

Leveraging Public Research for Innovation and Growth: China

CASTED

19 July, 2016

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1. Overview of the role of universities and PROs in the country's national innovation system

- 1.1 the development of Chinese universities and PROs

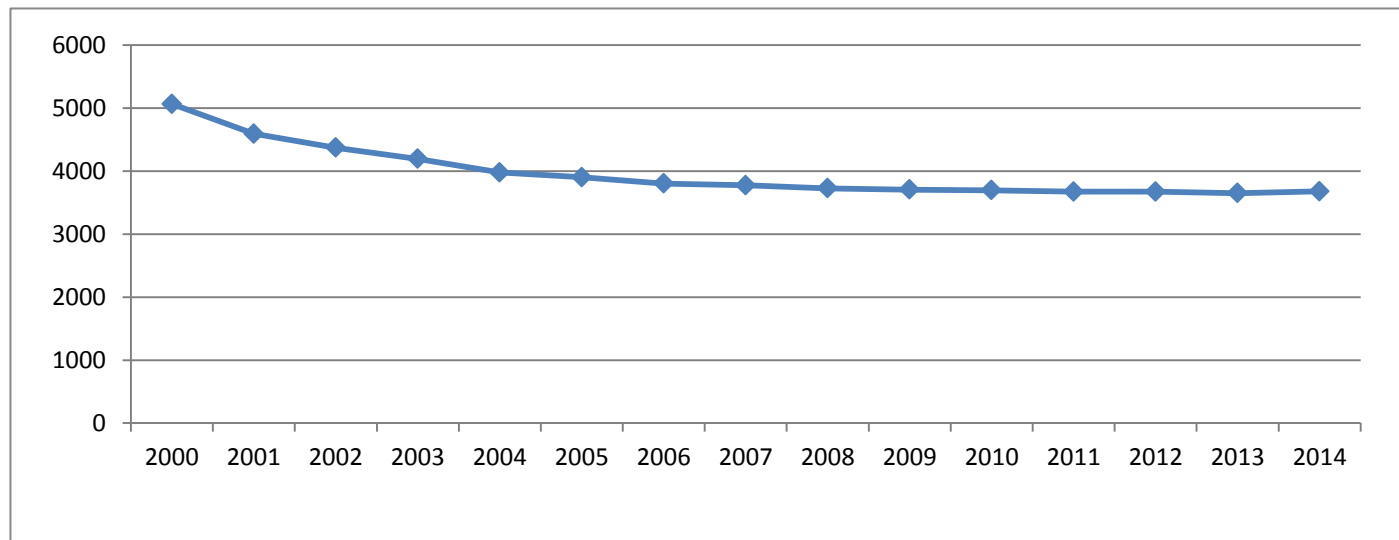
PROs developed with the reform of science and technology management system

—— **Decision on Reforming the Science and Technology System(1985)**, promoting the combination of S&T with economic systems, the PROs' structure and function had changed a lot. The number of PROs reduced gradually, from above 5000, to 3000, majoring in the fields of fundamental, front technology and social public welfare research.

1. Overview of the role of universities and PROs in the country's national innovation system

— R&D institutions held by enterprises and other social funds increased substantially.

In 2014, Chinese PROs supported by financial assistance at or above the county level reached 3677, among these, 720 R&D institutions belonged to the central government, the other 2957 R&D institutions belonged to the local governments.



the number of Chinese PROs (2000–2014)

1. Overview of the role of universities and PROs in the country's national innovation system

— Among the R&D institutions set up by the central government, Chinese Academy of Sciences is one of the most important.

12 branch academies

105 institutions

3 universities

more than **130** national important laboratories and engineering centers

more than **210** field observation station

operating more than **20** major national S&T infrastructures

68 thousand formal staffs

52 thousand graduate students

a complete system of natural sciences

1. Overview of the role of universities and PROs in the country's national innovation system

education reform and development of universities

— Since 1990s, education system pay more attention to scientific research, emphasizing both teaching and scientific research in many high level universities. Universities are required to step out of the **ivory tower**, to offer all kinds of technology services to the society.

— "211 Project" (launched by the Ministry of Education) promote important universities **both focusing on teaching and research functions**.

— the Law of Higher Education(1998) made it clear Chinese universities have three basic functions— **cultivating talents, scientific research and social service**.

— "985 Project" support some important universities to establish the world level universities, China began to establish **research universities**.

— In 2014, China had 2824 universities, 1566 thousand teachers. Until now, China has 112 "211 Project" universities, 37 "985 project" universities.

1. Overview of the role of universities and PROs in the country's national innovation system

1.2 Universities and PROs play important role in the national innovation system

National Outline for Medium and Long Term S&T Development (2006)

