The Evolving Role of Universities in the Chinese National System of Innovation

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1. Introduction

A look back at the 20th century reveals that education provided the momentum for economic growth and social development in both developing and developed countries. Global economic competition is, in a sense, a competition for science and technology, education, and human resources.

In the 21st century, the world faces the challenge of the high-technology revolution. More and more experts think that this century will be dominated by knowledge-based economy, and the most important sources of economic growth will turn out to be the production, processing, dissemination, and application of knowledge as well as information.

In the era of the knowledge-based economy, the crucial element is talents, which heavily depends on education. Education will play a prominent and basic role both in knowledge innovation and human resource development. Only those who control education will possibly survive the fierce worldwide competition.

China has the largest population in the world, but the percentage of the skilled labor is relative lower. In order to maintain the fast and continuous development of the national economy, China has to develop education vigorously, and become a great power with abundant human resource.

With the deepening of the education system reform in China, the Chinese higher education has developed flourish. The Chinese Universities have become an important actor of the Chinese National System of Innovation (NSI), and play a necessary role in talent training, science research, technology transfer and social service. This paper mainly examines the roles that the universities are playing in the Chinese NSI.

2. Evolution of University System in the Chinese NSI

Since the People's Republic of China was founded in 1949, the evolution of university system and the relationship between the NSI and universities have experienced four phases.

Phase I 1950s–Soviet pattern

In this phase, the characteristics of the NSI were (chart 1):

a) The government was the only supporter of research.

b) The government directly organized and carried out all kinds of S&T plans and programs, and directly administrated research institutions.

c) Research institutions, universities and enterprises were separated from each other.

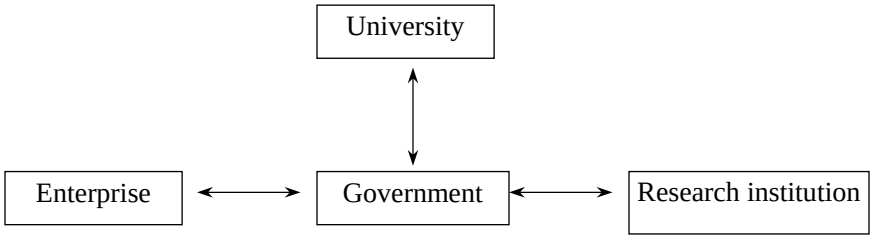

Chart 1 Chinese NSI in 1950s

The characteristics of university system were also Soviet:

a) University system was paralleled to research system.

b) Traditional function of universities was to provide skilled human source for research institutions and enterprises.

c) Education was the single aim and mission of universities.

Phase II 1966~1978–the Culture Revolution

In this era, the NSI and university system were both chaotic and blank because of the Culture Revolution, and the only mission of universities was to foster person with political ability.

Phase III 1978~1990

The characteristics of NSI were (chart 2):

a) Changing from “government ruling” to “government guiding”.

b) Enterprises were relatively separated from universities and research institutions.

c) Some research institutions began to foster graduate education, and universities began to undertake research projects, but it was still lack of interaction between universities and research institutions.

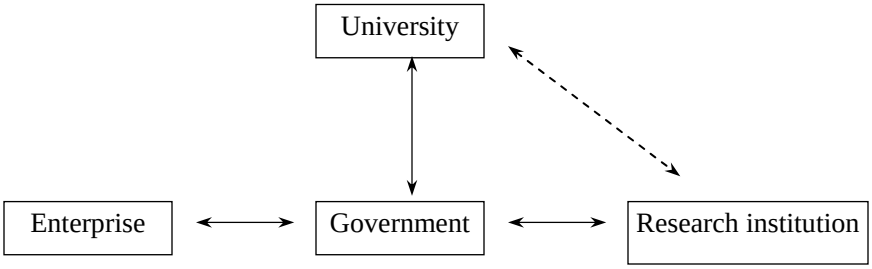

Chart 2 Chinese NSI in 1978-1990

The characteristics of university system were:

a) In 1979, the government decided that universities were not only the education center, but also the research center. Both education and research were the primary missions of universities.

b) Universities were the component of research system.

Phase IV 1990s

The characteristics of NSI were (chart 3):

a) Science and Technology System Reform required that research must aim at economic development.

b) Some research institutions transformed into enterprises and some entered enterprises to become internal research institutions of enterprises.

c) Enterprises played a more active role in technology innovation and were becoming the focus of the NSI.

d) Interaction between enterprises, universities and research institutions was more frequent than before.

e) The NSI was more open.

