

Four Major Chinese Universities

--- Advancing to World's Top Level with
Overwhelming Power of Human Resources ---

(Tentative Translation)

April 2014

Survey Representative

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Japan Science and Technology Agency (JST) has conducted a survey of four major universities in China. The original report was published in September 2013 as Japanese version. The following is the tentative English translation of the summary of this report.

1. Introduction

After the construction of New China, there was still a snubbing / hostile policy against intellectuals until the end of the Cultural Revolution, and Chinese universities were sluggish. After the end of the Cultural Revolution, particularly in accordance with the progress of the reform and opening-up policy followed by the development of economy, Chinese universities have started to develop. Now, the number of students at the universities in China is the world's largest, and a large number of the students from China are studying at famous universities or graduate schools all over the world. In addition, with the recall policy for excellent scientists and researchers staying abroad, the technological innovation capability of the universities in China have gradually improved, and the level of top universities is approaching to that of American and European universities.

Although there are approximately 2,000 universities in China, the authors decided to focus on top-level universities in terms of technological innovation capability, as the objects of survey this time. Then, based on the data of Thomson Reuters and the data in China, the following four universities were chosen: Peking University, Tsinghua University, Shanghai Jiao Tong University, and Zhejiang University.

As the methods of survey, the authors carried out preliminary investigation based on HP of each university, successively interviewed involved persons by visiting the local campuses, and evaluated / analyzed the results.

2. Overview of Universities in China

The number of universities in China in 2012 is 2,358, which is short of 4,495 in the United States, but about twice the number of 1,212 in Japan. The number of students in 2010 consists of 22.3 million as undergraduates and

1.5 million as graduates, which is about twice the number of 12.9 million, which includes undergraduates and graduates in the United States. University entrance rate is 26.9% in 2011, which is about half of 58.9% in the United State or 57.2% in Japan.

The operating costs of universities can be broadly classified as “education expenditure” and “science and technology expenditure.” “Education expenditure” is allotted to the construction of school buildings, purchase of school equipment, and labor costs of education staff. “Science and technology expenses” are allotted to the activities of universities such as basic research, applied research, and development research. The external funding sources for science and technology expenditure are mostly the government and private enterprises.

There are two important funding sources in the government for supporting science and technology expenditure: (1) Ministry of Science and Technology, which is responsible for Program 863, Program 973, and state key laboratories, and (2) NSFC (National Natural Science Foundation Committee), which is responsible for basic researches. As the university intensifying policy, there are Project 211, Project 985, state key subjects, and Project 111. As the human resource acquisition policy, there are Program 100 persons, Yangtze River scholar incentive program, and Program 1000 persons.

3. Findings at Four Major Universities

(1) Peking University

Peking University, which was established in 1898, is one of the most prestigious universities in China. The Faculty of Liberal Arts and the Faculty of Science are traditionally strong, and the School of Medicine is positioned as top class after integrating Beijing Medical University in recent years. However, Peking University is inferior to Tsinghua University in the fields of engineering and industry-university collaboration.

As the characteristics and strong points of Peking University, the following can be point out: (a) excellent students selected from the whole nation, (b) generous financial support for graduates, such as tuition waiver and living expense support, (c) returned scholars from overseas as the driving force for improving science and technology level, (e) environment

that can allow free and unconstrained studies, and (f) improvement in scientific and technological capability supported by extensive research funds.

On the other hand, the following items are left as future challenges: (a) insufficient maintenance and management of frontier research facilities in order not lose to American and European universities, (b) shortage in researcher support system (presently, lack in academic staff and administrative staff), (c) difficulty in the implementation of large-scale themes from the limitation of the number of graduate students per teacher, and (e) lack of charm for top-level overseas teachers and students due to its “export-oriented” internationalization.

(2) Tsinghua University

Tsinghua University was established using a portion of the monetary compensation for the Boxer Rebellion incident, which was returned from the U.S. government. With about 3.6 billion yuan (about 580 million US dollar), which is the largest science and technology expenditure spent by a university of China, Tsinghua University has an excellent research environment. Its engineering department positions at the top in China, and also at the top level in the world. On the other hand, its science department is behind Peking University, and its medical department, which is the future’s important field, is at the lowest level among the four universities surveyed this time.

