer errors, a fact we found during the data cleaning process. In WOS, it takes each state of the United States as an independent political entity in the country field. UK is also divided into England, Wales, Scotland and Northern Ireland separately for its information retrieval presentation. In comparison, Scopus had more blank items and erroneous items which might present statistical errors.

The search results drawn from the two databases were compared in terms of countries, institutions and researchers. 1,657 WOS papers covered 55 countries (or regions) while Scopus covered 56 countries (or regions). Although the paper count of Scopus was twice more than that of WOS, the number of country (or region) coverage was quite close with each other.

As shown in Fig. 2, the United States, Japan, China as well as EU countries are making outstanding progress in EV research. As far as the evaluation is concerned, the top 10 countries that made into the top-ranking list stemming from these two databases are basically the same except for some small changes in their ranking order. What's more, the difference between the data curves of the two databases seems to be obvious only when the country (or region) gets a higher ranking order.

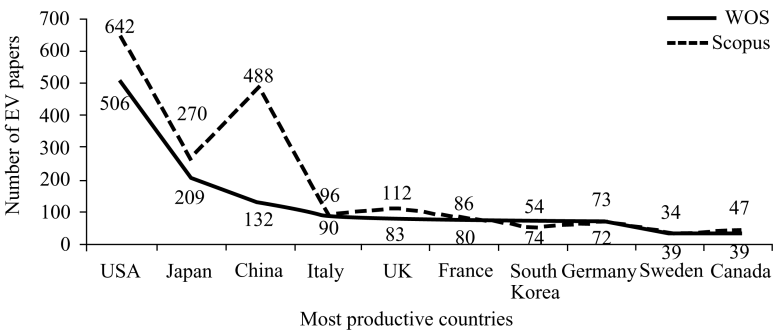

Fig. 2 Top 10 most productive countries/regions of EV paper publications (1995–2007).

Research Papers

Compared with Fig. 2, Fig. 3 and Fig. 4 showed greater differences at institution and individual levels. There were 5 institutions appearing in both top 10 institutions lists. However, there were only 2 researchers appearing simultaneously on both top 10 lists. Scopus contained more Chinese institutions and researchers than that in WOS. Scopus included 500 Chinese journals whereas there were 76 Chinese journal titles included in WOS database. This pronounced disparity might mislead people to think that Scopus is a better choice for the scientific evaluation of China's organizations or individuals. As a whole, a detailed analysis of above issue tells us that the disparity of these two databases in this particular area will become larger only when the items being evaluated are changed from a macro-perspective to a micro-perspective level. As for country ranking, these two databases produce very similar results. However, they perform differently on institution and researcher

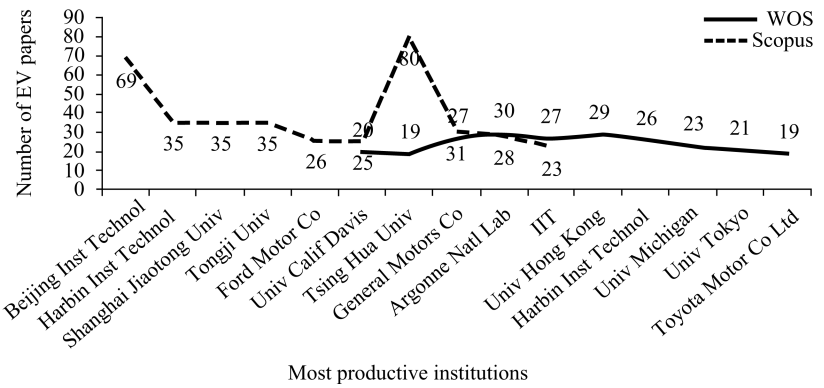

Fig. 3. Top 10 most productive institutions of EV paper publications (1995–2007).