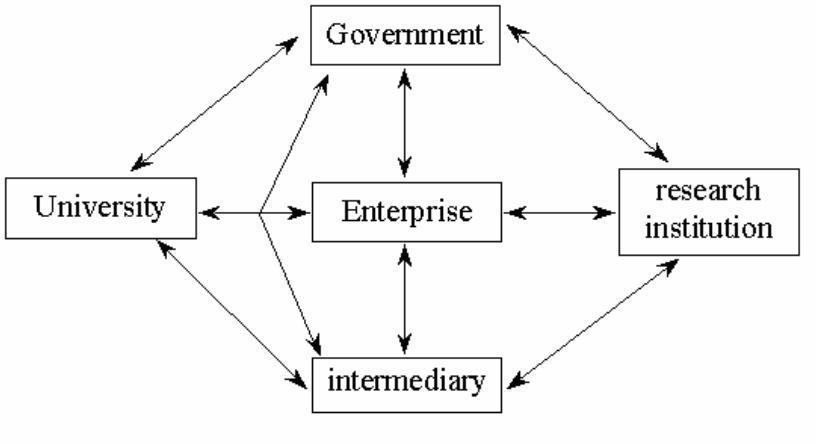

Chart 3 Chinese NSI in 1990s

The characteristics of university system were:

a) In 1995, education strategy–Vitalizing the Nation through Science and Education (Strategy VNSE) required that universities must serve economic development.

b) The cooperation and linkage between universities and research institutions, universities and enterprises were closer than ever before.

c) More and more universities set up their own enterprises.

3. The Characteristics of Current Chinese NSI

In a knowledge-based society, the generation, diffusion and appropriation of knowledge are more active than ever before. NSI, as a core conceptual framework for analyzing technological change within a country, is becoming very important. There are many kinds of definitions on NSI, and this paper follows this one: “NSI is that system constituted by elements and relationships in which the production, diffusion, use and transformation of new and economically useful knowledge take place. The concept of

elements here basically refers to two major components of the system, organizations and institutions. Institutions include things like policies, rules, regulations and norms. On the other hand organizations are formal structures where things happen …”

Nowadays , the Chinese NSI is changing from the former government-dominated pattern to a new market-dominated one. Through a series of reform, the research system in China has experienced significant changes: the function and position of the former research institutions have been changed; the research capability and the status of the enterprises have been promoted; and the universities have become an important part of the Chinese research system. Therefore, a new kind of research system consisted of multi-actors has been formed. There are various kinds of interaction such as co-research, personnel training and flow among the knowledge producers, especially among the enterprises, research institutions and universities.

The characteristics of current Chinese NSI are as follows:

a) The government is trying to build up a more effective NSI

b) Enterprises are becoming the most important or the core actors

c) The linkage between actors in NSI is closer than before

d) Actors including universities, research institutions, enterprises and government are on different and clear duties

This section mainly presents the distribution of the R&D expenditure in China, and explores the roles of different actors play in Chinese NSI.

Distribution of R&D Expenditure

R&D activities are important parts in NSI. With the implement of "Strategy VNSE" and the development of economy, the scale of the gross R&D expenditure (GERD) in China has increased rapidly (table 1). From 1998 to 2004, the average increase speed of the GERD in China was 21.3%, and in 2004, it reached 196.63 billion Yuan. The percentage of **GERD/GDP** was also increased from 0.70% in 1998 to 1.44% in 2004. However, there are still wide gaps between China and developed countries.

Table 1 GERD/GDP in China (2000-2004)

	2000	**2001**	**2002**	**2003**	**2004**
GERD (100 million)	895.7	1042.5	1287.6	1539.6	1966.3
GDP (100 million)	89442.2	97314.8	105172.3	117390.2	136875.9
GERD/GDP (%)	1.00	1.07	1.23	1.31	1.44

Source: *China Statistical Yearbook (2005).*

Table 2 shows the intramural expenditure for R&D by types of research from 2000 to 2004. In 2004, the R&D expenditure in fundamental research, applied research and experimental development were 11.72, 40.05 and 144.87 billion Yuan, and respectively increased by 33.6%, 28.6% and 27.0% than the last year. The percentage of the R&D expenditure in fundamental research, applied research and experimental development were 5.96%, 20.37% and 73.67%. Though the expenditure of the fundamental research kept increasing year by year, from 4.67 billion Yuan in 2000 to 11.72 billion Yuan in 2004, the percentage of it in the total R&D expenditure was still low, always between 5% and 6%. This was partly because of the pursuing of short-term research in R&D activities and the large share of experimental

development expenditure in government R&D expenditure, which will make a negative impact for the development of the long-term research.

