Competition and Excellence: Ranking of World-class Universities 2009 and Advance of Chinese Universities

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Abstract

This paper evaluates the scientific competitiveness of world-class universities via their research output, with a focus on the position of Chinese universities in the world. Aiming to promote the internationalization of China's education and scientific research, it observes the development of China's higher education from an international perspective. This program has been taken for five years during which three reports have been respectively published in 2005, 2007 and 2009. This is the third time to evaluate the world-class universities and research institutions. Original data are obtained from Essential Science Index (ESI) published by Thomson Reuters; subject competitiveness of world universities is evaluated and analyzed in a scientific, subjective and comprehensive way; three categories and thirty pieces of rankings are obtained. The results show that the rankings of most Chinese universities are in the back, revealing that there is still much room for improvement in Chinese universities.

Keywords: ESI; Research Competitiveness; World-class University Evaluation; Research Institution; Subject Construction

1. Introduction

University research is the manifestation of a country's comprehensive national strength. It can reflect the development of science, technology, education, and culture of a country. In recent years, it is important for countries to have more than one world-class university which represents the prosperity of a country or region (Ding, 2004). Bibliometric methods are now generally used by researchers, media workers, and educational institutes on large-scale research evaluation for universities. The results of evaluation may vary by the designs of chosen targets, perspective interpretation, indicator selection, data collection, and result presentation. With the influence of globalization

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and global competition, university research evaluation gradually transforms from the ranking of universities within one country, e.g. "America's Best Colleges 2010" by *U.S. News and World Report*, to all countries in the world.

Examples for renowned surveys of the world's best universities are "Academic Ranking of World Universities" of Shanghai Jiao Tong University in China (Shanghai Jiao Tong University, 2009) , "THE-QS World University Rankings" published by *Times Higher Education* and Quacquarelli Symonds (QS) (THE-QS Times Higher Education Supplement, 2009), "Performance Ranking of Scientific Papers for World Universities" of *Higher Education Evaluation and Accreditation Council* in Taiwan (Higher Education Evaluation and Accreditation Council, 2009), and "Webometrics Rankings of World Universities" of Centre for Scientific Information and Documentation (CINDOC-CSIC) in Spain (Cybermetrics Lab of the Centro de Información y Documentación, 2009).

Currently Chinese universities should not be confined to the domestic comparison but strive to become open, inclusive and high-level international universities (Shi Y. G., 2008; Ding, X. L., 2005). Meanwhile, *National Program for Medium-Long-term Scientific and Technological Development* (2009) specifies that China will pursue a goal in which the "volume of international papers are cited into the top five in the world." The database of Essential Science Indicators (ESI) developed by Thomson Reuters is an authoritative search tool designed to collect and reflect the paper citation condition of 22 major subjects. It can fully demonstrate the quality of papers, international research competitiveness, and the impact of scientific research institutions (including universities and research institutions). For the assessment of the scientific strength of the patents, we make use of the Derwent Innovations Index (DII) which indexes all the world's patent offices and organizations with comprehensive and authoritative information. Since March 2009, the Research Center for Chinese Science Evaluation has used ESI and DII as the authoritative data sources to focus research efforts on a more competitive and in-depth study. We analyzed the world universities and research institutes through disciplinary evaluation, and developed "2009 Rankings of the Scientific Competitiveness of World-class Universities", "2009 Rankings of Subject Competitiveness of World-class Universities and Research Institutions (22 subjects)" and "2009 Rankings of the Basic Indicators of Scientific Competitiveness of World-class Universities (7 indicators)". The results show that Chinese universities have achieved rapid progress in the past two years and made satisfactory achievements. Yet, when compared with other world universities, the gap is still large. There is a long way to go for building world-class universities. The task is very difficult, especially in producing cutting edge research, international competitiveness, and influence. These little-known ranking results and evaluation findings provide a more comprehensive, detailed, and unique evaluation report for various universities, research institutes, government administrative departments, researchers and students who want to study abroad, as well as other sectors of the community. This report is significant and valuable in that it provides a clear understanding of the position of Chinese universities in the world, thereby improving the international competitiveness of Chinese universities.