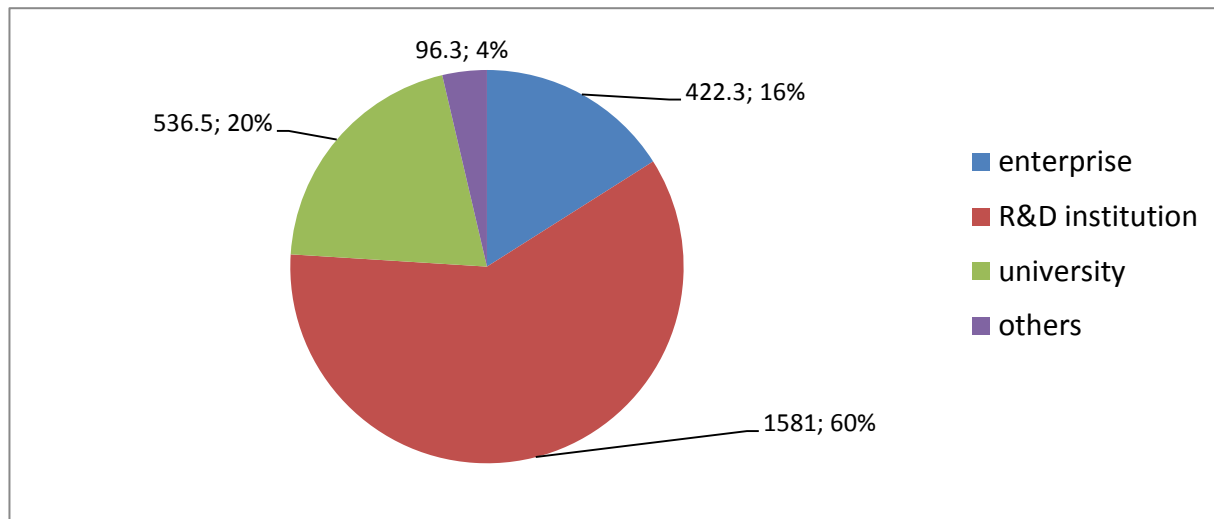
— **Universities** are “one of the most important powers of fundamental research and high technology original innovations”, “an emerging force of solving important science and technology problems, promoting technology transfer and transformation”.

— **Scientific research institutes** majoring in fundamental research, front technology research and social welfare research are important strength of national innovation, which play backbone and leading role in national innovation system.

1. Overview of the role of universities and PROs in the country's national innovation system

1.2 Universities and PROs play important role in the national innovation system

— Since late 1990s, Enterprises have become the main body of the whole society R&D performing, scientific research institute and universities are main bodies of government R&D expenses. In 2014, 60% of government R&D expense was performed by scientific research institute, 20% of government R&D expense was performed by universities.



performing
department of
government
R&D expense
in 2014

1. Overview of the role of universities and PROs in the country's national innovation system

1.2 Universities and PROs play important role in the national innovation system

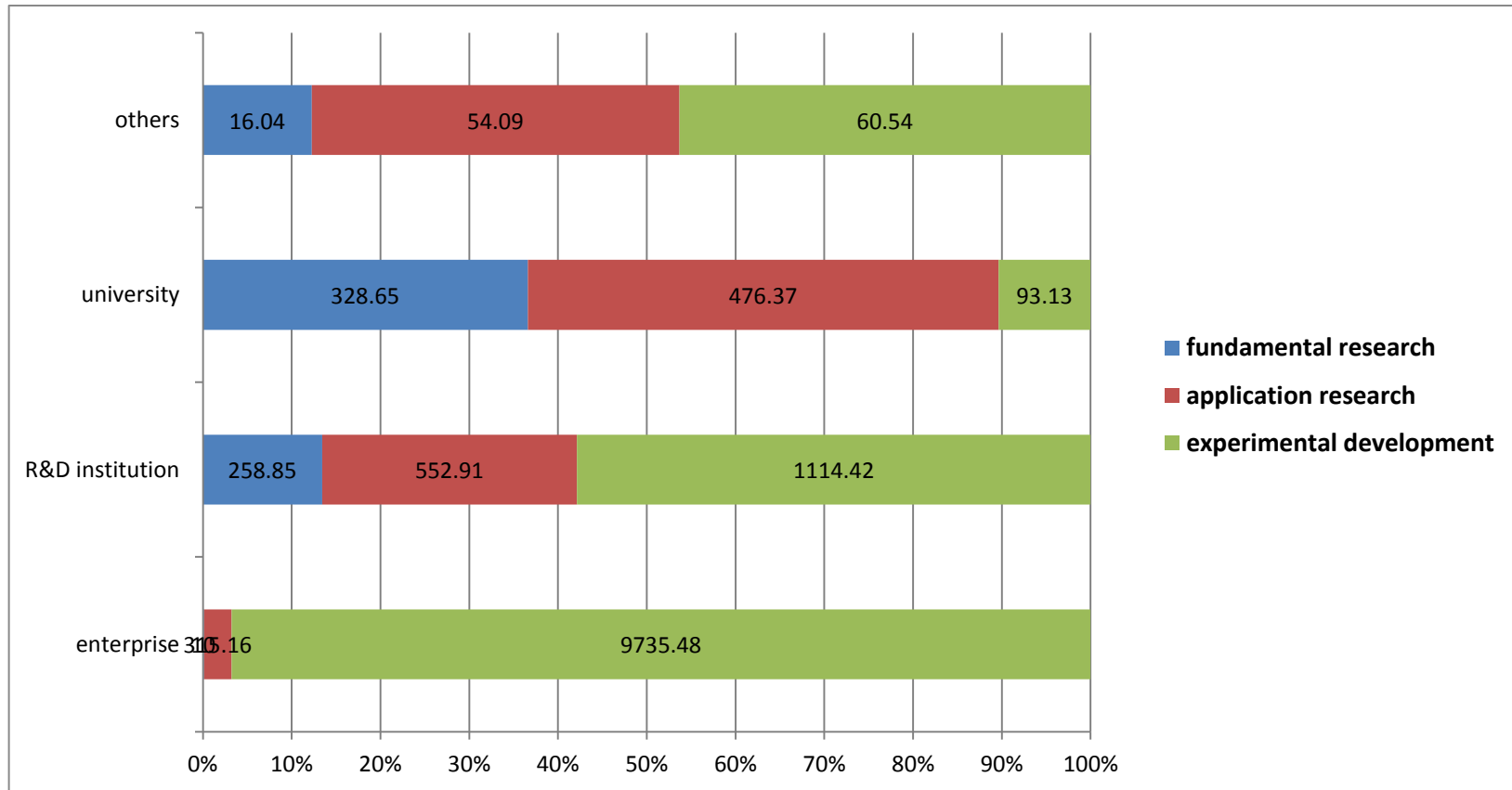
— **Fundamental research** played more and more important role in university R&D activities, but **application research is still most important.**