Table 2 Intramural Expenditure for R&D by Types of Research (2000-2004)

Unit: 100 million yuan

	2000		2001		2002		2003		2004	
Total	895.7	%	1042.5	%	1287.6	%	1539.6	%	1966.3	%
Fundamental Research	46.7	5.22	55.6	5.33	73.8	5.73	87.7	5.69	117.2	5.96
Applied Research	151.9	16.96	184.9	17.73	246.7	19.16	311.5	20.23	400.5	20.37
Experimental Development	697.0	77.82	802.0	76.93	967.2	75.12	1140.5	74.08	1448.7	73.67

Source: *China Statistical Yearbook on Science and Technology (2005).*

In 2004, the R&D expenditure performed by universities was 20.09 billion Yuan, and increased by 23.8% than the last year; the R&D expenditure performed by independent research institutions was 43.17 billion Yuan, and increased by 8.2%; the R&D expenditure performed by enterprises was 131.4 billion Yuan, and increased by 36.8%. The share of the R&D expenditure performed by universities, research institutions and enterprises in the gross R&D expenditure were respectively 10.2%, 22.0% and 66.8%. According to the data in table 3, the R&D expenditure performed by enterprises is growing stably, and the enterprises are becoming the core actors of the R&D activities. However, the share of university R&D activities is still much lower.

Table 3 Intramural Expenditure for R&D by Performer (2000-2004)

Unit: 100 million yuan

	2000		2001		2002		2003		2004	
Total	895.7	%	1042.5	%	1287.6	%	1539.6	%	1966.3	%
Independent Research Institution	258.0	28.8	288.5	27.7	351.3	27.3	399.0	25.9	431.7	22.0
Enterprises	537.0	59.9	630.0	60.4	787.8	61.2	960.2	62.4	1314.0	66.8

Higher Education Institutions	76.7	8.6	442.3	9.8	130.5	10.1	162.3	10.5	200.9	10.2
Others	24.0	2.7	21.6	2.1	18.0	1.4	18.1	1.2	19.7	1.0

Source: *China Statistical Yearbook on Science and Technology (2005).*

- **Public R&D**

The sources of R&D funds in China include the government funds, enterprises funds, foreign funds and other funds. Table 4 shows the sources of R&D funds in 2003 and 2004.

Table 4 Intramural Expenditure for R&D by Sources (2003-2004)

Unit: 100 million yuan

	2003		**2004**	
Total	**1539.6**	**%**	**1966.3**	**%**
Government Funds	460.6	29.9	523.6	26.6
Enterprises Funds	925.4	60.1	1291.3	65.7
Foreign Funds	30	1.9	25.2	1.3
Other Funds	123.8	8.1	126.2	6.4

Source: *China Statistical Yearbook on Science and Technology (2005).*

The government fund is an important source of R&D funds in China, but its percentage is decreasing. In 2004, the R&D funds from government were 52.36 billion Yuan, only accounted for 26.6% of the total funds. However, due to its guidance and strategic function, the government funds still play a significant role in the development of the science and technology.

Table 5 Intramural Expenditure for R&D from Government (2003-2004)

Unit: 100 million yuan

	2003		2004	
Total	460.6	%	523.6	%
Independent Research Institution	320.3	69.5	344.3	65.8
Enterprises	47.3	10.3	62.6	11.9
Higher Education Institutions	87.7	19.1	108.8	20.8
Others	5.2	1.1	7.8	1.5

Source: *China Statistical Yearbook on Science and Technology (2005).*

Table 5 shows the distribution of the government R&D funds in 2003 and 2004. More than 80% of the total government R&D funds were distributed to public R&D section. The share of the research institutions was above 60%, while the share of the universities was only about 20%. This was mainly because of the traditional Soviet scientific system, which does not attach importance to R&D activities in universities.

- **Industry R&D**

With the implement of the reform and opening policy, the industry structure of China has been adjusted continuously. The share of agriculture had deceased from 28.1% in 1978 to 15.2% in 2004, and meanwhile the share of the service industry had increased from 23.7% to 31.9%. However, the fundament of agriculture is still weak in China, and the development of service industry is relative slower.

Table 6 Industrial Structure of GDP in China（%）

	1978	1989	1997	2004
Primary Industry	28.1	25.0	19.1	15.2
Secondary Industry	48.2	43.0	50.0	52.9

Tertiary Industry	23.7	32.0	30.9	31.9

Source: *China Statistical Yearbook (2005).*

In manufacturing industry, the R&D intensity (share of R&D expenditure in value added) is the most important indicator. In 2003, the average R&D intensity of Chinese manufacture industries was 2%, much lower than the average level of developed countries. Therefore, the standard of high-tech industries in China is also lower than the one in developed countries. The high-tech industries in China include manufacture of aircraft and spacecraft, manufacture of electronic and telecommunications equipments, manufacture of medical equipments and meter, manufacture of medical and pharmaceutical products, and manufacture of computers and office equipments. Table 7 shows the R&D intensity of these high-tech industries in 2003.

