Chinese University and Industry

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Academic Ranking of World Universities

(ARWU)

Dream of Chinese for WCU

- WCU is a dream for generations of Chinese. It's not only for pride, but also for the future of China.
- Recently, Chinese government has launched several initiatives for research universities. The best-known one is specially designed to build WCU.

Extra Funding in 985 Project (2001-2003)

Institution	Funding (Billion RMB)
Peking Univ. **Tsinghua Univ.**	**1.8**
Fudan Univ. **Nanjing Univ.** **Shanghai Jiao Tong Univ.** **Zhejiang Univ.**	**1.2-1.4**
Univ. Sci. Tech. China (CAS) Xi'an Jiao Tong Univ. (Shanxi) Harbin Inst. Tech. Heilongjiang)	0.9-1.0

Goals of Top Chinese Universities

- **Many top Chinese universities have setup their strategic goals as WCU.**
- **Most of them has also set a time table for reaching the goal of WCU. For example:**
  2016 for Peking University
  2020 for Tsinghua University

Questions About WCU

- Is there a clear definition for WCU?
- Are there any common characteristics for WCU?
- How many WCU should there be in the world?
- What are the positions of Chinese universities in the world?
- How can Chinese universities improve themselves to reach the goal of WCU?

Ranking of World Universities

- Our original purpose of doing the Academic Ranking of World Universities (ARWU) was to find out the position of Chinese universities in the world and the gap between them and WCU.
- ARWU was put on the internet upon on the encouragement of colleagues from all over the world. There have been more than 2,000,000 visitors since 2003, an average of 2000 every day.

Features of ARWU

- It's done for pure academic interests, without any external support. It has nothing to do with any commercial business activities.
- Only non-subjective indicators and internationally comparable data that everyone could verify in some way were used.

Cautions About Ranking

- The quality of universities may not be precisely measured by mere numbers.
- The quality of world universities may not be accurately compared because of the huge differences of various types of universities in different countries.
- The choice of indicators and their weights make significant differences to the final ranking results.

Methodologies and Results of ARWU

Selection of Universities

- Any university that has any Nobel Laureates, Fields Medals, Highly Cited Researchers, or papers published in Nature or Science.
- Major universities of every country with significant amount of papers indexed by SCIE, SSCI and AHCI.
- Number of universities scanned: >2000
- Number of universities actually ranked: >1000
- Number of ranked universities on our web: 500

Design of Ranking Criteria

- It would be impossible to rank the quality of education, administration, campus culture, and national contribution etc.
- We chose to rank universities worldwide by their academic or research performance, which is a good indication of its international reputation.

Ranking Criteria and Weights

Criteria	Indicator	Code	Weight
Quality of Education	Alumni of an institution winning Nobel Prizes and Fields Medals	Alumni	10%
Quality of Faculty	Staff of an institution winning Nobel Prizes and Fields Medals	Award	20%
	Highly cited researchers in 21 broad subject categories	HiCi	20%
Research Output	Articles published in Nature and Science*	N&S	20%
	Articles in SCIE , SSCI and AHCI	SCI	20%
Size of Institution	Academic performance with respect to the size of an institution	Size	10%
Total			100%

For institutions specialized in humanities and social sciences such as London School of Economics, N&S is not considered, and the weight of N&S is relocated to other indicators.

Main Sources of Data

- **Nobel laureates:**
  http://www.nobel.se
- **Fields Medals:**
  http://www.mathunion.org/medals/
- **Highly cited researchers:**
  http://www.isihighlycited.com
- **Articles published in Nature and Science:**
  http://www.isiknowledge.com
- **Articles indexed in SCIE, SSCI, and AHCI:**
  http://www.isiknowledge.com

Top 500 Universities by Region

Region	Top 20	Top 100	Top 200	Top 300	Top 400	Top 500
Americas	17	57	100	140	165	198
Europe	2	35	79	123	168	205
Asia-Pacific	1	8	23	36	65	93
Africas				1	2	4
Total	20	100	202	300	400	500

Top 500 Universities by Country

	Country	Top 20	Top 100	Top 200	Top 300	Top 400	Top 500
1	United States	17	53	90	119	140	165
2	United Kingdom	2	11	14	30	36	40
3	Japan	1	5	9	13	24	34
4	Germany		5	16	23	33	40
5	Canada		4	8	17	19	23
6	France		4	8	13	19	21
7	Sweden		4	5	9	11	11
8	Switzerland		3	6	6	7	8
9	Netherlands		2	7	9	11	12
10	Australia		2	6	9	10	14
19	China			2	6	15	18

Problems with and Future of ARWU

Methodological: Social Sciences

- **Many well-known institutions specialized in humanities and social sciences are ranked relatively low.**
- **Nevertheless, if a university specialized in social sciences and humanities had Nobel Laureates in economics and Highly Cited Researchers in social sciences, it should have good standing.**
- **Since 2004, the indicator of N&S is not considered for institutions specialized in humanities and social sciences, its weight is relocated to other indicators.**
- **Since 2005, a weight of 2 for articles indexed by SSCI and AHCI is considered.**

Methodological: Language Bias

- English is the language of international academic community.
- Any ranking based on academic performance will be biased towards institutions in English-speaking countries.
- Possible solution: any paper published in non-native languages are offered a special weight.

