Asian Region

Graduate Education Reforms and International Mobility of Scientists and Engineers in China

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Historical Sketch

China is a nation with a long history of an ancient higher education system, and a shorter period with a more modern one. Compared with the leading Western nations, the process of development of Chinese graduate education has been convoluted. Its modern stage can be traced to 1902, when the Qing Dynasty government issued the first official regulations for a modern educational system, which stipulated the establishment of a Grand School (graduate school) above the existing undergraduate education system. During the period 1911-34, the government made numerous efforts to establish the academic degree system, which finally came into being as a result of these efforts in 1935. However, due to World War II and the Japanese intervention of 1937-45, the Regulations on Degree Conferment, aimed at improving education and science in China, were not fully implemented. For the 14-year period between 1935-49, only baccalaureate degrees and 200 master's degrees were granted—not a single doctoral degree was awarded (B. Wu 1993). The training of graduate students took place largely in foreign countries.

After the founding of the People's Republic of China (PRC) in 1949, the communist government abolished the academic degree system; it was not reestablished until 1981. During the period from 1949-65, before the Cultural Revolution occurred in 1966, only about 20,900 students graduated from the Soviet-pattern graduate schools that had been established (Guo 1998). As the old academic degree system had been abolished earlier, not one of these students was actually granted a graduate degree.

The Cultural Revolution led to a 12-year suspension of graduate enrollment. This resulted in a great loss to higher education institutions. When the Cultural Revolution ended in 1976, the number of full professors had decreased by 25 percent as compared with 1965, associate professors by 19 percent, and lecturers by 6 percent (MOE 1985). In the first years after graduate education was resumed in 1978, the shortage of high-level scientific and educational personnel and the low quality of teachers was evident everywhere in China. During the Cultural Revolution alone, China had lost 1.5 million specialists (Chen 1992). It has been estimated that the Cultural Revolution set China's socioeconomic and scientific development back about 20 years (Min 1997).

Subsequently, Chinese leaders became aware of the correlation between high-level specialized personnel and the realization of their ambitious "Four Modernizations" (of industry, agriculture, science and technology, and national defense). With the new national policies for reform, as well as the opening up of the country to the outside world in 1978, the Chinese government resumed graduate education in China and gave priority to its development. Within a short period, Chinese graduate education experienced notable development, which has attracted international attention. In terms of enrollment and output, between 1978-94, 460,000 graduate students had been admitted—nearly 20 times the number (23,400) for the 17-year period between 1949 and the beginning of the Cultural Revolution in 1965 (Z. Wu 1995). Between 1978-97, 430,000 graduate students (including 390,000 master's degree and 34,000 doctoral degree) had graduated, over 20 times the number (20,900) graduated prior to the Cultural Revolution (Zhang 1998).

Current System

The existing higher education system in China basically derived from the Soviet model, and its pattern of governance is still a prominent force in its impact on the universities. In recent years, however, Chinese higher education has been shifting from a rigid model of state control to a model of state supervision that is more in accord with the transformation from a planned to a market economy.

Before focusing on the administrative structure of graduate education, two important features that are derived from the Soviet model and that characterize Chinese higher and graduate education need to be understood.

- **Within and Without Research Institutions.** Unlike undergraduate education, which is exclusively carried out in institutions of higher learning, graduate education in China is undertaken by

both institutions of higher learning and research institutes outside universities. This is due to the traditional division of teaching and research between universities and research institutes. Currently, these institutions of graduate learning can be divided into four categories in terms of type of control and sources of funding.

– Thirty-six key comprehensive, polytechnic, and normal institutions are administered directly by the State Education Commission (SEdC),[1] which is also responsible for the overall guidance of the higher and graduate education system in China by formulating policies, decrees, and plans. Many of them are prestigious, pace-setting institutions, with broad scope in both undergraduate and graduate education.