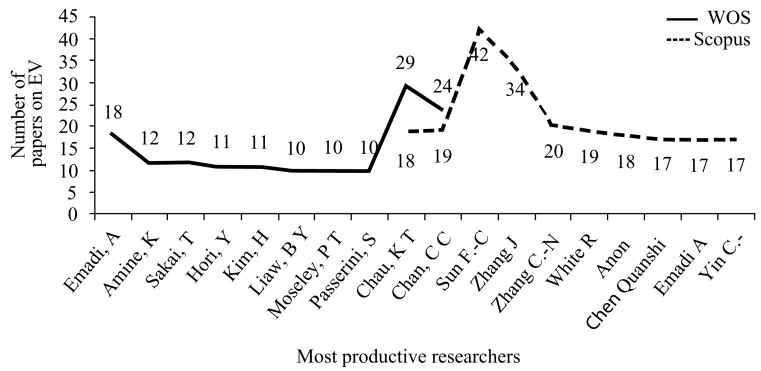

Fig. 4. Top 10 most productive researchers for EV topics (1995–2007).

ranking. It seems that Scopus is not necessarily a better choice than WOS, since they can generate very similar country evaluation results. As a result, we should choose them with great care and on the basis of certain evaluation criteria and methods.

3.2 Citation comparison

Both WOS and Scopus provided citation data, which helped judge the level of academic excellence of papers, countries, institutions as well as individual researchers. As noted, all the citations going back as far as 1900 are listed for a paper in WOS, however, Scopus only has its citations well recorded after 1996[1]. As a result, to WOS's advantage, it is a better choice to use WOS citation data to evaluate the process of scientific development of certain disciplines or journals.

In this research, we found that the Scopus data in 1995 did not have citation records at all. But it will not bring obvious errors to our citation comparison because of its small paper quantity. Table 1 and Table 2 displayed the statistics of citation counts from these two databases. In terms of total citations, Scopus returned higher number of results than those of WOS. However, the gap was not as large as the number of source journals included in these two databases. With respect to country ranking, Table 1 showed the similar results from both databases except for some slight variations. Accordingly, we focused our attention to the non-cited documents in order to find out possible reasons for the disparity.

Table 1 EV paper cited by main countries and regions (1995–2007)

Rank	WOS			Scopus		
	Country	Total citations	0-citation	Country	Total citations	0-citation
1	USA	6,235	118	USA	7,816	179
2	Japan	1,581	74	Japan	2,089	107
3	Italy	1,001	20	Italy	1,548	21
4	UK	651	22	France	949	22
5	France	647	22	UK	922	42
6	Switzerland	446	4	China	692	344
7	South Korea	428	21	South Korea	625	1
8	China	376	62	Germany	570	7
9	Germany	368	13	Sweden	460	9
10	Canada	347	5	Australia	411	11
11	Australia	307	9	Switzerland	409	8
12	Taiwan	171	16	Canada	345	9
13	Holland	133	5	Holland	228	8
14	Spain	133	10	India	185	15
15	Sweden	133	7	Taiwan	176	13

Table 2 EV paper cited by main institutions (1995–2007)

Institution name	Total citations		0-citation		Average citations per paper	
	WOS	Scopus	WOS	Scopus	WOS	Scopus
Argonne Natl Lab	435	441	6	5	14.5	15.75
General Motors Co	194	257	1	4	7.19	8.29
Ford Motor Co	188	291	2	6	11.06	11.19
Univ Hong Kong	137	172	8	4	4.72	6.83
Illinois Inst of Technol	132	173	6	2	4.89	7.52
Toyota Motor Co Ltd	113	108	7	8	5.95	5.4
Tsing Hua Univ	84	127	9	49	4.42	1.59
Univ Michigan	71	123	7	4	3.09	6.83
Univ Calif Davis	47	85	7	7	2.35	3.4
Harbin Inst Technol	18	10	16	28	0.69	0.29

In general, a scientific publication is digested and understood during a period of 1–2 years and then gets cited in new publications. Literature databases, however, also contain non-cited publications. Fig. 5 and Fig. 6 presented statistics on the proportion of non-cited paper of both databases. To Scopus' disadvantage, the proportion of non-cited papers of different countries or of institutions was basically larger here than in the case of WOS.