Methodological: Award and Alumni

- **Universities started after the 1911 do not have a fair chance.**
- **Disciplines not related to the awarding fields do not have a fair chance. Other important awards include Abel, Pulitzer, Turing, Tyler, etc.**
- **Institutions for winning awards and those for doing the researches may not be the same.**
- **Institutions for obtaining degrees and those for pursuing the studies may not be the same.**
- **Postdoctoral training is not considered.**

Methodological: Per Capita Performance

- The weight of the Size indicator for per capita performance is rather low. Large institutions have relatively high positions in the ranking.
- However, it's very difficult to obtain internationally comparable data on the number of academic staff.
- The types of academic staff: such as purely teaching staff, teaching and research staff, purely research staff.
- The ranks of academic staff: such as professor, associate professor, reader, lecturer, instructor, scientist etc.

Technical: Attributions

- **Many universities have more than one commonly used names: such as Virginia Tech and Virginia Polytechnic and State University.**
- **Variations due to translation: such as *Univ Koln* and Univ Cologne, Univ Vienna and Univ Wien.**
- **Abbreviated names: such as ETH Zurich for Swiss Federal Institute of Technology Zurich.**
- **Some authors only write their departmental or institute name without mentioning their university name.**

Technical: Definition of Institution

- **University systems: such as Univ California system, Univ London system.**
- **Affiliated institutions and research organizations: such as *Ecole Polytechnique Montreal* (affiliated to University of Montreal), CNRS Labs (affiliated to French universities).**
- **Teaching and affiliated Hospitals: complex!**
- **Our answer: according to author's expression.**

Other Technical Problems

Merging, splitting, inheriting, discontinuing, name-changing of institutions such as:

- **Univ Kwazulu-Natal in South Africa merged from Univ Natal and Univ Durban-Westville.**
- **University of Innsbruck in Austria splitted into Univ Innsbruck and Innsbruck Medical Univ.**
- **Humboldt Univ Berlin and Free Univ Berlin inheriting the Nobel Prizes of the Berlin University before world war II.**
- ***Vrjie Universiteit Brussel* and *Universite Libre Bruxelles* share the same English name of Free University of Brussels.**

Future Efforts

- Study all the above mentioned problems and continuously improve the ranking methodologies.
- Establish more comprehensive databases of WCU.
- Update ARWU annually (in August) .
- Provide ranking of broad subject areas such as physical sciences, social sciences, life sciences, clinical medicine, and engineering etc.

Future Efforts (Cont'ed)

- **Provide ranking of universities specialized or oriented in engineering, medicine, etc. based on the scientific classification of world universities.**
- **Provide ranking with a much higher weight of the Size indicator once internationally comparable data on the number of academic staff were obtained.**

Challenges of Building WCU in China

Challenges from the Inside of Universities

- **Difficulties in gaining desired autonomy for effective leadership and management.**
- **Difficulties in recruiting world-class scholars who carry out research for interests/curiosities.**
- **Difficulties in balancing fundamental research, applied research and industrial development.**

Challenges from the outside of Universities

- **Strong competition for research funding and excellent graduate students from independent research institutes.**
- **Strong competition for funding from outside the education, science and technology sectors.**
- **Strong competition from other countries, particularly those with special initiatives such as COE of Japan, BK21 of Korea, Elite University of German, etc.**

Chinese Universities & Innovation System

Soviet Model

- In 1950s, China adopted the Soviet model of establishing independent research institutes, including Chinese Academy of Sciences (CAS), Chinese Academy of Social Sciences, and the numerous institutes belonging to various ministries of the central governments.
- Until the 1980s, most research activities were carried out in those independent research institutes, covering almost all disciplines.
- The focus of Chinese universities was on teaching.

Research at Universities in 1980s

- The establishment of National Natural Science Foundation of China in 1986 offered Chinese universities with opportunities of competing for research funding.
- The setup of many research initiatives by the Ministry of Science and Technology and other ministries of Chinese central government also provided major opportunities.
- Meanwhile, Chinese universities have been paying more and more attention to research, partly due to the lack of university funding and the low income of professors.

Current Status of Research at Universities

- **Universities have become a major player:**
- **Articles indexed in SCIE and SSCI: 75% of all China**
- **Articles indexed in Engineering Index: 75% of all China**
- **Research grants from NSF China: 75% of national total**
- **State Key Labs: 63% of national total**
- **Academicians: 37% of national total**

- **Competition from independent institutes is strong:**
- **CAS has been approved to grant degrees at the graduate level, its enrolment plan is 50,000 in 2010.**
- **CAS has been provided with extra financial support, about 2 billion RMB per year.**

Performance of Top 9 Universities

Indicator	Percentage of All Universities
Articles in SCIE and SSCI	42.1%
State Key Labs	44.3%
Research income	20.2%
Doctoral students	20.0%
National Key Programs	30.6%
Academicians	41.5%

Performance of Top 53 Universities

Indicator	Percentage of All Universities
Articles in SCIE and SSCI	73.8%
State Key Labs	92.0%
Research income	60.0%
Doctoral students	78.0%
National Key Programs	75.2%
Academicians	72.5%

Chinese Universities and Industry

Strong Linkages

- University-industry collaboration is very popular in China.
- It is encouraged by both central and local governments in many ways.
- There are ongoing debates about the nature of research which are carried out at universities.