The main purpose of this study is to help to recognize the position of Chinese universities in the world, to promote the internationalization of China's education and scientific research, to observe the development of China's higher education at international level, and to provide detailed and accurate data reference for training a number of universities to become internationally influential step by step. It is on this base that the system and measures for further reformation are developed to achieve healthy and rapid development of higher education in China. This study has much contribution. Firstly, it provides statistical data to encourage China's colleges and universities in scientific and technological innovation. Secondly, it offers a quantitative basis for decision making for the scientific management and government management department. Thirdly, it gives a detailed and in-depth consultation report of studying abroad for the young students. Finally, it provides reference data for competition and development of foreign universities in the world.

2. Methodology

2.1 Objective and Scope

Based on the characteristics of subject development, ESI has set 22 subjects, including one multidisciplinary subject. In the *Rankings of the Scientific Research Competitiveness of World-class Universities*, there are total 1,475 ESI-indexed universities whose cited times are in the top 1% in recent 11 years. Concurrently, there are totally 2,413 scientific research institutions, whose cited times are in the top 1% in recent 11 years, covered by the ranking list of ESI. In general, these universities and institutions meet the requirements of this evaluation.

The data of any institution which has more than one name are combined in this study, such as "SUN YAT SEN UNIV" and "ZHONGSHAN UNIV". They are the same institution appearing with different names, so the final data of this institution contain the data of "SUN YAT SEN UNIV" and "ZHONGSHAN UNIV". In addition, there are universities and scientific institutions which have merged, such as UNIV KEELE (KEELE UNIV and UNIV KEELE), UNIV CATANIA (UNIV CATANIA and CATANIA UNIV), HUAZHONG NORMAL UNIV (CENT CHINA NORMAL UNIV and HUAZHONG NORMAL UNIV) and so on.

2.2 Data Source

The span of the papers from ESI is from Jan. 1st, 1998 to Dec. 31st, 2008, and the span of the patents from DII is from the year of 2004 to 2008. According to the characteristics of the subjects in ESI and DII databases, the patent data of the departments of Chemistry, Electrical & Electronics and Engineering are divided into the subjects of Chemistry, Physics, and Engineering in ESI. The explanation for certain indicators is as follows. Firstly, highly-cited papers refer to the papers, in a given subject and a period of time, having cited times in the top 1%. Secondly, hot papers refer to the papers published in recent two years with cited times in the top 0.1% in recent two months. The 22 subjects in ESI alphabetically are Agricultural Sciences, Biology & Biochemistry, Chemistry, Clinical Medicine, Computer Science, Economics & Business, Engineering, Environment/Ecology, Geosciences, Immunology, Material Science, Mathematics, Microbiology, Molecular Biology & Genetics, Multidisciplinary, Neuroscience & Behavior, Pharmacology & Toxicology, Physics, Plant & Animal Science, Psychiatry/Psychology, Social Sciences, General, and Space Science.

2.3 Structure of the Index System

In this section, we introduce the indicators and weightings. The scientific research competitiveness of world-class universities is evaluated by four dimensions which are the scientific productivity, the scientific impact, the scientific innovation, and the scientific potentials.

Scientific Productivity

Scientific productivity is measured by the number of papers published in recent 11 years, i.e. the number of papers indexed by ESI, which can reflect the universities' devotion to the international academic exchanges. Papers indexed by ESI are in good quality because they have been reviewed by professional peers and prestigious journals in the world.

Scientific Impact

It is measured by the total cited times of the papers published in recent 11 years, the number of highly-cited papers, and the number of subjects indexed by ESI. The accumulation of the quantity is important, but the quality of papers reflected by the total cited times is another essential indicator. Concurrently, the more subjects are indexed by ESI, the greater influence of the scientific research institution will exert.