In relation to this disparity, it is interesting to note that there are very different publication selection criteria between these two databases. Dr. Eugene Garfield said that an effective citation database should have strict selection criteria on its coverage scope so as to include as much as possible information for their users. However, Scopus seemed to have its focal point on extending its breadth of coverage. With its enlarged number of non-cited paper, Scopus might have greatly weakened the

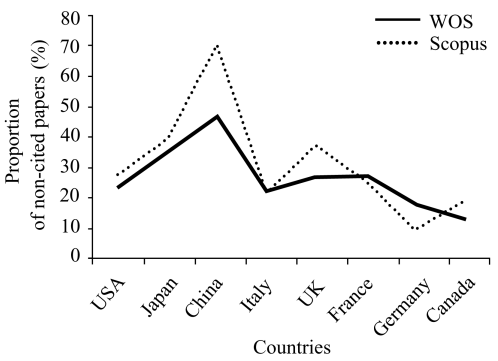

Fig. 5 Proportion of non-cited papers of different countries or regions (1995–2007).

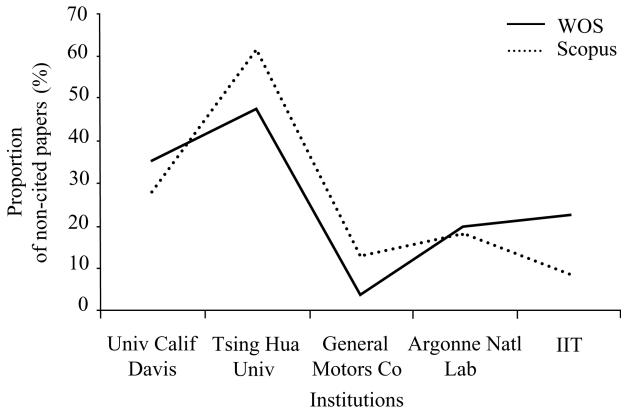

Fig. 6 Proportion of non-cited papers of different institutions (1995–2007).

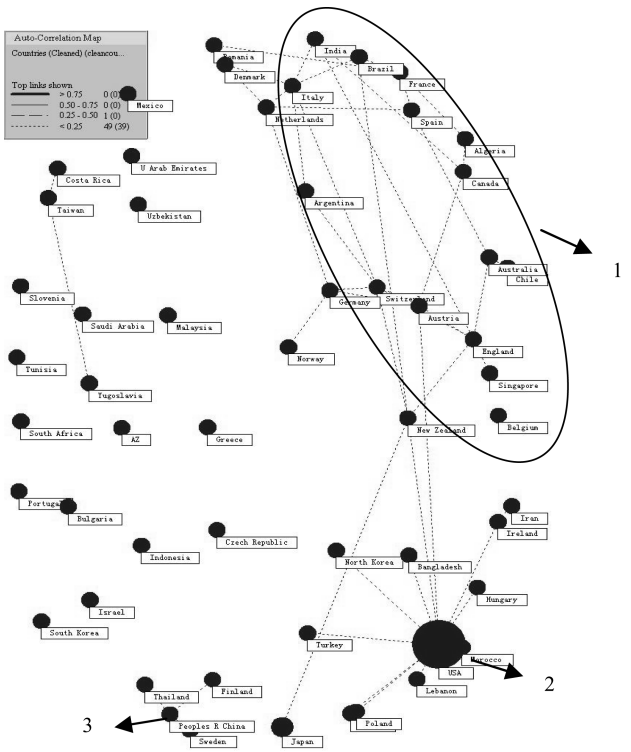

Fig. 7 Cross-country/region cooperation cluster map based on WOS (1995–2007).
Notes: 1, EU countries; 2, USA; 3, China.

relationship intrinsic between citations and papers, and thus its database would become less interesting for the evaluation work.

3.3 Co-authorship comparison

In the last few decades, international scientific collaboration has strongly intensified and its results are expected to appear in the scientific literature[11]. Therefore, relevant databases can also be used as a tool to measure the international collaboration on joint research endeavours. In the co-authorship analysis, bilateral relation between countries and regions were studied. A link between two entities was established, whenever the two given entities co-occurred in the corporate address field of a paper. We used Thomson Data Analyser to calculate co-authorship matrix and generate collaboration map in the end.