Major Types of Collaboration

- Enterprises provide contracted research projects to universities.
- Enterprises and universities apply governmental R&D funding and carry out researches together.
- Enterprises and universities develop joint laboratories or research centers of common interests.
- Establish professional extension centers on campus to disseminate research findings.

Pull and Push Factors

- The lack of R & D capability in most Chinese industrial enterprises means they could not rely on themselves for solving complex technical problems.
- Those industrial enterprises thus need technical services from independent research institutes and research universities.
- Government appropriation for Chinese universities has been far from adequate over a long period of time.
- Research funding from the industry has become a major source of income for Chinese universities.

Sources of Research Income

- Research funding from the industry has become a major source of income for Chinese universities.
- On average, less than half of the research income of national universities is from government sources. The rest is mainly from industries.
- The percentage of governmental research income varies greatly by institutions, 88% for Peking University whereas 29% for Harbin Institute of Technology.

Sources of Research Income (Cont'ed)

Institution	2004 Total (Million RMB)	Percentage from Governments
80 National Universities	**17,777**	**49%**
Top 9 Universities	**6,805**	**54%**
Peking Univ.	**797**	**88%**
Tsinghua Univ.	**1,365**	**48%**
Fudan Univ.	**450**	**75%**
Zhejiang Univ.	**1,135**	**49%**
Nanjing Univ.	**241**	**74%**
Shanghai Jiao Tong Univ.	**983**	**45%**
Univ. Sci. Tech. China	**309**	**87%**
Xi'an Jiao Tong Univ.	564	50%
Harbin Inst. Tech.	957	29%

R&D Expenditures of Universities

- National universities of China are spending the majority of their research funding on applied research (62%), and a significant amount on development (15%).
- The percentage of R&D funding spent on basic research varies greatly by institutions, 58% for Peking University whereas 7% for Harbin Institute of Technology.

R&D Expenditures (Cont'ed)

Institution	Basic Research	Applied Research	Development
80 National Universities	**23%**	**62%**	**15%**
Top 9 Universities	**26%**	**61%**	**13%**
Peking Univ.	**58%**	**26%**	**15%**
Tsinghua Univ.	**25%**	**74%**	**1%**
Fudan Univ.	**43%**	**46%**	**11%**
Zhejiang Univ.	**16%**	**56%**	**28%**
Nanjing Univ.	**49%**	**51%**	**0%**
Shanghai Jiao Tong Univ.	**13%**	**64%**	**22%**
Univ. Sci. Tech. China	**77%**	**18%**	**4%**
Xi'an Jiao Tong Univ.	26%	34%	40%
Harbin Inst. Tech.	7%	92%	1%

University Science Parks

- The first University Science Park was established in Northeast University at Liaoning Province in 1990. Followed by Tsinghua, Peking, etc.
- In 2000, the central government recognize the contribution of University Science Parks to the country's economy and decide to establish more.
- Up to 2005, there are 50 University Science Parks approved jointly by the Ministry of Science and Technology and the Ministry of Education. The 50 University Science Parks are affiliated to more than 100 universities.

University Science Parks (Cont'ed)

By the end of 2002, University Science Parks:

- **Attracted 30 billion RMB investments,**
- **Employed 100,000 persons in 1,200 R&D centers,**
- **Supported 5,500 high-tech companies,**
- **Incubated 2,300 start-ups, of which 29 had been listed on stock exchange.**

Patents and Technology Transfer

- Patent activity in China has been much weaker than that in industrialized countries.
- Before 2003, foreigners were more active than Chinese in patenting in China. However, Chinese are becoming more and more likely to patent.
- Universities are paying more and more attention on patenting. Among the 7,800 patents approved in 2003 by the Chinese Patent Office, 1,730 were from universities.
- The percentage of patent commercialization is low and revenues from patent licensing are minimal.

Chinese Industry in 2020

- At the national conference on science and technology held by the central government in January, 2006, it was clearly stated that enterprises will become the main player of technical innovation in China in 2020.
- On one hand, the reliance of industry on universities for technical services will be less and less. On the other hand, industry will need more advanced technologies from universities.

Chinese Universities in 2020

- Chinese universities will carry out less developmental research, but more fundamental and high-tech research.
- Chinese universities will commercialize their research results mainly through patent licensing.
- Chinese universities will incubate more high-tech companies through university science parks.
- Chinese universities will have regulations and criteria for their staff involving in technology transfer and enterprises.
- Chinese universities will not be directly involved in the management of enterprises.

Thank you very much for your attention!

http://ed.sjtu.edu.cn/ranking.htm
http://ed.sjtu.edu.cn/en/