Table 7 The R&D Intensity of High-tech Industries in China（2003）

Industries	R&D Intensity
Manufacture of Aircraft and Spacecraft	15.8%
Manufacture of Electronic and Telecommunications Equipments	5.4%
Manufacture of Medical Equipments and Meter	3%
Manufacture of Medical and Pharmaceutical Products	2.7%
Manufacture of Computers and Office Equipments	2.5%

Source: *China Statistics Yearbook on High Technology Industry (2005).*

Regard to the imports and exports of manufactured goods, though the share of high-tech products is increasing, the main parts were still labor-intensive products (table 8) until 2004.

Table 8 Percentage of Imports and Exports of High-tech Products, Manufactured Goods and Primary Goods（2000-2004）

Unit: USD 100 million

	2000	2001	2002	2003	2004
Manufactured Goods	85.0	85.9	87.5	87.4	86.3
Of which: High-tech Products	18.9	21.7	24.3	27.0	28.3
Primary Goods	15.0	14.1	12.5	12.6	13.7
Total	100	100	100	100	100

Source: *China Statistical Yearbook on Science and Technology (2005).*

Table 9 shows the share of exports and imports of high-tech products in 2004. The data indicates that the exports and imports of high-tech products in China mainly concentrate on three industries: computers, telecommunications and electronics. They all together accounted for about 90% of the total foreign trade value.

Table 9 Percentage of Export and Imports of High-tech Products（2004）

	Export (%)	Import (%)
Computers	50.7	17.7
Telecommunications	31.7	13.7
Life Science	2.0	2.4
Electronics	11.1	47.8
Computer Integrated Manufacturing	0.9	10.8
Aerospace and Aeronautics	0.6	3.9
Optic-electronics	2.3	2.0
Biotechnology	0.1	0.1
Material	0.4	1.4
Others	0.2	0.2

Total	100	100

Source: *China Statistical Yearbook on Science and Technology (2005).*

- **Universities R&D**

The sources of the R&D funds in Chinese universities are multiplex. Besides government funds, external funds, especially the funds from enterprises are increasing. In 2004, the enterprises funds was 7.45 billion Yuan, accounted for 37.1% of the total R&D funds in universities, and increased by 1.2 percentage than the last year (table 10). Compare with the research institutions, which mainly dependent on the government funds, the universities are closer to the market, and the relationship between universities and enterprises is much closer.

Table 10 Intramural Expenditure for R&D in HEIs by Sources（2003-2004）

	2003		2004	
	(100 million yuan)	%	(100 million yuan)	%
Total	**162.3**	**100**	**200.9**	**100**
Government Funds	87.7	54.0	108.8	54.2
Enterprises Funds	58.3	35.9	74.5	37.1
Foreign Funds	3.0	1.8	2.6	1.3
Other Funds	13.4	8.3	14.9	7.4

Source: *China Statistical Yearbook on Science and Technology (2005).*

Comparing the R&D expenditure in three kinds of research between the research institutions and universities, we can see that the universities emphasize fundamental research and applied research, while the research institutions emphasize experimental development (table 11).

Table 11 Comparison of R&D Expenditure between Research Institutions and HEIs

	Research Institutions		HEIs	
Fundamental Research	51.7	12.0%	47.9	23.8%
Applied Research	159.1	36.8%	108.8	54.2%
Experimental Development	221.0	51.2%	44.2	22.0%

Source: *China Statistical Yearbook on Science and Technology (2005).*

4. The Characteristics of Current Chinese University System

The experience of educational development in China indicates that a high-quality educational system is one of the most important infrastructures and has a particularly strategic role in narrowing the gap between China and developed countries. The Chinese government is vigorously carrying out its educational strategy—Vitalizing the Nation through Science and Education (Strategy VESE). Higher education has developed vigorously and steadily.

The scale of higher education has been enlarged under macro adjustment and control. In 2004, the number of the higher education institutions in China had been reached 3423, including 1731 Regular Higher Education Institutions (Regular HEIs), 505 Adults HEIs, and 1187 other Non-government HEIs (table 12).

Table 12 The Number of HEIs in China (2004)

	Total	HEIs under Central Ministries & Agencies	HEIs under local Auth.	Non-state/ Private
Institutions Providing Graduate Programs	(769)	369	400	

● Regular HEIs ● Research Institutes	(454) (315)	97 272	357 43	
Regular HEIs ● HEIs Providing Degree-level Programs ● Short-cycle HEIs Of which: Tertiary Vocational	1731 684 1047 (872)	111 104 7 2	1394 571 823 662	226 9 217 208
HEIs for Adults	505	19	484	2
Non-government HEIs	1187			1187

Note: Data in "()" don't count number of school.

Source: *Educational Statistical Yearbook of China (2004).*

According to the ISCED, Chinese universities should refer to the Regular HEIs which provide the 6 level and 5A level education. However, because many Regular HEIs also provide 5B level education, and the official statistical data classifies the tertiary vocational school into Regular HEIs, the data cited in this paper is wider than the real ones about the Chinese universities.