Fig. 7 and Fig. 8 illustrate the basic structural characteristics for international scientific collaboration on EV related projects. The United States and several EU countries can be considered as the most important countries in international

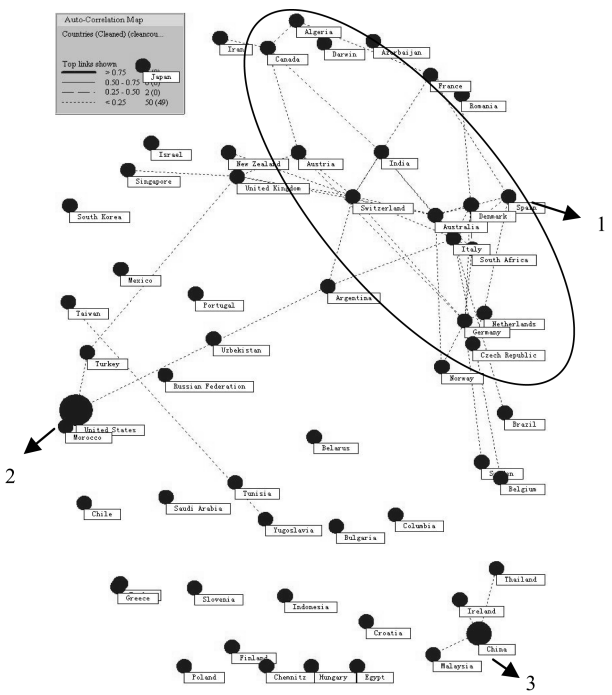

Fig. 8 Cross- country/region cooperation cluster map based on Scopus (1995–2007).
Notes: 1, EU countries; 2, USA; 3, China.

collaboration for EV research and development. Japan as a strong EV production country is not active in international cooperation in this area, probably due to its great concern about the necessity to protect its own intellectual property right.

The co-authorship maps on country/region level are similar to each other as a whole. The map from the WOS database may highlight the important position of the United States, whereas Scopus gives us a more comprehensive view of the overall EV development in a particular country or region. Also, from Scopus map, we can see that China has formed its own collaboration circle. However, it is in a somewhat aloof situation from the core circle of international collaboration in the field of EV research and development. Fig. 9 and Fig. 10 are the maps indicating EV development of institutions. The outcome of subject-related bibliographic items generated by Scopus database seems to be more closely connected with one another

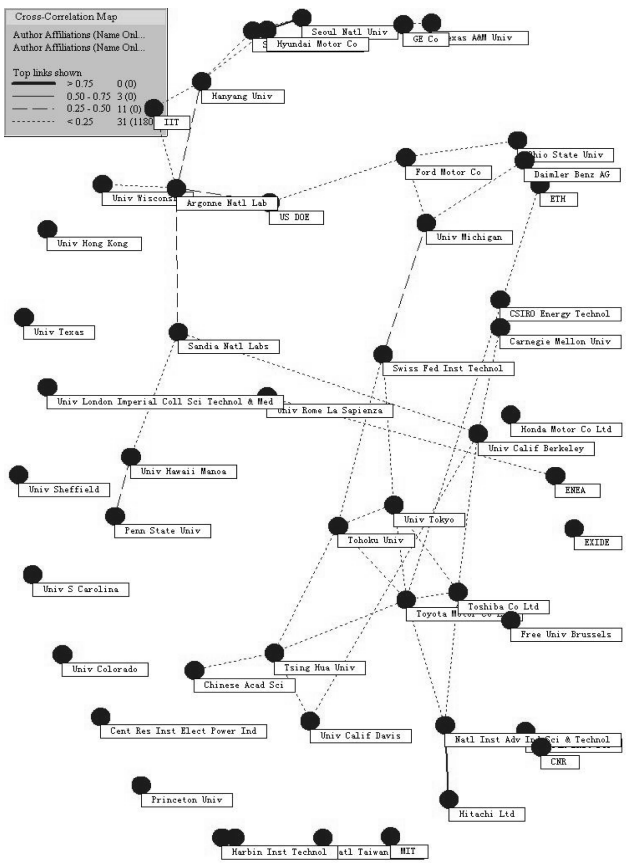

Fig. 9 Research institution cluster map based on WOS (1995–2007).