— **R&D personnel** of fundamental research and application research increased faster than expense increasing rate.

— Universities are the main bodies of **Chinese SCI papers output**, accounting for 78.77% of papers during 2003-2010.

1. Overview of the role of universities and PROs in the country's national innovation system

1.2 Universities and PROs play important role in the national innovation system



Chinese R&D expense distribution by institutions and activities (2010)

1. Overview of the role of universities and PROs in the country's national innovation system

1.2 Universities and PROs play important role in the national innovation system

Annual growth rate of universities R&D activities by types

time (year)	2001-2005	2006-2010	2011-2014
	18.80%	16.63%	9.25%
Fundamental research	24.44%	20.30%	13.17%
Application research	17.17%	19.67%	8.56%
Experimental development	17.72%	3.32%	1.21%
	5.83%	3.69%	3.86%
Fundamental research	8.87%	5.92%	6.31%
Application research	3.83%	5.54%	2.39%
Experimental development	6.85%	-11.65%	-1.70%

1. Overview of the role of universities and PROs in the country's national innovation system

1.2 Universities and PROs play important role in the national innovation system

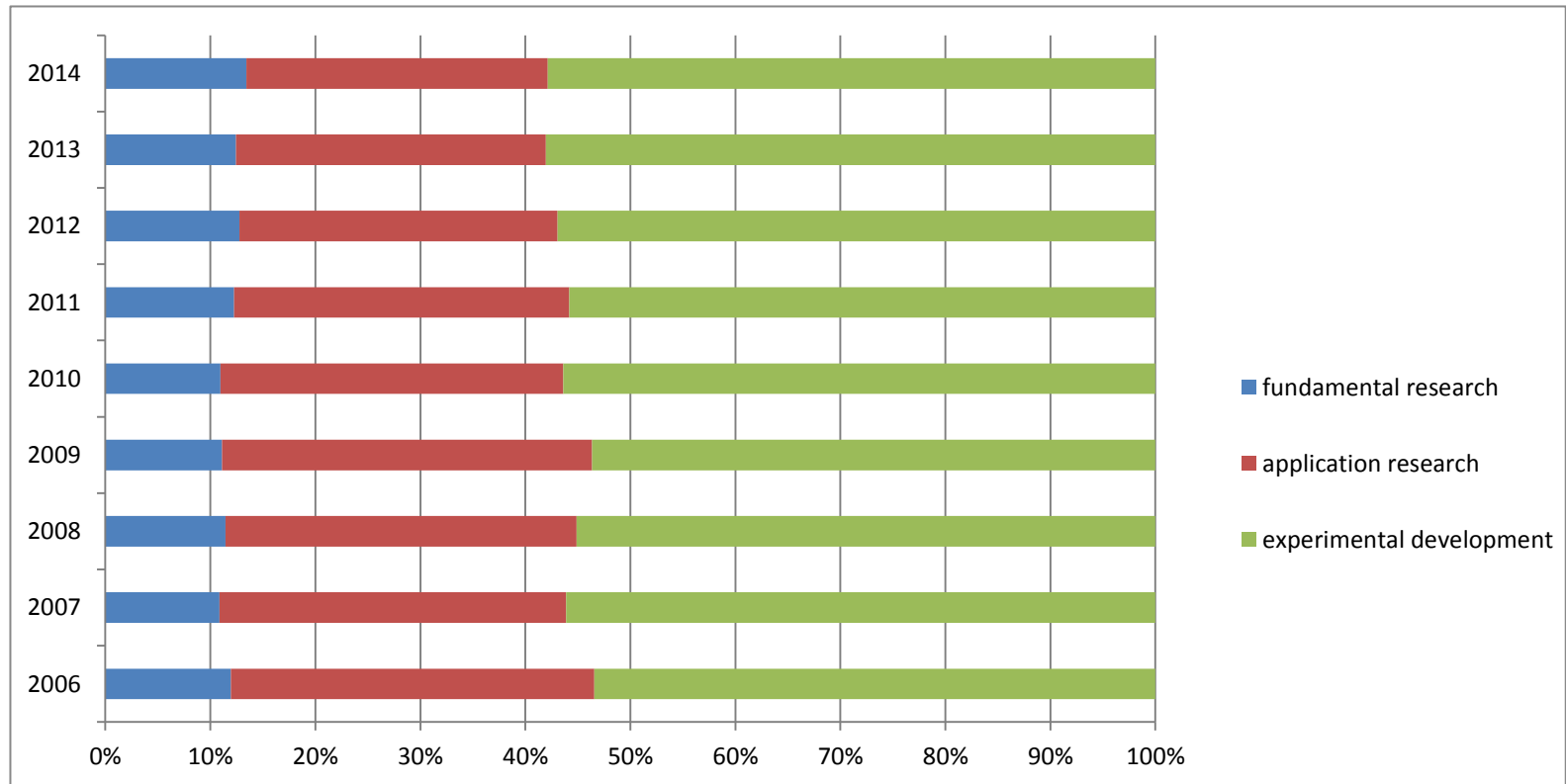
—In **application research**, universities and scientific research institutes play important role. On the side of **experimental development**, scientific research institution is important units, only second to enterprises.