Scientific Innovation

It is measured by hot papers and patents. Hot papers with high innovation are the source power of making an organization or subject full of vigor. One of the patent features is novelty, which is not only an important manifestation of scientific and technological progress, but also one of the most valuable knowledge assets which can be transformed into productive forces. But it is necessary to emphasize that, because of the limitation of the subjects for patent application, patents in this study include only three subjects, Physics, Chemistry and Engineering. In this evaluation, we use the number of patents for invention rather than the utility patents or design patents. According to the statistical data of invention-type patents in China and other countries (State Intellectual Property Office, 2009; World Intellectual Property Organization, 2009), the number of invention-type patents from different countries over the past five years can be obtained to calculate the number of invention-type patents.

Scientific Potentials

It is measured by the ratio of highly cited papers, which is calculated by the number of highly-cited papers divided by the number of total published papers. The higher the ratio of highly cited papers, the more excellent papers will be produced in a given institution during the course of future development. It also means

Table 1. Index system to evaluate the research competitiveness of world-class universities

First-level Indicator	Second-level Indicator
Scientific Productivity	Number of Published Papers
Scientific Impact	Number of Total Cited times
	Number of Highly Cited Papers
	Number of Subjects Indexed by ESI
Scientific Innovation	Number of Patents
	Number of Hot Papers
Scientific Potentials	Number of Ratio of Highly Cited Papers

more abilities to maintain leadership in this field. The definition and categorization of world-class universities and subjects in this evaluation are introduced in the following section. See Table 1 for the detailed index system.

2.4 Definition of World-class Universities and World-class Subjects

It is necessary to define what a world-class university is before providing and interpreting the results. Among the 1,475 world universities, we define the top 600 (the top 0.5% in the global world) as the high-level universities in the world. The high-level universities are divided into three grades according to the orientation and planning of universities: the top 100 universities are regarded as "the top universities in the world"; the universities ranking from no. 101 to 300 are regarded as "the high-level and famous universities in the world"; the universities ranking from no. 301 to 600 are regarded as "the high-level and well-known universities." Universities in the first two categories are considered as world-class universities. As for world-class subjects, we define the number of world-class subjects by the number of ESI subjects in which an institution has outstanding performance. That is, if one institution is ranking in the top 10% in a certain subject, this subject to this institution is a world-class subject. There are also three grades for world-class subjects: the subject in which an institution ranks in the top 1% (including 1%) is regarded as "the top subject in the world"; the subject in which an institution ranks from 1% to 5% (including 5%) is regarded as "the high-level and famous subject in the world"; the subject in which an institution ranks from 5% to 10% (including 10%) is regarded as "the high-level and well-known subject in the world."

2.5 Features of Subject Competitiveness Evaluation of World-class Universities and Research Institutions

Many little-known evaluation results have been acquired through a comprehensive, systematic and in-depth analysis, and so is our evaluation on the 1,475 universities (whose total cited times for papers in ESI have ranked the top 1% in the past 11 years) and 2,413 research institutes (they are also in the ESI subject ranking list). This is the most authoritative evaluation report with rich content and reliable data, and the main features are shown in the following:

Firstly, the report has comprehensive content, a rounded system, and rich information. It is so far the only institute that continually publishes the best comprehensive evaluation results of the research competitiveness of world-class universities and research institutions. The report published the research competitiveness rankings of world-class universities in 2009 and used many indicators such as the scientific productivity, the scientific impact, the scientific innovation, and the scientific potentials. All of them can reflect the construction and development of the world-class universities and subjects from different perspectives.

Secondly, the report is of new concept, scientific indicators, and authoritative data. It makes use of the ESI databases developed by Thomson Reuters and the patent databases DII. Both of them have significant influence on the world, which can ensure the authority and credibility of the data sources. In this evaluation, we continue to measure scientific research competitiveness via an index system consisted of the four dimentions to get objective and realistic assessments.