– Over 400 specialized institutions and research institutes are under the control of central ministries like the Ministry of Agriculture, Ministry of Public Health, etc., and specialize in training personnel for their sponsoring ministries, with emphasis on national needs.

– About 100 provincial-level institutions and research institutes are governed by provincial educational commissions (or bureaus) and commissions for science and technology. Most have a relatively small number of graduate students.

– There are also 130-odd research institutes and a few other institutions of higher learning affiliated with the Chinese Academy of Sciences (CAS) and the Chinese Academy of Social Sciences (CASS); these are traditionally focused on basic research.

To maintain standards in degree courses, only selected universities and research institutes have been authorized to grant degrees. According to 1996 statistics, there were a total of 1,054 institutions of higher education in China (DFA 1996), of which only 471 institutions of higher education and 315 research institutes were authorized to grant graduate degrees. The majority of these were under the jurisdiction of the SEdC, the central ministries, or the CAS/CASS.

- **Division of Authority for Academic Matters.** American universities generally operate under the authority of state governments to grant accredited degrees and enjoy substantial autonomy (Johnstone 1993). In China, authority for graduate admissions, training, management, and the formulation of degree standards is shared by two state administrative organs—the SEdC and the Academic Degrees Committee (ADC) under the State Council[2]—operating in parallel. Both have their own corresponding vertical administrative structures and exercise somewhat different responsibilities and authorities. Generally speaking, the former has a more executive function, while the latter has a more legislative function. A brief description of their respective structures and functions follows.

Administration of Graduate Education

China has a three-level graduate education administrative system, with the SEdC at the top; the education commissions and bureaus of higher education under the central ministries, provinces, and the CAS at the middle level; and the training institutions and research institutes at the base.

- The SEdC exercises unified leadership over graduate education in the country and is responsible for macro-level guidance and administration.

- The middle-level administrative entities are responsible for administering graduate education in the institutions of higher learning under their respective jurisdictions.

- At the micro-level, the president/director, or one of the vice presidents/directors, of the university or research institute takes charge of the work of graduate education. An administering body, such as a graduate school, graduate department or di-

[1]Before 1985, this institution was called the Ministry of Education, and recently—in March 1998—it reverted back to this title.

[2]The State Council in China is comparable to the U.S. cabinet or to a council of ministers.

vision, or graduate section, can be set up to do the daily administrative work in accordance with the scope of graduate education and actual needs.

Administration of Academic Degrees

Similar and parallel to the administrative system of graduate education, a three-tiered administrative structure has been applied in the management of academic degrees: the ADC is at the top; the central ministries and commissions, CAS/CASS, and provinces are at the middle; and the degree-granting institutions (including both universities and research institutes) are at the bottom of the system.

- The ADC was set up under the State Council in December 1980 to supervise the conferring of academic degrees all over the country. Its main duties include formulating national guiding principles and policies for academic degree work, examining and approving graduate degree-granting universities and research institutes, and certifying disciplines and specialties as well as doctoral supervisors.

- The ministry- and provincial-level degree administrative agencies take charge of the degree work under their own jurisdictions. Their main responsibility is to coordinate work within the scope of their own authority and to provide additional funding for key and urgently needed degree programs.

- An academic degree evaluation committee is established in each degree-granting institution as a leading agency responsible for the quality of degree work and granting of degrees.

By the middle of 1998, the ADC system had accredited 633 institutions to confer master's degrees in 8,248 disciplines and specialties, 229 institutions to confer doctoral degrees in 2,292 disciplines and specialties, and more than 10,000 doctoral supervisors (Chisa 1998).[3]

Thus, the SEdC takes charge of developing the basics of graduate education, graduate teaching, and research training, while the ADC has responsibility for checking and accepting the resulting "products"—the graduate programs and graduates—in accordance with ADC standards.