—Compared with universities, Scientific research institutions pay more attention to **experiment development research**.

1. Overview of the role of universities and PROs in the country's national innovation system

1.2 Universities and PROs play important role in the national innovation system

R&D institutions R&D expenses distribution by activities types (2006-2014)



1. Overview of the role of universities and PROs in the country's national innovation system

1.3 scientific resource of government allocation with higher concentration

—The education resources is relatively concentrated in eastern developed provinces. most research universities are located in eastern coastal regions.

—Scientific resources are more liable to focus on stronger units and institutions. The funds of “211 project” universities and “985 project” universities account for 75.1% and 22.3% of the whole scientific and technological resources of Chinese universities respectively.

1. Overview of the role of universities and PROs in the country's national innovation system

1.3 scientific resource of government allocation with higher concentration

Chart the universities whose scientific research funds ranked first 15 in 2013

	Name	scientific research funds (100 million)	scientific research funds per capita (100 million)
1	Tsinghua University	43.52	80.24
2	Shanghai Jiaotong University	34.50	27.21
3	Zhejiang University	33.94	22.59
4	Beijing University	24.93	19.14
5	Harbin Institute of Technology	24.59	83.40
6	Tongji University	24.21	44.65
7	Beijing University of Aeronautics and Astronautics	23.33	120.16
8	Sichuan University	22.20	24.30
9	Huazhong University of Science and Technology	21.60	27.64
10	Fudan University	21.09	23.54
11	Tianjin University	20.54	71.49
12	Beijing Institute of Technology	20.18	88.44
13	Northwestern Polytechnical University	18.53	88.37
14	University of Science and Technology of China	16.46	84.31
15	Northeastern University	15.68	65.87

1. Overview of the role of universities and PROs in the country's national innovation system

1.4 Universities and PROs strengthen their technology resource supply continually

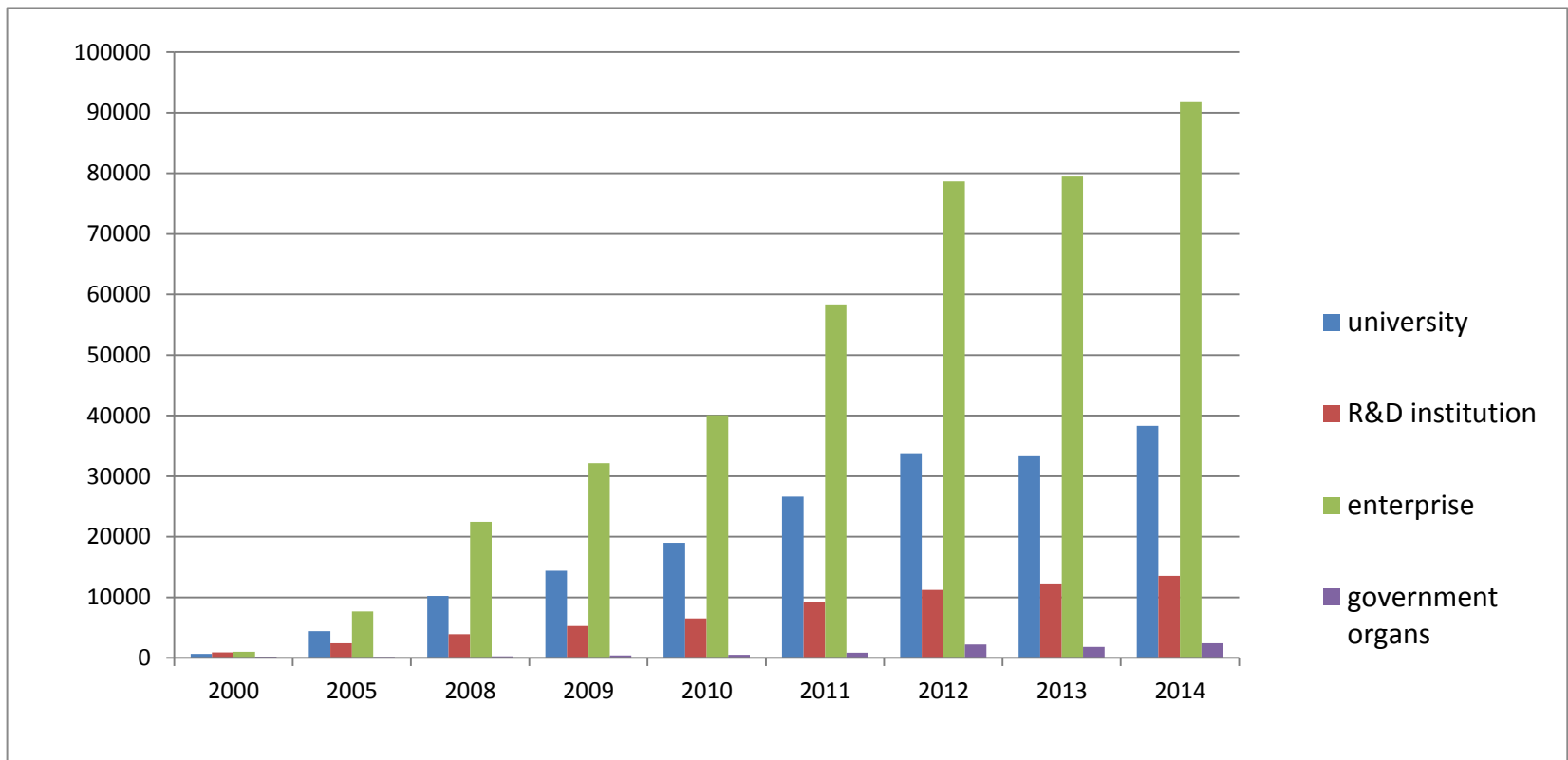
—Application research and experimental development of universities and scientific research institute have produced a large number of scientific and technological achievements.