As the strong points of Tsinghua University, the following can be pointed out: (a) high level in the quality of students, teachers, and researchers, (b) active industry-university collaboration because of traditionally strong engineering department, and (c) adoption of promotion system based on flexible evaluation system. With sufficient supports to students such as scholarship and research assistance funds, the internationalization of students is progressing rapidly. Cooperation with enterprises is very strong and about 70% of research funds are allocated to applied researches. For example, in the Faculty of Engineering and Chemistry, about 70% of research funds are from enterprises, and most teachers are conducting joint research with domestic or foreign enterprises.

On the other hand, the following shortcomings are pointed out: (a) shortage in graduate students at laboratories due to the system to limit the number of graduate students, and (b) restless attitude of students toward

research. In addition, disparity in research capacity is large among teachers, and in particular, only a small number of teachers among their later 50s have overseas experience and are conducting good research. So, it is pointed out that the quality of teachers does not match the high quality of excellent students.

(3) Shanghai Jiao Tong University

Shanghai Jiao Tong University, which was founded in Shanghai in 1896, has distinctive characteristics in engineering, especially in mechanical engineering. In recent years, it has integrated Shanghai Second Medical University.

The research level of this university is high: for example, it holds the first place in the acquisition amount of funds in the general program of NSFC for three years since 2010. Within these funds, the funds in medical field accounts for 40% or more. However, with the exception of mechanical engineering, which is traditionally strong field, this university is relatively inferior to Zhejiang University and Tsinghua University in engineering. The medical department is also strong part, but inferior to Peking University, and nearly neck and neck with Zhejiang University.

The development of Shanghai Jiao Tong University depends largely on geographical factor. Thanks to its location in the international city of Shanghai, it can collect many excellent faculties with research experience abroad, regardless of their native places. In addition, collaboration with enterprises is active because of Shanghai being a gigantic economy city, which provides abundant research funds. The rapid economic development of whole China has brought about a tailwind for Shanghai Jiao Tong University that has strong engineering department. For example, Machinery Dynamics School, which is the mainstay of the university, receives about half of its research funds from private enterprises.

Although collaboration with enterprises will be actively implemented in the future, the university is shifting emphasis in the direction of basic research as the whole university. In recent years, it is also exploring actively the new discipline that makes use of engineering and medicine as the strong point of the university.

(4) Zhejiang University

Located in Hangzhou City of Zhejiang Province, which lies to the southwest of Shanghai, Zhejiang University is one of the prestigious universities in China. Within the universities surveyed this time, this is the only university with local color, and its scale is large. Although Zhejiang University is positioned at the top level in China in engineering, science, and medical departments, it is inferior for instance to Tsinghua University in engineering, and it also lags behind Peking University in science and medicine. However, within the universities surveyed this time, it is the only university with strength in agriculture.

From the fact that it is located in Zhejiang Province, which is an integrated area of China's leading manufacturing sites, this university has strength in high application capability and research / development capability in engineering, which promotes active industry-university collaboration with enterprises. In addition, with a high level of human resources and abounding science and technology budget, this university is also strengthening basic research capability.

In order to achieve the long-term goal to become China's top-level university and even the university of world-class from one local university in China, it is conducting various renovations such as the invitation of overseas high-level researchers, reform of undergraduate admission system, introduction of "Special Academic Zone" system, and reform of the evaluation system of disciplinary faculties.

(5) Comparison of Four Major Universities

The total number of each university surveyed this time is nearly 1.5 to 2 times those of the University of Tokyo in Japan or Seoul National University in South Korea. The number of undergraduates is not much different, but the number of graduates is high at the universities of China. The number of teaching staff does not much differ from those of the University of Tokyo and Seoul National University. The four universities surveyed this time are comprehensive universities with almost all faculties. The numbers of foreign students and foreign teachers are almost the same as those of the University of Tokyo and Seoul National University.

The total budget of the university is about 11 billion yuan at Tsinghua University and Peking University, and about 7 billion yuan at Zhejiang

University and Shanghai Jiao Tong University. These figures are smaller than about 25 billion yuan (IMF exchange rate conversion; the same shall apply hereinafter) of Harvard University, about 18 billion yuan of MIT, and about 17 billion yuan of the University of Tokyo. However, it is considered that these figures exceed those of these universities in purchasing power parity conversion. As for science and technology expenditure, Tsinghua University comes first in China at about 3.5 billion yuan, and three other universities spend about 2.7 billion yuan.