Thirdly, the report focuses on the status of China from a global vision. It has made a detailed and comparative analysis on Chinese universities and subjects entered the ESI rankings, with a discussion of the changes in the past two years. Besides, the report made a comparison on evaluation results between 2007 and 2009, which provides strong data for a better understanding of the world position of Chinese higher education as well as the development of world-class universities and subjects.

3. Analysis of Results

This evaluation so far has produced three rankings, including the "2009 Rankings of Scientific Competitiveness of World-class Universities," "2009 Rankings of Subject Competitiveness of World-class Universities and Research Institutions (22 subjects respectively)" and "2009 Rankings of the Basic Indicators of Scientific Competitiveness of World-class Universities (7 indicators respectively)." All the detailed ranking results can be consulted in our evaluation center. We take the top 600 universities in the research competitiveness rankings of world universities in 2009 as statistical samples, and then discuss the performance of Chinese universities. The statistical data are available in tables in the following section. Among the tables, Table 2 shows the top 30 countries (regions) in research competitiveness in 2009; Table 3 shows the country distribution of World-class Universities in 2009; Table 4 shows the subject distribution of the World-class Universities in 2009 (Top 10 and Chinese Universities). Based on the above analysis and evaluation, we have drawn the following conclusions.

3.1 The overall scientific research strength of China shows remarkable improvement

The total score and the scores of each indicator of the top 30 countries and regions are shown in Table 2. The United States, Britain, Japan, Germany, Canada ranked the top five; the United States stands out on the top with the highest scores in each indicator, showing its powerful strength of scientific research. Compared with 2007, China has advanced by 8 places and ranked 12th, which is the greatest progress among the top 30 countries. Hong Kong has no change, ranking 22nd. Taiwan has advanced by 1 place and ranked 26th. It shows that China's scientific research strength has really improved, whether looking from the number of universities that are in the ESI rankings or the absolute data in all indicators, these achievements should be confirmed. For instance, the number of universities in China in the ESI rankings has advanced by 21, from 49 universities in 2007 to 70 universities in 2009.There is no change in Hong Kong, still 6. Taiwan has 11 more universities in 2009 than that in 2007. In addition, when compared with the evaluation results of 2007, the scores of each indicator (except for patents) of China have increased, which is a delightful achievement for Chinese universities in the path of transforming into world-class universities. Although far away from the target of "cited times of international scientific papers reaching the world top five" put forward in the *Compendium*, these achievements brighten the prospects of reaching this goal in the future.

3.2 There is still a large gap between Chinese universities and the world-class universities

Chinese universities have made significant progress, while world universities are progressing as well; Is China forward or behind? Slow progress means falling behind. From Table 3, we can see that 73% of the top 100 (the world's top universities), 65.5% of the top 200 and 64% of the top 300 (the high level and famous universities) are in the United States, Britain, Germany, Japan and France. Thus it is obvious that the five countries own the majority of the world's excellent research institutions as well as the strong scientific research strength and influence. In the top 100, there is no universities from China, but there are 3 Chinese universities in the top 200, which are Peking University (155), Tsinghua University (156) and Zhejiang University (165), accounting for 1.5%. There are 7 Chinese universities in the top 400, which are the above-listed three, along with Nanjing University (266), Shanghai Jiao Tong University (267), University of Science and Technology of China (268), and Fudan University (282), accounting for 1.75%. There are 20 Chinese universities in the top 600, including the seven as previously mentioned, Shandong University (408), Jilin University (418), Sichuan University (422), Nankai University (426), Wuhan University (439), Zhongshan University (447), Huazhong University of Technology (461), Harbin Institute of Technology (483), Dalian University of Technology (517), Lanzhou University (518), Xi'an Jiaotong University (550), Tianjin University (562), and Beijing Normal University (575), accounting for 3.33%. There are 34 Chinese universities in the top 800, accounting for 4.25%; there are 47 Chinese universities in top 1000, accounting for 4.7%; there are 55 Chinese universities in the top 1200, accounting for 4.28%; there are 69 Chinese universities in the top 1400, accounting for 4.79%. From the proportion above, the general distribution of 70 Chinese colleges is illustrated. There are extremely rare Chinese colleges and universities in the top 300 and the majority of Chinese universities are ranked after no. 600 or even after 800; in other words, the overall level of scientific research of China is still in a low-and middle- level in the world.