In 2014, **post invention patent application number of universities accounted for 17.3% of the whole country, their **patent grants** accounted for 26.2% of the whole country.**

—Post invention patent application number of scientific research institutions accounted for 6.1% of the whole country, their grants accounted for 9.3% of the whole country.

1. Overview of the role of universities and PROs in the country's national innovation system

1.4 Universities and PROs strengthen their technology resource supply continually



Chinese civil post invention patent grants distribution by sector (2000-2014)

1. Overview of the role of universities and PROs in the country's national innovation system

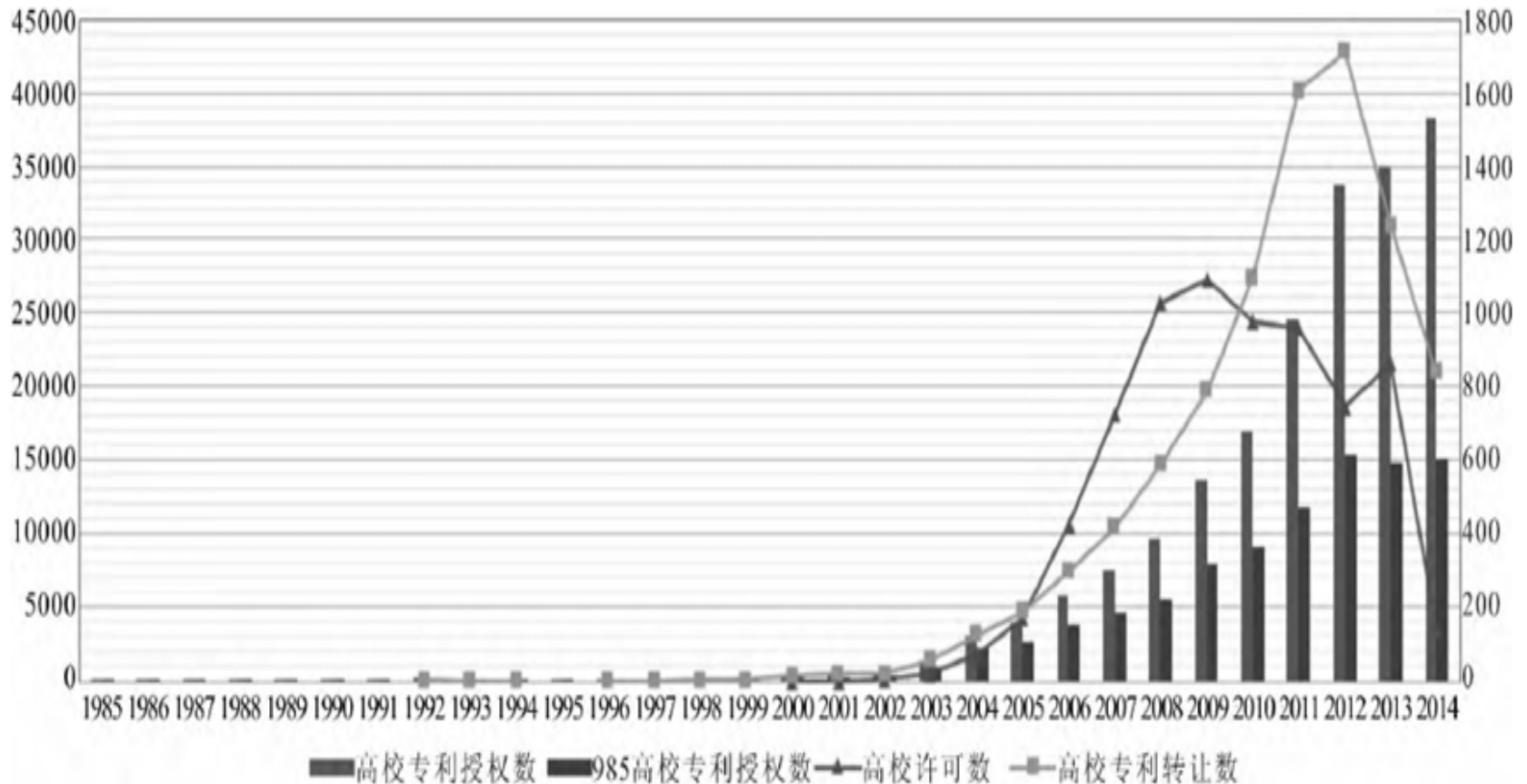
1.4 Universities and PROs strengthen their technology resource supply continually

—Different from abroad, another major technology transfer channel of universities and PROs in China is the **technology development contract granted by enterprises**. In 2014, the number of R&D projects of scientific research institutions granted by enterprises reached 4435, the funds reached 3.09 billion yuan. the number of R&D projects of universities granted by enterprises reached 170 thousand , the funds reached 24.55 billion yuan.