The Number of Students

The scale of the Regular HEIs in China is expanding in the recent 20 years. From 1985 to 2004, the number of the Regular HEIs had grown from 1016 to 1731, and the number of enrollment students had grown from 1.7 million to 13.3 million.

Table 13 The Number of Regular HEIs& Students Enrollment (1985-2004)

	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
Schools(institutions)	1016	1054	1063	1075	1075	1075	1075	1053	1065	1080
Students(10000persons)	170.3	188.0	195.9	206.6	208.2	206.3	204.4	218.4	253.6	279.9
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Schools(institutions)	1054	1032	1020	1022	1071	1041	1225	1396	1552	1731
Students(10000persons)	290.6	302.1	317.4	340.9	413.4	556.1	719.1	903.4	1108.6	1333.5

Source: *China Statistical Yearbook (2005).*

Table 14 shows the number of graduates, entrants and enrolments of Regular HEIs in 2004. In this year, 4.5 million students enrolled in the Regular HEIs for undergraduate education, and the enrolments reached 13.3 million. The number of postgraduates also increased to 779 thousand.

Table 14 Data on Students in Regular HEIs in China (2004)

	Graduates	**Entrants**	**Enrolments**
Postgraduates	**143813**	**310672**	**779408**
Doctor's Degree	20607	47502	148561
Master's Degree	123206	263170	630847
Undergraduates in Regular HEIs	**2391152**	**4473422**	**13334969**
Normal Courses	1196290	2099151	7378436
Short-cycle Courses	1194862	2374271	5956533

Source: *Educational Statistical Yearbook of China (2004).*

In 2004, the average number of students in Regular HEIs per 1000 inhabitants was 10.9 persons, and the average number of graduates was 2.0 persons.

Table 15 The Number of Students in Regular HEIs per 1000 inhabitants (2004)

	2004
Total Population (10000 persons)	129988
Number of Students Enrollment (10000 persons)	1411.4
Number of Students Enrollment per 1000 inhabitants (persons)	10.9
Number of Graduates (10000 persons)	253.5
Number of Graduates per 1000 inhabitants (persons)	2.0

Source: *China Statistical Yearbook (2005), Educational Statistical Yearbook of China (2004).*

Table 16 shows the number of students in Regular HEIs by academic field. Compared with developed countries, the development of social science and humanities in China relatively lag behind. However, the number of student received social science and humanities education is enlarged in recent years, and the respective share of them in undergraduate, master and doctor students were 49.1%, 38.3% and 28.2% in 2004.

Table 16 The Number of Students in Regular HEIs by Academic Field

		Doctor's Degree		**Master's Degree**		**Undergraduate**	
	Total	**148561**		**630847**		**13334969**	
Social Science & Humanities	Philosophy	2036	28.2%	7291	38.3%	9980	49.1%
	Economics	7922		33061		731263	
	Law	6166		48133		629549	
	Education	2433		20231		724416	
	Literature	6279		50826		2118209	
	History	2714		8407		60071	
	Military Science	109		312		/	
	Administration	14294		73551		2272728	

Natural Science	Science	19921	71.8%	65722	61.7%	1156113	50.9%
	Engineering	63768		238528		4376167	
	Agriculture	5617		22155		280212	
	Medicine	17302		62630		976261	

Source: *China Statistical Yearbook on Science and Technology (2005).*

Non-government Regular HEIs

During the recent decade, the scale of Non-government Regular HEIs in China is also expanding. Though they seldom do any research, their role will be more important in the evolving Chinese research system. In 2004, there were 226 non-government regular HEIs. The total number of students was about 710 thousand.

Table 17 The Number of Students in Non-government Regular HEIs

	Graduates	Entrants	Enrollments
Normal Courses	3266	21635	76420
Short-cycle Courses	84697	297272	633216
Total	87963	318907	709636

Source: *Educational Statistical Yearbook of China (2004).*

Tertiary Vocational School

In China, tertiary vocational schools are the main institutions that provide 5B level education. Due to the complication of their structure, there are not exact data to describe the general conditions of the Chinese tertiary vocational schools. According to an article published in Guang Ming Daily Newspaper, from 1998 to 2003, the number of entrants in tertiary vocational

schools had increased from 0.54 million to 2 million, and the number of enrollments from 1.17 million to 4.8 million. They respectively account for 52.24% and 43.24% of the total numbers of entrants and enrollments in Regular HEIs(Wu Qidi, 2004). However, due to some tertiary vocational schools have not found their suitable orientation and lack of their own teaching feature, their graduates are not widely recognized by the society. The employment rate of the graduates in tertiary vocational schools was only 55% in 2003.