3.3 There is still a large gap in the number of high-quality papers between China and the countries with scientific research powers

From Table 2, we can see that highly cited papers and hot papers of China both ranked

Table 2. 2009 Ranking of Research Competitiveness of Country/Region (Top 30)

Rank	Country/ Region	Published Papers Scores	Total Cited Papers Scores	Highly Cited Papers Scores	Hot Papers Scores	Patents Scores	Highly Cited Ratio Scores	Total Scores
1	USA	1	1	1	1	1	1	100.00
2	UK	3	2	2	2	6	3	47.23
3	Japan	2	3	4	5	2	5	45.09
4	Germany	4	4	3	3	5	4	42.87
5	France	8	7	6	6	7	2	33.32
6	Italy	6	6	7	7	15	6	33.23
7	Canada	5	5	5	4	8	8	32.37
8	China	7	12	11	11	3	7	27.94
9	Australia	9	10	10	8	12	11	25.68
10	Spain	10	11	12	13	11	9	24.84
11	Netherlands	11	8	8	9	18	13	23.93
12	Sweden	12	9	9	10	30	12	23.54
13	South Korea	13	16	16	16	4	18	20.07
14	Brazil	14	19	22	17	14	15	18.42

(continued)

Rank	Country/ Region	Published Papers Scores	Total Cited Papers Scores	Highly Cited Papers Scores	Hot Papers Scores	Patents Scores	Highly Cited Ratio Scores	Total Scores
15	Taiwan	15	20	21	21	10	14	18.07
16	Belgium	17	14	14	14	20	22	17.68
17	Switzerland	20	13	13	12	19	17	16.41
18	Finland	19	15	17	18	36	23	15.87
19	Denmark	21	17	15	15	22	21	15.69
20	Israel	18	18	18	27	21	20	15.56
21	Turkey	16	24	30	24	37	25	14.93
22	Austria	24	21	19	28	24	16	14.70
23	Hong Kong, China	23	22	20	19	13	33	13.88
24	Poland	22	25	25	29	43	19	13.74
25	Greece	26	26	28	33	44	24	12.14
26	Norway	29	23	23	22	35	28	11.86
27	India	25	28	31	30	16	29	11.79
28	New Zealand	30	27	26	23	29	32	11.02
29	Ireland	38	30	27	26	27	26	10.09
30	Singapore	27	29	24	20	17	44	10.03

the 11th; the rankings of highly cited papers have advanced by 5 (compared to 2007) and 11 (compared to 2005); the rankings of hot papers have no change compared to 2007 but have advanced by 11 compared to 2005. All of which show that the influence of Chinese scientific research is continuing to increase. Despite of the achievements and progress of Chinese scientific research, we also could see that there is still a larger gap in absolute number. It is possible to have first-class scientists and even Nobel Prize winners in China after China has high-quality papers and first-class achievements. Less high-quality papers show that China has a lack of scientists with international influence and the talents for innovative knowledge; having less hot papers also indicates the low innovativeness of Chinese scientific papers. For China, the most important of all is paying attention to the cultivation of talents and reserves, and giving the protection in the policy, mechanisms, funding, and the environment in order to change