According to the simple comparison of Thomson Reuters, as for the number of papers, Zhejiang University ranks at 62nd in the world ranking (from 2003 to 2013), Tsinghua University at 75th, Beijing University at 85th, and Shanghai Jiao Tong University at 87th. These figures are not so high when compared with 17th of the University of Tokyo and 42nd of Seoul University. In the comparison of the number of literature citation, these universities in China are all 100th or below, where the difference is spread compared with 35th of the University of Tokyo. As for the number of literature citation in individual field, the universities in China are strong in chemistry, materials science, and engineering, and weak in medicine and life sciences. Tsinghua University is ranked in the world at 10th in materials science and 11th in engineering, which are the world's top level, overtaking the ranking of the University of Tokyo.

When it comes to the number of articles published in "Nature," the universities in China have progressed in recent years. However, compared with the 9th of the University of Tokyo (2012), Tsinghua University at 88th and Peking University at 93th are behind the world's top class yet.

According to the international university ranking of QS and Times of the UK basis, Tsinghua University and Peking University are ranked at almost the same position and not much different from the ranking of the University of Tokyo and Seoul National University. However, according to the ranking of Shanghai Jiao Tong University and Taiwan, there is considerable distance from the ranking of the University of Tokyo.

According to the university ranking in China, the order is Peking University, Tsinghua University, Zhejiang University, (Fudan University), and Shanghai Jiao Tong University, while Peking University is ranked at top in medicine and science and Tsinghua University is ranked at top in engineering.

4. Features of Four Major Universities in China

(1) Energy and Self-confidence

As the common trait among the university teachers with whom the authors have interviewed this time, it is noticed that each person is full of energy and self-confidence. The brilliance in the stage of development, which is found in all sectors of society in China, such as political circles, official circles, and industrial circles, can also be seen in the major universities of China. In addition, influential teachers enjoy blessed life in general. Industry-university collaboration is very active, and a large amount of research funds are allocated to their own laboratories. Teachers often start their own business or join enterprises as the executives. A majority of current teachers have experienced overwhelming economic development due to success in economic policy after the Cultural Revolution had ended, which has led to their energy and self-confidence.

(2) Clear-cut Goal to Reach World's Top Level

The goal of the top universities in China is very clear. Their goal is that the own university reach the world's top level that does not lag behind leading universities such as Harvard University and MIT in the United States, as well as Cambridge University in the United Kingdom. Although it would be impossible to line up with Harvard University immediately at the moment, they are making efforts for reform with the goal in mind that between from a few decades to a hundred years, they can catch up with and overtake major American and European universities.

(3) Flexibility

What impressed us most strongly in the survey of four universities this time is the flexibility with boundless freedom of the university system in China. Since China is the one-party dictatorship of the Communist Party, its political system has rigid structure. Therefore, the authors imagined that the research activities at universities are systematic under rigorous control, but the reality was quite different. Of course, there is the rough framework of structural and legal restriction on the installation and operation of universities even in China, but the authors felt a strong impression on the

latitude that teachers are allowed to freely behave on what is considered to be good as far as becoming the number one in the world and achieving sufficient results. Regarding payroll, personnel affairs, and evaluation, even in the same faculty of the same university, there is a degree of freedom that can determine things depending on teachers' own judgment and fund-raising results.

(4) Abundant Research Funds

Since the persons who accepted our interview this time are mostly powerful and famous teachers or researchers, most of them replied that they have sufficient research funds for their laboratories.

According to the data, Tsinghua University, which has the engineering department of world's top level, has the most abundant research funds. On the other hand, Shanghai Jiao Tong University and Zhejiang University, whose engineering departments are also strong, gather abundant private funds through industry-university collaboration. As for Peking University, whose engineering department is not very strong and whose science department, which has little industry-university collaboration, is at the world's top level, it cannot enjoy so much the fruits of private funds. However, since this university is located in the capital Beijing, where the Ministry of Science and Technology and NSFC as the major funding sources of science and technology in China exist, necessary research expenditure is sufficiently reserved. In addition, the Department of Medicine, which is involved in researches close to the exit of academy even at Peking University, links with industry is strong, and teachers who accepted the visit this time are supported by large pharmaceutical companies.