Source of Educational Funds

There are various channels for the Regular HEIs to get funds in China, including government appropriation for education, funds of social organizations and citizens for running schools, donations and fund-raising for running schools, tuition and miscellaneous fee and other educational funds. Table 18 shows different sources of educational funds in Regular HEIs in 2003. The government funds are the most important fund source for Regular HEIs, which account for nearly half of the total amount. The percentage of tuition and miscellaneous fee is growing, and become another important fund source.

Table 18 Educational Funds in Regular HEIs (2003)

Unit: 10000 yuan

Total	17543468	%
Government Appropriation for Education	8405779	47.9
Funds of Social Organizations and Citizens for Running Schools	603015	3.4
Donations and Fund-Raising for Running Schools	256375	1.5
Tuition and Miscellaneous Fee	5057307	28.8

Other Educational Funds	3220992	18.4

Source: *China Statistical Yearbook (2005).*

Education System Reform

In 1985, the Chinese government began to implement the reform of education system, which included the reform of higher education system. The reform aimed at changing the enrollment and graduate distribution system of HEIs, and extending the right of self-determination of HEIs. In 1993, the government carried out a series of steps to further extended the right of HEIs.

The system of higher education has been reformed continuously through joint efforts by the government and universities: the universities have the right of enrolling self-financing students; the right of establishing teaching plan and material; the right of taking co-research with enterprises; the right of appointing and dismissing the vice-present; the right of relocating the educational funds from government… Through the reform, the universities could orient to the market more actively, and the relationship between the universities and the society has been strengthened.

In 1998, the reform of State Council brought opportunities to the reform of HEIs. Many universities that were former managed by the central government began to be managed by the local government, and some universities and colleges merged each other. The four universities, for example, have been merged to form Zhejiang University, which has the most number of disciplines and departments in China.

5. The Roles of Universities in the Chinese NSI

Nowadays, the Chinese universities take an active part in the development of the society. The universities are not only the education center and research center, but also the enterprises incubator and the networker of NSI. This section generalizes four roles of the universities in Chinese NSI: education, research, technology transfer and social service. They perform their roles through various forms, such as talent training, technology licensing, co-research, publication, establishing enterprises and etc.

Education

Education is the most basic role of universities. As the same as in other countries, the universities are the base of talent training in China, and provide wide levels of excellent persons including undergraduates, masters and doctors.

Besides regular higher education, Chinese universities also provide continuous higher education through correspondence, sparetime schools, short-cycle courses and etc (table 19).

Table 19 The Number of Students in Correspondence divisions、Sparetime Schools & Short-cycle Courses for Adults run by Regular HEIs（2004）

	Graduates	Entrants	Enrolment
Divisions of Correspondence and Sparetime Schools	1074327	1371001	2823639
Short-cycle courses for Adults	398483	411739	633247

Source: *Educational Statistical Yearbook of China (2004).*

However, due to the fast expansion of Chinese universities, the publics begin

to doubt the quality of the higher education. A survey among the universities students indicates that 79% students think they can't learn useful knowledge in universities, 77% students think that what they learn are not relative to the practice, and 80% students don't satisfy with the courses and content (Lin Jian, 2001). So how to maintain and improve the quality of higher education is a challenge for the Chinese Universities.

Research

Research is also a basic role of universities. On one hand, it is helpful to improve the quality of the high education; on the other hand, it is also benefit for the development of the science & technology, economy and society.

In 1979, the Chinese government decided that the key universities should become the research center, which marked that research formally became the mission of Chinese universities. In 1980s, the number of research institutions in universities was increased fast, and the achievements in R&D became one of the important indicators to measure the level of a university.

Nowadays, the R&D income and outcome of Chinese universities indicate that they are playing a significant role in R&D activities. The National Natural Science Fundation is the most normative and equitable competitive research fundation in China, and the universities are the main receivers. From table 20, we can see that the universities gained more than 70% of the total fund in 2004.

Table 20 Projects Funds Approved by the National Natural Science Foundation by Sectors (2004)

Unit: 10000 yuan

	Universities	**Research Institution**	**Others**	**Total**
General Programs	127982	37524	2010	167516
Leading Programs	21705	11625	/	33330
Major Programs	6300	7550	/	13850
Major Research Plan	8239	4997	250	13486
Projects of State Sciences Foundation for Distinguished Young Scientists	9690	5680	/	15370
Programs of Joint Funds	2080	1080	/	3160
Programs of Innovation Joint Research Funds	3960	3120	/	7080
President and Directors' Funds	4058	1232	209	5499
Special Funded Projects	1766	746	104	2616
International Cooperation and Exchange	4142	2903	1272	8317
Total	189922	76457	3845	270224

Source: *China Statistical Yearbook on Science and Technology (2005).*

Table 21 shows the data about the R&D projects and achievements in Regular HEIs in 2004. Nowadays, the Key HEIs is becoming an important strength of the Chinese NSI.