Table 3. 2009 Distribution of World Universities by Country

Country/ Region	Top 100		Top 200		Top 300		Top 400		Top 500		Top 600	
	Num.	Percentage	Num.	Percentage	Num.	Percentage	Num.	Percentage	Num.	Percentage	Num.	Percentage
USA	54	54.00	85	42.50	109	36.33	137	34.25	157	31.40	178	29.67
UK	7	7.00	17	8.50	28	9.33	35	8.75	40	8.00	47	7.83
Germany	3	3.00	15	7.50	31	10.33	39	9.75	44	8.80	45	7.50
Japan	7	7.00	9	4.50	14	4.67	22	5.50	32	6.40	44	7.33
France	2	2.00	5	2.50	10	3.33	16	4.00	20	4.00	28	4.67
Italy	1	1.00	8	4.00	11	3.67	16	4.00	27	5.40	28	4.67
Canada	5	5.00	9	4.50	14	4.67	20	5.00	21	4.20	23	3.83
Spain	0	0.00	2	1.00	5	1.67	8	2.00	11	2.20	18	3.00
Australia	3	3.00	7	3.50	8	2.67	8	2.00	10	2.00	17	2.83
Netherland	3	3.00	7	3.50	10	3.33	12	3.00	13	2.60	13	2.17
China	0	0.00	3	1.50	7	2.33	7	1.75	15	3.00	20	3.33
Taiwan	1	1.00	1	0.50	2	0.67	3	0.75	5	1.00	8	1.33
Hong Kong, China	0	0.00	2	1.00	4	1.33	5	1.25	5	1.00	6	1.00

the passive situation of Chinese scientific research.

3.4 There is a great distance in research innovation between China and the top countries in the world

A country's patent level and the number of hot papers can reflect the innovation capacity of scientific research. In order to reflect scientific innovation of a country, university or institution, we use the number of invention-type patents as patent data in 2009. Regarding to the proportion of invention-type patents in the world, the patent share of China accounts for only 11% of all granted patents, while the proportion of the top countries in the world is now close to 90%. It shows that scientific research innovation in China is still scarce.

From the data of Table 2, it can be seen that China's patent applications rank the 3rd in the world. However, its absolute number is still only one-fifth of the United States and one-third of Japan. China ranks the 11th in the hot paper indicator. In the total research output and innovation results, China has a relatively small proportion of innovation results. There is a great distance in building an innovative country and world universities. It should require long-term efforts and enhancement of the construction of research innovation.

3.5 Vigorously strengthen the building of top disciplines

In this evaluation, the number of disciplines indexed by ESI increases when compared with 2007. As can be seen from Table 4, the results show that universities in China are still weak in terms of the discipline construction. Except for physics, chemistry, engineering, materials science and other few disciplines, Chinese universities had no more ESI-indexed disciplines. The following specific analysis is about the top 5 universities and Chinese Academy of Sciences which entered the ESI ranking.

Peking University has a total of 12 academic disciplines entering the ESI rankings, which is an increase of three disciplines compared to 2007. The 12 disciplines are: Chemistry (46/853), Mathematics (82/186), Physics (92/647), Geosciences (126/388), Material Science (106/574), Pharmacology and Toxicology (164/329), Engineering (172/959), Biology & Biochemistry (190/611), Plant & Animal Science (211/760), Environment/Ecology (257/474), Clinical Medicine (397/1488), and Social Sciences, General (437/560). Pharmacology and Toxicology, Environment/Ecology, and Social Sciences, General are the increase of three disciplines compared to 2007. Among them, Social Sciences, General is the only discipline which entered the ESI ranking in Chinese universities. Peking University performs well in the Chemistry area which has entered the top 10%. In addition, Engineering, Material Science, and Physics all show great potential.