2. Common channels for knowledge transfer

- **2.1 Overview of patent transfer of universities in China**
- According to “Compilation of Universities’ S&T Statistics 2014”, **invention patent applications** of 32 "985 Project" universities accounted for 29.7% of total applications of all universities in China, granted patents of the 32 universities accounted for 34.6% of all.
- **patent sales amount and current year revenue** accounted for 44.3% and 42.4% respectively.

2. Common channels for knowledge transfer



Invention patents granted and transfer of universities in SIPO(1985—2014)

2. Common channels for knowledge transfer

- **2.2 Public R&D institutions' knowledge transfer modes**
- **China's public R&D institutions have explored many kinds of patent transfer modes:**
 - **——technology transfer services**
 - **——spin-offs**
 - **——patent operations**
 - **——co-building platforms with enterprises**
 - **——co-founding research institutes with local governments**
 - **——university S&T parks.**

2. Common channels for knowledge transfer

- **2.2.1 Technology Transfer Services**
- **Its characteristics is not simply property transactions, often involved with technical services and supports.**
- **Typical Case 1:** Hunan University of Chinese Medicine transferred its newly developed Chinese traditional medicine to pharmaceutical enterprises, fee is 68 million yuan.
- **Typical Case 2:** Central South University of Forestry and Technology offering technology services to 400 bamboo enterprises.
- **Typical Case 3:** Changzhou University signed 22 technology transfer contracts with 20 major manufacturers of domestic phosphorus chemical industry, have income of over 20 million yuan.

2. Common channels for knowledge transfer

- **2.2.2 Spin-offs**
- **two types: solely founded enterprise and jointly founded enterprise. jointly founded enterprise has been the main way of spin-offs.**
- **Typical Case 1:** Founder founded by Peking University in 1986, has introduced many university achievements to the market, and improved its own R&D capability based on market feedback at the same time. Now has more than 20 wholly-owned or joint-venture companies at home and abroad.
- **Typical Case 2:** Based on different sources of capital and partner, there are a variety of forms of cooperation between researchers and university management, which is also the main source of university spin-offs. Establishing a joint venture company with other enterprises is another popular form, and it's always related with patent transfer or technical support services.

2. Common channels for knowledge transfer

- **2.2.3 Patent Operations**
- **patent operated by transfer institutes. 3 types:**
- **——National Technology Transfer Center or Demonstration Institutions.**
- **——Industrial research institutes or industrial technology research institutes.**
- **——Technology transfer centers or technology transfer offices.**
- **According to Ministry of Education, nearly 90 percent of universities' S&T achievements transfer are done through this mode.**
- **Typical Case 1:** Central South University formed a unified industry-academia consortium with related enterprises.
- **Typical Case 2:** Wuhan University and Changshu Zijin Intellectual Property Service Co.Ltd. reached an agreement on intellectual property cooperation, to carry out an effective intellectual property layout, cultivation, tracking and achievements transformation on the basis of the university's research projects.

2. Common channels for knowledge transfer

- **2.2.4 Co-building Platforms With Enterprises**
- Public R&D institutions continue delivering technology to industry by building joint R&D centers and pilot bases, and transforming technology to products through joint development and experiment with enterprises.
- **Typical Case 1:** Zhejiang University and Huawei Technologies Co., Ltd. signed a strategic cooperation framework co-building a joint IT laboratory
- **Typical Case 2:** Social venture capital was involved in creating International Innovation Institute of Zhejiang University.

2. Common channels for knowledge transfer

- **2.2.5 Co-founding Research Institutes with Local Governments**
- establishment of research institutes, branch campus, or graduate schools with local governments.
- **Typical Case 1:** Tsinghua University established a number of research institutes with local governments.
- **Typical Case 2:** Based on technical support from its own research institution or research team, Xi'an Jiao Tong University incubated some high-tech enterprises jointly launched by university and local governments.
- **Typical Case 3:** Starting from 2010, Suzhou Industrial Park decided to prioritize nanotechnology as an emerging industry.
- **Typical Case 4:** Shenzhen government has been quite active in Government-Industry-University-Institute Collaboration.

2. Common channels for knowledge transfer

- **2.2.6. University S&T parks**
- Providing services and platforms for achievements transformation, high-tech enterprise incubator, and personnel training.
- In 2015, the number of identified national university S&T parks reached 115, covering 140 universities from 24 provinces, with incubation area of 829.3 square meters, R&D institutions of nearly 16 million invention patents, 2306 S&T achievements transformation, 7457 enterprises in incubation, 585 high-tech enterprises, and 32 listed companies.
- **Typical Case:** Chongqing government actively promoted the construction and development of Chongqing University National University S&T Park.