Table 21 Statistics of R&D Projects and Achievements in Regular HEIs(2004)

	Projects	Awards	
		Total	National
Key HEIs	93520	1867	136
Ordinary Degree Level HEIs	95186	2193	51
Short-Cycle HEIs	3038	42	3
Total	191744	4102	190

Source: *Educational Statistical Yearbook of China (2004).*

However, with more and more teachers beginning to do research in universities, the conflict between education and research is emerging. Furthermore, Chinese universities pay much attention to fundamental research and applied research. How to combine education and research effectively and how to balance fundamental research and applied research are the urgent problems that the universities must to solve.

Technology transfer

In most literature, the activities related to technology transfer in universities are called “the third mission”. There are many forms of technology transfer in Chinese universities, such as publication, international meetings, co-research, licensing, spin-off enterprises, and etc.

- **Publication & International Meetings**

Publication and international meetings are the common technology transfer form for all the universities. However, due to the participants are mainly academics, but not potential technology user, they are not efficient form for technology transfer.

Table 22 The Number of Publications in Regular HEIs(2004)

	Monographs	Papers
Key HEIs	2711	182316
Ordinary Degree Level HEIs	4996	232082
Short-Cycle HEIs	912	13831
Total	8619	428229

Source: *Educational Statistical Yearbook of China (2004).*

Table 23 International Communication of Key HEIs(2004)

International Co-research	Send (persons)	Receive (persons)	
	10329	9024	
International Academic Meeting	Participants(persons)	Paper	Report
	20031	16251	2233

Source: *Statistical Data on Science and Technology of Higher Educational Institutions (2004).*

- **Co-research**

The direct co-research between universities and enterprises in China began in 1980s. The universities not only provide professional training to the workers in enterprises, but also cooperate with enterprises through research projects to resolve the practical problems.

In 1992, the Chinese government began to implement the project of "enterprise-university-institution cooperation" to encourage the cooperation between the enterprises and the universities and research institutions. The enterprises funds in universities R&D increased from 3.6 billion Yuan in 1998 to 7.45 billion Yuan in 2004. Nowadays, the enterprise-oriented technology transfer is an important source of R&D funds for universities.

Due to the traditional S&T system, the Chinese enterprises do not have much R&D resource, and their R&D capability is very weak, so they have to search help from universities to solve the practical technology problem.

In table 11, the applied research in universities accounted for 54.2% in 2004, which indicates that the universities have the advantage of making co-research with enterprises. Nowadays, co-research is an important form of

technology transfer in China.

- **Licensing**

Table 24 and 25 are the number of patents granted and technical contract deals of Chinese universities from 2000 to 2004. Though the number of patents granted in universities is increasing year by year, the number of contract deals in domestic technical markets which universities as sellers does not increase as fast as the patents. This in some way reflects that the patents of universities are not close to the market demand.

Table 24 The number of Patents Granted in Universities (2000-2004)

	2000	2001	2002	2003	2004
Invention	652	579	697	1730	3484
Utility Model	868	943	973	1582	1910
Design	28	12	40	104	111
Total	1548	1534	1710	3416	5505

Source: *China Statistical Yearbook on Science and Technology (2005).*

Table 25 Contract Deals in Domestic Technical Markets which Universities as Sellers (2000-2004)

	2000	2001	2002	2003	2004
Total	241008	229702	237093	267997	264638
Universities	31202	29553	31257	37974	39289

Source: *China Statistical Yearbook on Science and Technology (2005).*

Table 26 shows the technology transfer data of the Key HEIs in China. The technology transfer in Key HEIs mainly flows to state-owned enterprises.

Table 26 The Data of Technology Transfer in Key HEIs (2004)

	State-owned enterprises	Foreign enterprises	Private enterprises	Collectively-run enterprises	Others	Total
Contacts	1439	359	958	711	1044	4511
%	31.90	7.96	21.24	15.76	23.14	100
Value (thousand)	567337	51967	297769	169796	472467	1559336
%	36.38	3.33	19.10	10.89	30.30	100

Source: *Statistical Data on Science and Technology of Higher Educational Institutions (2004).*

- **Spin-off Enterprises (University-owned Enterprises)**

In 1990s, many Chinese universities began to set up their own enterprises. On one hand, these university-owned enterprises directly make great contributions to the development of economy, and on the other hand, the universities also obtain urgent finances for their own development. The most important influence is that more and more people are recognizing that the universities are the source of motivation for the development of knowledge-based society.