Zhejiang University has a total of 11 academic disciplines entering the ESI rankings. They are: Chemistry (59/853), Agricultural Sciences (72/375), Material Science (72/574), Engineering (86/959), Computer Science (76/312), Physics (109/647), Plant & Animal Science (172/760), Pharmacology and Toxicology (173/329), Environment/Ecology (212/474), Biology & Biochemistry (254/611), and Clinical Medicine (467/1488), which is also an increase of three disciplines compared to 2007. The three newly indexed disciplines are: Pharmacology and Toxicology, Environment/Ecology, and Biology & Biochemistry. Zhejiang University performs well in the disciplines of Chemistry, Agricultural Sciences, and Engineering.

Tsinghua University has a total of 8 academic disciplines entering the ESI rankings. They are: Engineering (17/959), Material Science (17/574), Computer Science (26/312), Chemistry (80/853), Physics (114/647), Mathematics (120/186), Biology & Biochemistry (385/611), and Environment/Ecology (411/474), showing an increase of three disciplines compared to 2007. The newly indexed disciplines are: Mathematics, Biology & Biochemistry, and Environment/Ecology.

Fudan University has a total of 8 academic disciplines entering the ESI rankings. They are: Chemistry (79/853), Material Science (109/574), Mathematics (128/186), Engineering (283/959), Physics (330/647), Biology & Biochemistry (365/611), Clinical Medicine (515/1488), and Plant & Animal Science (519/760), showing an increase of one discipline compared to 2007. The newly indexed discipline is Biology & Biochemistry.

Nanjing University has a total of 7 academic disciplines entering the ESI rankings. They are: Chemistry (68/853), Material Science (120/574), Physics (158/647), Engineering (212/959), Geosciences (202/388), Environment/Ecology (344/474), and Clinical Medicine (995/1488). This is an increase of two disciplines compared to 2007, and they are Clinical Medicine and Environment/Ecology.

The research strength of Chinese Academy of Sciences is stronger than the universities. It has a total of 19 academic disciplines entering the ESI rankings. Among them, there is one new discipline compared to 2007. Agricultural Sciences (40/375), Biology & Biochemistry (24/611), Chemistry (1/853), Clinical Medicine (574/1488), Computer Science (18/312), Engineering (1/959), Environment/Ecology (4/474), Geosciences (4/388), Material Science (1/574), Mathematics (13/186), Microbiology (75/289), Molecular Biology & Genetics (86/359), Multidisciplinary (2/64), Neuroscience & Behavior (195/390), Pharmacology and Toxicology (24/329), Physics (2/647), Plant & Animal Science (5/760), Social Sciences, General (294/560), and Space Science (41/119), are the18 disciplines that had reached a world-class academic standards, showing an increase of two disciplines compared to 2007. Physics, Chemistry, Engineering, Environment/Ecology, Material Science, and Plant & Animal Science, are the six disciplines that had reached the level of the world's top academic, showing an increase of three disciplines compared to 2007.

Generally speaking, the discipline construction and development of Chinese Academy of Sciences are more comprehensive. As China's largest research institution, Chinese Academy of Sciences is influential in the international arena. But its three disciplines (Economics & Business, Immunology, and Psychiatry/Psychology) still need to be strengthened in terms of the discipline construction.

3.6 Re-examine the characteristics of World-class Universities and the evaluation criteria

As can be seen from Table 4, the top 10

universities all have the 22 disciplines indexed by ESI. And each discipline has great influence. Take Massachusetts Institute of Technology for example, it is generally believed to be single-disciplinary oriented and technology-based. But from the original data and evaluation results, it

Table 4. 2009 World University discipline distribution (Top 10 and Some Chinese Universities)