(5) Excellent Students

What has given the strongest impression to us in this survey is the profound confidence of university teachers toward their students, and this is common in four universities. When we asked what the largest advantage of the universities of China is, most of the teachers stressed unanimously the excellence of their students.

Students in China study frantically for four years. They live in a student dormitory on the campus, and since they use the shops and cafeterias on the campus, they mostly never go walk out of the campus to streets. In addition,

after graduating from undergraduate course, the students of top-level go abroad for studying in such prestigious universities as in the United States. On the other hand, as for graduates at each university, half of enrollment is from other universities in China. These students, who could not enter Tsinghua University or Peking University in undergraduate admissions at that time, study desperately for four years at local universities, sit for a graduate school entrance examination to gain excellent results, and enter as graduates at Peking University or Tsinghua University. The students who joined through the graduate school entrance examination and those who stayed at graduate schools without going abroad study hard competitively. Excellent students after obtaining doctorate also go abroad for post-doctoral training, for instance, in the United States.

The situation blessed for graduate students in China is that in the case of top-level universities, graduate school tuition is free for most graduates, and in addition to this, living expenses are paid from the laboratory they belong to. Amount to be paid is also different between each laboratory, and the laboratory that has attracted much research funds can pay much living expenses. Graduate students, who were provided with the cost of living, strive to engage in experiment or the like in order to reward desperately for the debt for the professor who presides over the laboratory.

In this way, excellent young persons, who won the severe competition among China with intrinsically large population, are enrolled, and in addition, they are always exposed to competition in the period from the enrollment as undergraduates until doctoral graduation. This fact has led to the belief of teachers that the students of major universities in China are excellent in the world.

(6) Undergraduates and Graduates Aiming at Internationalization

What is really important for universities is to implement research and education that are internationally valid. This idea is thoroughly accepted in China, and universities think that the internationalization of their teachers and students is important, and they are thoroughly promoting this idea. The four universities surveyed this time encourage excellent graduates to study abroad as much as possible, and the teachers in charge burden the costs for graduates in their doctoral or master course to participate in overseas events, such as international conference or training. In addition, it is ruled that

researchers without experience in foreign universities are not adopted as teachers in general, and it is strongly encouraged to send research life abroad for the doctors who have been brought up at own universities.

(7) Carefully Selected Teachers

The strength of the major universities in China also exists in the high quality of their teaching staff. The teachers who were interviewed in this survey mostly have research experience abroad, and they have strong confidence in conducting top-level research with sufficient recognition of the research level of the world. In addition, in employing a teacher in one's own laboratory, they do not matter what university he/she comes from, or even the age and gender.

(8) Active Cooperation between Industry and University

Apart from the state-owned enterprises for defense etc., common enterprises in China do not have strong capability in research and development. For this reason, instead of performing their own technological development, technologies are introduced from abroad, or the development is entrusted in many cases to universities in China or institutes such as the Chinese Academy of Sciences. For the universities in China, there are merits in that research and development funds flow in, and that the technologies developed by themselves are actually applied to real fields, which further promote industry-university collaboration.

The survey of OECD revealed that whopping 33.2% of the science and technology expenditure of Chinese universities are funded from the private sector in 2010. Compared with 2.6 % in Japan and 5.3% in the United States, this ratio is very high.

(9) Just Falling Short of Basic Research Capacity

What annoys most of the major universities in China is the fear that basic research is inferior from the viewpoint of the world level. There are excellent researchers, equipment and facilities are global levels, and research funds are sufficiently usable at the same level as in the United States, major European countries, and Japan. However, these universities do not display their power yet in basic research, which is the major mission of university itself.

Although the major universities in China are looking to the world's top level with overwhelming economic development, they have not reached the level of top universities in the United States and major European countries, when it comes to originality in individual research. Excellent research with originality cannot be achieved by scholars just because of good academic results at university in China or the experience of research in foreign countries such as the United States. In order to acquire the ability to exert originality, the accumulation of history and culture in academic activities and basic researches in the whole Chinese society is required. At the universities of China, which had risen in a very short period of time after the Cultural Revolution, the accumulation of academic activities and basic researches that support originality may not be sufficient.