3. Policies and practices

- **3.1 Legal Framework system and practice system to promote scientific and technological achievement transformation**
- **Laws and Regulations**
- ——1980's: the Patent Law, the Trademark Law, the Copyright Law, and the Regulations on Computer Software Protection, the Regulations for the Protection of Integrated Circuit Layout Design,
- ——1990's: the Science and Technology Progress Law, Contract Law , Company Law, the Law on Promoting the Transformation of Scientific and Technological Achievements(issued in 1996)
- ——2015: the Law on Promoting the Transformation of Scientific and Technological Achievements(amended in 2015)

3. Policies and practices

- **3.1 Legal Framework system and practice system to promote scientific and technological achievement transformation**
- **Departmental Rules**
- “National technology transfer promotion action plan” (2007, issued by Most, Ministry of Education, and Chinese Academy of Sciences)
- Several Provisions of Promoting the Transformation of Scientific and Technological Achievements(March, 2016).
- the program of promoting scientific and technological achievements transfer and transformation(May, 2016)

3. Policies and practices

- **3.2 Universities and PROs technology transfer under the laws and regulations**
- From the perspective of legal obligation, China universities and PROs technology transfer experienced two phases.
 - ——Before 2015, universities and PROs have no legal obligation of technology transfer.
 - ——After 2015, the release of the law on Promoting transformation of Scientific and Technological Achievements, the situations changed, universities and PROs are endowed with legal obligation of technology transfer.
- The 17th provision of the Law regulates that the research and development institutions and universities established by the State shall strengthen the management, organization and coordination of the transformation of scientific and technological achievements.

3. Policies and practices

- **3.2 Universities and PROs technology transfer under the laws and regulations**
- **universities and PROs obligations:**
 - —a system mechanism has been set up to evaluate the results of universities and PROs
 - —universities and PROs should deliver their scientific and technological achievements transformation annual report
 - —should set up technology transfer mechanism, one is to set up their own professional technology transfer institutions, another is to grant their achievements to the social professional technology transfer institutions, overall, they should try their best to promote their achievement transformation.

3. Policies and practices

- **3.3 IP Ownership reform in universities and PROs**
- According to the Patent Law, the 6th provision is a special provision for regulating the ownership of post invention application. According to the Patent Law, post inventors and designers have the right to sign their name on the patent document and get some rewards and repayment.
- In China, the ownership of IP funded by government belongs to the project commitment unit. According to article 20 of Law of Science and Technology Progress, the invention patent right, computer software copyright, integrated circuit design proprietary right and new plant species right, which are created by the project funded by science and technology fund or science and technology plan, are authorized to the project undertakers, except those involving national security and national interests and major social and public interests.

3. Policies and practices

- **3.3 IP Ownership reform in universities and PROs**
- Although universities and PROs have the ownership of IP created by public financial project, when they dispose of these IP, they must report to the Ministry of Finance or management department. Generally, this is the main reason that universities and PROs didn't have enough stimulation to promote technology transfer. The reason is that universities and PROs are owned by the state, and IP assets are state-owned asset, they must obtain approval.
- In 2015, R&D institutions and universities established by the state have the right to dispose of their S&T achievements, including deciding their transferring, licensing or being evaluated in terms of shares.
- The ownership reform resolved the problems of universities and PROs having no rights to dispose of their IP and S&T achievements. the reform was accompanied by substantial increase of the reward ratio to the R&D personnel.

3. Policies and practices

- **3.4 the actions to promote scientific and technological transfer and transformation**
- **the program of promoting scientific and technological achievements transfer and transformation** (issued by the State Council, May, 2016) includes a series of actions and measures:
 - --promote information exchange and release of scientific and technological achievements.
 - --set up coordination mechanism for industry, university and R&D institutions to cooperate deeply.
 - --set up scientific and technological achievements industrialization base.
 - --strengthen the transfer of scientific and technological achievements into market-oriented services.
 - --promote entrepreneurship, such as maker spaces, promote public resources open to the society.
 - --train a lot of professional technology transfer personnel.

3. Policies and practices

- **3.4 the actions to promote scientific and technological transferr and transformation**
- Another two actions are to **promote the transfer of local** scientific and technological achievements, and strengthen the transformation of scientific and technological achievements by **diversified investment funds**.
- The local governments also take many measures.
- --they increase the **reward ratio** to R&D personnel, many local government increased the ratio to above 60%, and some 70%.
- --set up special scientific and technological achievements transformation **funds**, in JiangSu province, the fund reached 2 billion yuan in 2014.
- --Compared with central government, local governments always take more **radical measures**, technology transfer was more related to local economic growth.

3. Policies and practices

- **3.5 Policies and practices taken by leading universities and PROs**
- 7 practices:
- --Increasing **reward ratio** to R&D and transferring personnel. For example, in 2015, the Drug Research Institution of Chinese Academy of Sciences paid nearly 12 million yuan reward to inventors and transferring personnel.
- --Setting up **technology transfer mechanism**. Tianjin university has set up the center of technology transfer, employed nearly 20 technology agents and other personnel.
- --Implementing **classified evaluation system**
- --Establishing the technology transferring system managing process

3. Policies and practices

- **3.5 Policies and practices taken by leading universities and PROs**
- --Strengthening the **cooperation** between institution and local or university and local
- --**Release information** of scientific and technological achievements to the society
- --Permitting university academics to **take a leave of absence to work with a firm**
- --Policies for **spin-offs**. Beijing Institute of Technology has set up a total of 7 disciplinary companies, more than 100 teachers hold shares.