Table 27 and 28 are the comparison of operating data of university-owned enterprises in China from 2000 to 2004. In 2004, the total turnover of the university-owned enterprises was 96.9 billion Yuan, and increased by 17.25% than the last year. The turnover of high and new S&T enterprises was 80.7 billion Yuan, and account for 82.23% of the total turnover of the university-owned enterprises.

Table 27 The Comparison of Operating Data of University-owned Enterprises in China (2000-2004)

Year	Number of	Turnover (100	Total profit (100	Net profit (100

	enterprises	million Yuan)	million Yuan)	million Yuan)
2000	5451	484.55	45.64	36.04
2001	5039	602.98	48.17	35.32
2002	5047	720.08	45.93	35.33
2003	4839	826.67	42.98	27.95
2004	4563	969.3	49.93	29.53

Source: Center for Science and Technology Development, Ministry of Education of the People's Republic of China, *Statistics and Analysis Report on China's University-owned Enterprises (2004).*

Table 28 The Comparison of Operating Data of University-owned High and New S&T Enterprises in China (2000-2004)

Year	Number of S&T enterprises	Turnover (100 million Yuan)	Total profit (100 million Yuan)	Net profit (100 million Yuan)
2000	2097	368.12	35.43	28.03
2001	1993	447.75	31.54	23.98
2002	2216	539.08	25.37	18.63
2003	2447	668.07	27.61	14.73
2004	2355	806.78	40.98	23.86

Source: Center for Science and Technology Development, Ministry of Education of the People's Republic of China, *Statistics and Analysis Report on China's University-owned Enterprises (2004).*

In China, an important carrier of technology transfer in some Key Universities is University S&T Park. In 1991, the first University S&T Park was established in Northeast University. Then, Peking University, Tsinghua Universities established their own University S&T Park in succession.

Nowadays, there are 50 National University S&T Parks in China.

According to an incomplete statistic of 42 National University S&T Parks, up to the end of 2004, they all together had 5037 enterprises in incubation, and 1256 graduated enterprises. The University S&T Parks have been an exchange platform for various innovative resources, and promote the flourish of innovation activities in China.

However, as universities' technology transfer is more active, the functions of education and research are weaker than ever. Furthermore, for lacking of linkage between industry and the academia, especially for different cultural adoptions, different system for cooperation, mission alignment and different social responsibility, the university-industry gap cannot be eliminated. University and industry must make some balance between the short and long-term benefits, and consider clearly about the return on investment in cooperation. How to find an effective way to strengthen the cooperation between university and industry is another challenge.

Social service

In this paper, the activities related to the social needs in universities are called "the fourth mission", such as support of public authorities, health service, law assistance, organization of social events, etc. In developing countries, these activities are necessary and beneficial for the development of society.

In China, the universities play this role through various ways, such as providing consultation for the development of local economy and society, supporting the management of poverty-areas, and opening libraries, labs and

other facilities to the society, etc.

However, the Chinese universities pay much attention to the technology transfer activities, and neglect their social service role. Therefore, they should strengthen their contribution in this aspect in the future.

6. Conclusion

The role of university in NSI is not static, and it will evolve all the time to adapt the changes of economy, society and S&T system.

Universities, research institutions and enterprises should play different roles. The most important mission of university is education and research, and then technology transfer and social service.

The linkage between research system (including universities and research institutions) and industrial system should be strengthened further.

Reference

Andersen B: The Evolution of Technological Trajectories 1890-1990. Structural Change and Economic Dynamic 1998-9.

Archbugi D. and Michie J.: Technological Globalization or National Systems of Innovation? Futures, 1997, Vol.29, No.2.

Edquist C. (ed): Systems of Innovation Technologies, Institutions and Organizations, London and Washington Pinter, 1997.

Freeman C. and Soete L.: The Economics of Industrial Innovation (Third Edition), 1997.

Nelson R. R.: The Agenda for Growth Theory: A Different Point of View, Cambridge Journal of Economics 22,1998.

B-A Lundvall, Bjorn Johnson, Esben Sloth Andersen, Bent Dalum: National systems of Production, innovation and competence building, Research Policy 31(2002) 213-231.

OECD: Managing National Innovation Systems, 1999.

Center for Science and Technology Development, Ministry of Education of the People's Republic of China: Statistics and Analysis Report on China's University-owned Enterprises, 2004.

National Center for Education Development Research: 2004 Green Paper on Education in China, Educational and Science Publishing House, 2004.

Wu Qidi: Developing the Employment-oriented Vocational Education, Guang Ming Daily Newspaper, 2004-4-1.

The Project Team of "R&D Analysis in China": The Distribution of R&D Resource on National System of Innovation, Science and Technology Press, 2004.

China Statistical Yearbook (2005).

China Statistical Yearbook on Science and Technology (2005).

China Statistics Yearbook on High Technology Industry (2005).

Educational Statistical Yearbook of China (2004).