Rank	Name	Country/ Region	Number of the Disciplines Indexed by ESI	Percentage of 22 ESI-indexed Disciplines	Number of the Top 10 Disciplines	Percentage of Owning Ranking Disciplines
1	Harvard University	USA	22	100.0	14	63.6
2	Johns Hopkins University	USA	22	100.0	6	27.3
3	Stanford	USA	21	95.5	13	61.9
4	University of Washington (Seattle)	USA	22	100.0	10	45.5
5	University of Tokyo	Japan	21	95.5	5	23.8
6	University of California at Los Angeles	USA	22	100.0	6	27.3
7	University of Michigan	USA	21	95.5	4	19.0
8	University of California, Berkeley	USA	22	100.0	10	45.5
9	Massachusetts Institute of Technology	USA	21	95.5	7	33.3
10	University of Toronto	Canada	22	100.0	2	9.1
100	National Taiwan University	Taiwan	15	68.2	3	20.0
123	University of Hong Kong	China-HK	18	81.8	2	11.1
155	Peking University	China	12	54.5	1	8.3
156	Zhejiang University	China	11	50.0	2	18.2
165	Tsinghua University	China	8	36.4	4	50.0
196	Chinese University of Hong Kong	China-HK	14	63.6	0	0.0
261	Hong Kong University of Science And Technology	China-HK	12	54.5	1	8.3
263	National Cheng Kung University	Taiwan	10	45.5	1	10.0
266	Nanjing University	China	7	31.8	1	14.3
267	Shanghai Jiao Tong University	China	5	22.7	2	40.0

(continued)

Rank	Name	Country/ Region	Number of the Disciplines Indexed by ESI	Percentage of 22 ESI-indexed Disciplines	Number of the Top 10 Disciplines	Percentage of Owning Ranking Disciplines
268	University of Science and Technology of China	China	5	22.7	2	40.0
282	Fudan University	China	8	36.4	1	12.5
297	City University of Hong Kong	China-HK	10	45.5	1	10.0
313	Hong Kong Polytechnic University	China-HK	10	45.5	1	10.0
379	Tsinghua University, Taiwan	Taiwan	5	22.7	0	0.0
405	Jiao Tong University, Taiwan	Taiwan	6	27.3	1	16.7
408	Shandong University	China	5	22.7	0	0.0
418	Jilin University	China	4	18.2	0	0.0
422	Sichuan University	China	5	22.7	0	0.0
426	Nankai University	China	4	18.2	1	25.0
439	Wuhan University	China	6	27.3	0	0.0
447	Sun Yat-sen University	China	4	18.2	0	0.0
461	Huazhong University of Science and Technology	China	5	22.7	0	0.0
463	Taiwan Sun Yat-sen University	Taiwan	6	27.3	0	0.0
483	Harbin Institute of Technology	China	3	13.6	1	33.3
508	National Central University , Taiwan	Taiwan	5	22.7	0	0.0
517	Dalian University of Technology	China	4	18.2	0	0.0
518	Lanzhou University	China	5	22.7	0	0.0
538	National Yang-Ming University, Taiwan	Taiwan	4	18.2	0	0.0
545	National Chung Hsing University, Taiwan	Taiwan	6	27.3	0	0.0
550	Xi’an Jiaotong University	China	3	13.6	0	0.0
562	Tianjin University	China	3	13.6	0	0.0
564	Baptist University, Hong Kong	China-HK	6	27.3	0	0.0
575	Beijing Normal University	China	4	18.2	0	0.0

has a comprehensive range of discipline system. It shows that complementary disciplines are also important. The merger of China's universities is justified and reasonable and it can help to build world-class universities. Therefore, world-class universities should have the characteristics of obvious comprehensiveness and cutting-edge innovation. They should be research-type universities with high level and high-impact.

4. Conclusion

To sum up, this paper studies the world-class universities and research institutions. Based on the ranking results, the authors have drawn the following conclusions: (1) the overall scientific research strength of China has remarkable improvement; (2) there is still a large gap between Chinese universities and the world-class universities; (3) China has much less number of high-quality papers than the world's top countries; (4) a great distance exists in research innovation between China and the top countries in the world; (5) China should vigorously strengthen the building of top disciplines; (6) it is necessary to re-examine the characteristics of world-class universities and the evaluation criteria.

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(Received: 2010/6/25; Accepted: 2010/11/16)