3. Policies and practices

- **3.6 policies and practices of strengthening Industry-university-research cooperation**

Industry-university-research cooperation played an important role in technology transfer in China. From 1980's, China formulated many policies to promote Industry-university-research cooperation, but in different stages, the direction of main policies were different.

Two actions should be paid attention.

- **The industrial technology innovation strategic alliance.** The first batch of 56 alliances was set up in 2010, whose function were focused on promoting industrial technology innovation. By the organization of alliance, the achievements of universities and PROs had more chance to transform in industry.
- **National science and technology plan reform.** Now, nearly 90% national research and development plan projects have enterprises taking part in, and nearly 50% of the important science and technology projects are led by enterprises.

4. Review of the national economic literature on knowledge transfer

Technology transfer plays important role in promoting the economic growth, especially in the changing era of the new S&T revolution and industrial transformation. Technology transfer promote economic growth From the following several aspects.

4.1 Improve the industrial technology innovation chain

- there are 146 National alliances, gathering more than 5 thousand enterprises, universities and research institutions, there are more than 1000 regional alliances all over the country.

4.2 Promote the open and sharing of science and technology resources

- there are 23 national scientific and technological condition platforms, their users of enterprises have reached 470 thousand times.

4. Review of the national economic literature on knowledge transfer

- **4.3 Promote technology breakthrough and achievements transformation**
- In 2015, national technical transaction contract turnover reached 984 billion yuan, with a growth of 14.7% compared with 2014. The amount of all kinds of technical transaction organizations reached 20 thousand.
- **4.4 Increasing the innovation capacity of enterprises**
- In 2015, the total R&D expense reached 1400 billion yuan, only second to the United States in the amount of R&D expense, while R&D expense from enterprises account for nearly 78%.
- **4.5 Stimulating the vitality of universities and PROs**
- In 2012, total revenue from enterprises of national universities and PROs reached 26.1 billion yuan and 2.6 billion yuan respectively.

5. Availability and use of metrics

- **5.1 Main sources of knowledge transfer metrics in China**
- The survey and release of formal knowledge transfer metrics in China are mainly undertaken by the Ministry of Science and Technology, the Ministry of Education, the National Bureau of Statistics, and the State Intellectual Property Office.
- **Main source 1**—**The Patent Statistics Annual Report** is a regular annual report released by the State Intellectual Property Office, publicly available on the website. As of July 2016, there are a total of 30 years of reports (1985–2014).
- **Main source 2**—**China Statistical Yearbook on Science and Technology** is released on a regular basis, with a total of 25 yearbooks (1991–2015) by July 2016.
- **Main source 3**—**China Statistical Yearbook** is released on a regular basis, and publicly available on the website of the National Bureau of Statistics. There are a total of 19 yearbooks (1997–2015) by 2016.
- **Main source 4**—**Compilation of Universities' S&T Statistics** is a regular datum released annually, which could be publicly available through the website of the Ministry of Education. By 2016, there are 14 compilations (2002–2015) totally.

5. Availability and use of metrics

- 5.2 Patents data are available and relatively mature
- “Three Kinds of Applications for Patents Accepted” and “Three Kinds of Patents Granted” are available in China Statistical Yearbook, China Statistical Yearbook on Science and Technology, and Patent Statistics Annual Report.
- “Applications for Patents Accepted” and “Patents Granted” of HEIs (Higher Education Institutions) and that of HEIs directly affiliated with the Ministry of Education are available in Compilation of Universities’ S&T Statistics.
- However, the statistics of patents application and patents granted does not distinguish between home and abroad.

5. Availability and use of metrics

- 5.3 The “Technology Contracts” metrics in China are overlapped with some key international general metrics
- Many international general metrics such as “research agreements with firms” and “licenses with firms” are not available in China. However, some Chinese metrics referred to as “Technology Contracts” are overlapped with these two metrics.
- The metric of “technology development” can be roughly seen as “research agreements with firms”, and the metric of “patent license transfer” contained in “technology transfer” can be equivalent to “licenses with firms”. Nevertheless, the

5. Availability and use of metrics

- 5.4 Major gaps in the available Metrics and future adjustments
- The current knowledge transfer metric system of China is yet to be developed. Plenty of key knowledge transfer metrics such as “Number of universities with KTOs (Knowledge Transfer Organisations)”, “Number of PROs with KTOs”, and “Number of invention disclosures” are not in collection, not to mention supplementary knowledge transfer metrics.
- According to the Law of China on promoting S&T Achievements Transformation, the metric system will be supplemented to a certain extent. The first statistics data will be collected in March 2017.

Key knowledge transfer metrics in China

Key knowledge transfer (KT) metrics	Has any data on this metric been collected since 2005? (Y/N)	Organisation that collected the data
Number of universities with KTOs	N	-
Number of PROs with KTOs	N	-
Number of invention disclosures	N	-
Total number of patent applications	Y	Ministry of Science and Technology, State Intellectual Property Office,
Total number of patent grants	Y	Ministry of Science and Technology, State Intellectual Property Office
Total number of research agreements with firms	N (overlapped)	Ministry of Science and Technology, Ministry of Education
Total number of licenses with firms	N (overlapped)	Ministry of Science and Technology, Ministry of Education

Thank you!