(10) Excessive Industry-university Collaboration

Industry-university collaboration is very prosperous in the universities of China even from the world's viewpoint. Industry-university collaboration has merits as mentioned before, but also has demerits. From the industry side, since it spends research funds, it strongly urges the development of the technology that can be used by the industry. When too much of awareness is paid for the outcome to the industry side, the flexibility of research is lost, and basic research with originality tended to become impossible.

In the United States and Europe, there is research and development capability originally in the industry side in its own way, and on the other hand, there is a soil of basic research based on free ideas in the university side. To do the technological development that cannot be attained only by either side is the basis of industry-university collaboration. In the case of China with the weak potential of the industry side, it seems that the research and development capability of university are bought with corporate funds. In order for the major universities in China to become the world's top in a true sense, the modification of a sense of distance between universities and enterprises would be required.

(11) Restless Due to Full Schedule

All teachers who were interviewed in this survey were very busy. They said that they had just returned yesterday or were about to go out in the following day, to and from somewhere. Many teachers frequently travel to

and from between China and foreign countries such as the United States, Europe, and Japan. In addition, industry-university collaboration is prospering very widely, and some teachers at the faculty of engineering are also serving as the board members of corporations. They frequently travel on business to the provincial cities of China, where the offices or plants are located. Being busy in such way makes it difficult to be compatible with the advancement of original basic research, which is the primary mission of university research.

In addition, when research faculties become PI (Principal Investigator) in China, they are required to decide all matters by themselves, including indoor arrangement, layout, and equipment of their laboratories, and also they must determine by themselves the adoption of researchers as their subordinates. This system is believed to be close to that in the United States. However, different from the universities in the United States, where management staff and support system to researchers are well arranged, the burden of this obligation is quite large at the universities in China.

(12) Short-sighted Evaluation

Evaluation system for personnel and research results at the universities in China has adopted the “principle of reward and punishment.” However, due to the scarce accumulation of academic experience mainly in basic research, papers and patents, which are visible and quantifiable, have become the focus of evaluation, rather than evaluation from an academic perspective.

However, introspection on the past has recently appeared at the major universities in China. They fear that when such numerical evaluation is to be continued basic research as the mission of university would not grow. Among the universities interviewed this time, Peking University and Tsinghua University in particular showed increasing momentum to improve the evaluation system based on these automatic indexes.

(13) Students without Originality Due to Cramming System

It is often said that although the students of major universities in China are excellent and study very hard, when they have become researchers, it would be difficult at the present time to produce competitive or more excellent results, compared with researchers in the United States and major

European countries. As the reason for this, the lack of originality is pointed out. Many opinions indicate that since the best students in China experience severe examination war and subsequent competitive college life, they are very excellent in memory power for recording good results in tests, but they lack of capacity to think by themselves and to conduct researches with their own idea without only pursuing other researches.

Despite the above fact, hope for the future of China appears in the internationalization of students. If the universities in China continue to withdraw into own shells in China, the lack of originality would be a problem. However, as mentioned above, most of top-level students and PhD researchers of China have experience of studying in foreign countries like the United States. There is a possibility that the regressive system such as cramming education in China will be corrected during the course of internationalization.

(14) Limitation in the Number of Graduate Students

Although flexibility is high at the universities of China, the number of graduate students at each laboratory is relatively strictly controlled. The purpose is considered to ensure the quality of education for graduate students. Specifically, the number of graduate students per professor is limited to two persons, and even the laboratories with a lot of research funds from enterprises or the central government are not exception. Although there is some flexibility in such a way that professors accommodate graduate students through borrowing – lending with each other, but this number is not many.

There is no such limit in the Chinese Academy of Sciences as the rival of universities in China. When it comes to the researches like physical fitness game that require a large number of staffs, universities lag behind the Chinese Academy of Sciences. Although the adoption of such system as to limit the number of graduate students at the universities in China, which adopt flexible systems with boundless freedom in other fields, gives us strange impression, this might be a necessary measure in terms of education.