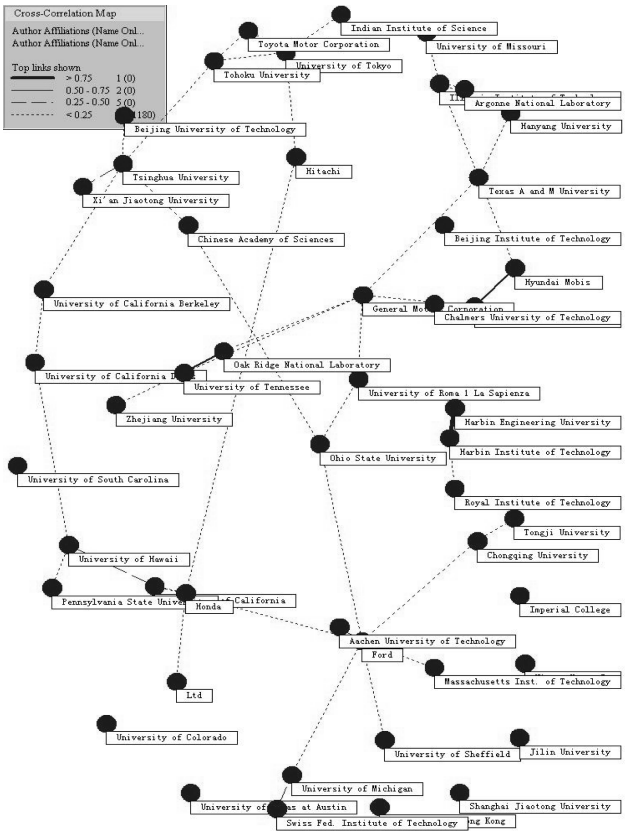

Fig. 10 Research institution cluster map based on Scopus (1995–2007).

than those in WOS database. Moreover, it is particular noticeable that in their maps about individual researchers, WOS database showed less evidence of close collaborations between or among top scientists than that of Scopus database. (Figs. 11 and 12).

About 50% of Scopus journal titles are from countries other than United States and UK, while the number in WOS is merely 36%. Accordingly, Scopus can give more information if you are looking for the S&T development in these "other" countries and also be good at painting a more worldwide collaboration map. A comparison of these three different types of maps may allow us to draw conclusions that WOS is good at highlighting the important role of more developed countries, institutions and researchers. Whereas Scopus does better in describing the comprehensive cooperation relationship among all the evaluated items including developing countries, institutions and researchers.

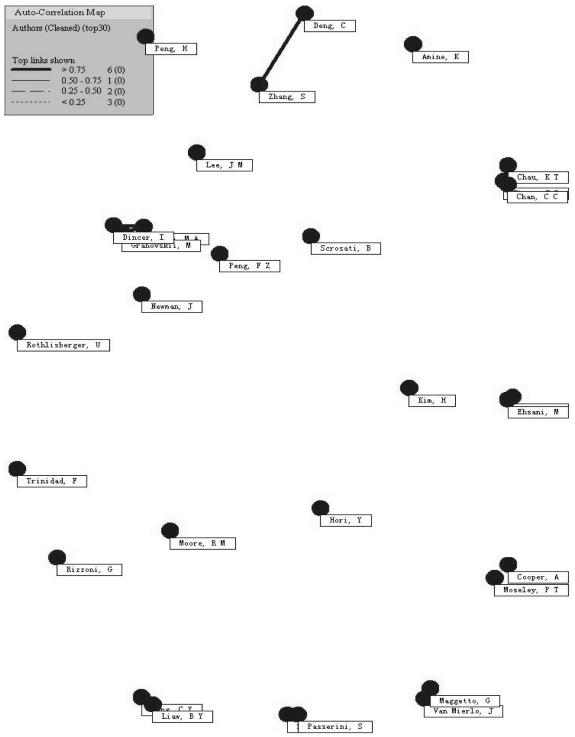

Fig. 11 Researcher cooperation map based on WOS (1995–2007).

4 Discussion and conclusions

Depending on the database chosen, the result of a bibliometric analysis may provide one type of information on one incidence but may be very different situation on another incidence. Both of WOS and Scopus remain very important resources. However, the current management strategies employed by them are different. The number of journals covered is expanded in terms of breadth with all subjects in one (Scopus) and in terms of depth mostly focusing on pure science in the other (WOS)[5].

In this paper, electric vehicle is selected as a primary sample topic for comparing WOS and Scopus. In consideration of the limited and specific objectives, this paper did not single out either one of these two databases as the right tool for researching all subjects in scientific and technological fields. It brings us a new question: Would we get a very different conclusion if we had chosen different key-word search terms

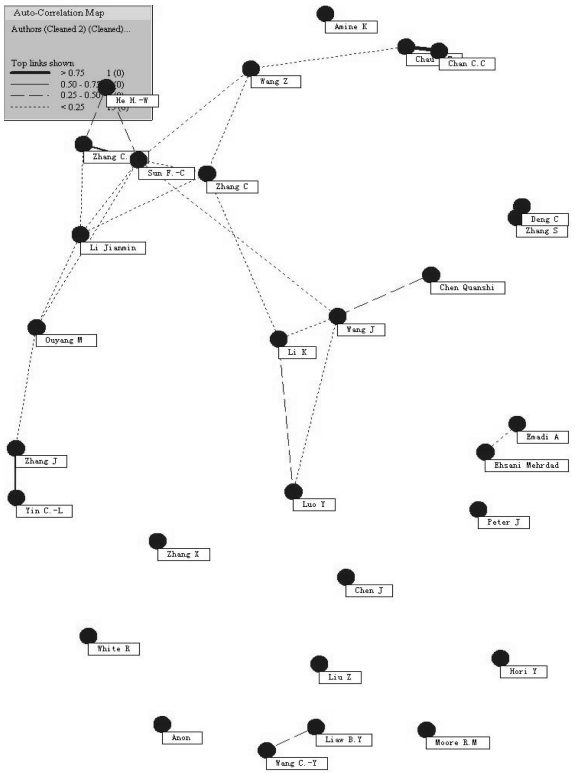

Fig. 12 Researcher cooperation map based on Scopus (1995–2007).

such as those related to medical science, pure science or some other subjects as our testing sample topics? As such being the case, we experimented with another topic "genetic engineering" in medical science to compare the results of these two different databases. In our preliminary research findings on this issue, we found that these two databases had a significant similarity of country evaluation and showed a different result in the areas of institutional and researcher ranking. In GE field, Chinese institutions got a comparatively higher ranking in terms of the number of document records retrieved from WOS than that of Scopus, a result different from the exercise with EV.

This study however indicated that at this point both of these two databases can give us similar evaluation results at macro-perspective level. It is left to the users to decide which database is more suitable to their research objectives. When the evaluation approach is changed into a micro-perspective, each of these two databases has its own distinctive advantages. WOS has been taken by a great majority of users

to be at the center of scientific communication due to its inclusion of enormous amount of key journals in its stated subject field of coverage. It is quite useful for researchers to find the top countries, institutions or scientists in a given field from this database. It performs better for a longer period of retrospective citation analysis and is superior in its data quality as found in our data cleaning process. However, despite of its lesser amount of highly valued journals indexed, Scopus could still yield a better result from a macroscopic perspective. It also showed strength in providing more papers and citations in our EV searching. Owing to the inclusion of a large number of Chinese journals, Scopus returned a higher number of documents and citations about EV's research and development activities in China. It is ironic that we may conveniently get a glimpse of the development of China's scientific and technological fields on the one hand, but at the same time, we may have possibly overlooked the fact that for the papers retrieved from Scopus, a larger portion of them never get cited at all, so the picture might be misleading.

Therefore, it will not be enough to simply take WOS as the one and only established database for searching topics in scientific and technological fields. We need to think about what other possible additional databases may suit equally well to researchers' objectives and perspectives. In the future, people who perform bibliometric analysis must be able to justify adequately why they chose to use one particular database over any other ones.

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