Finance

There are two major sources of funding for higher education in China: state appropriations, the major source, accounting for more than 80 percent of the total; and income generated by higher education institutions and research institutes themselves, which has been increasing in recent years. The allocation for the 36 national universities administered by the SEdC and the specialized institutions and research institutes under the control of central ministries and the CAS comes from the budget of the Ministry of Finance. The local universities and research institutes receive funds mainly from provincial finance departments.

There are other funding sources for graduate training and research activity. One fund allocation is from the Ministry of Finance and is based on a head-count enrollment. Another is from a variety of research foundations, such as the Chinese National Science Foundation. A third source is from contract projects.

Since the late 1970s, China has increased its allocation to higher education both in absolute terms and relative to government expenditure and gross national product (GNP). Total public expenditure increased 4.76 times, from 111.10 billion yuan in 1978 to 528.74 billion yuan in 1993; expenditure on higher education increased 10.0 times, from 1.50 billion yuan to 15.05 billion yuan, during the same time period (Min 1997). This reflects the high priority given to higher education in the country's modernization process.

Degree Structure

As in America, the levels of academic degrees in China are connected to different phases of higher education. There are three categories of official degrees: bachelor's degrees, master's degrees, and doctoral degrees.

Bachelor's Degree

Precollege education in China consists of 12 years. By taking national entrance examinations, senior high school graduates are enrolled for their college studies.

[3] In Chinese universities and research institutes, only disciplines (somewhat similar to disciplinary programs) and specialties of relatively high quality in terms of teachers, research facilities, and reputation are authorized by the ADC system to offer graduate courses and grant graduate degrees.

The average length of an undergraduate program is 4 years, with 5-year programs offered in a number of specialties in science universities. Medical universities provide 5- or 6-year undergraduate programs. Students who complete all requirements of the curriculum receive a bachelor's degree.

Graduate-Level Degrees

China's graduate education has two official levels—the master's degree and the doctoral degree. At each academic level, two kinds of people are trained to meet the country's different needs: academic personnel and applied science personnel. There are full-time and part-time graduate programs; the latter require from 1 to 3 years of additional study.

The Master's Degree. By passing graduate entrance examinations, those who hold bachelor's degrees or equivalent academic qualifications can pursue 2- or 3-year master's programs.[4] Master's degrees are conferred upon those who have passed certain prescribed courses, including written examinations; written and defended orally a thesis presenting original views on a designated research theme; have a firm grasp of basic theories and systematic knowledge of the relevant field; exhibit good command of a foreign language; and are able to conduct scientific research or specialized technical work independently.

In recent years, in addition to this regular path of earning a master's degree, five other alternative channels have been developed, mainly for employed professionals and self-study applicants (ADC and SEdC 1995, Qin 1994).

The Doctoral Degree. By passing entrance examinations, those who hold a master's degree or equivalent academic qualifications can pursue 3- to 4-year doctoral programs. In addition, a small number of outstanding newly graduated bachelor's degree-holders can directly enter doctoral programs upon special recommendation. To receive a doctorate, students must pass written examinations in prescribed courses (usually including political theory, two foreign languages, and two to three specialized subjects) and conduct an oral defense of a dissertation. This must be accompanied by qualified records demonstrating that the student has a firm and comprehensive grasp of basic theories, systematic and profound knowledge in the branch of learning concerned, good command of two foreign languages, the ability to undertake scientific research independently, and the capacity to turn out creative achievements in science or specialized technology.

As with the master's degree, there is an alternative way for employed professionals to obtain a doctoral degree. This route is similar to the Japanese *Ronbun hakase*—earning a doctoral degree by submitting a dissertation without enrolling at a university. Matriculation and coursework are not necessary; submission of the dissertation suffices for the degree.

In terms of administrative structure and degree structure, the current Chinese degree system is something of a hybrid of the old Soviet system and the American system, combined with elements indigenous to China itself. Its administrative structure is more like the Soviet model, while its degree structure resembles that common in America.

Expansion of Graduate Education

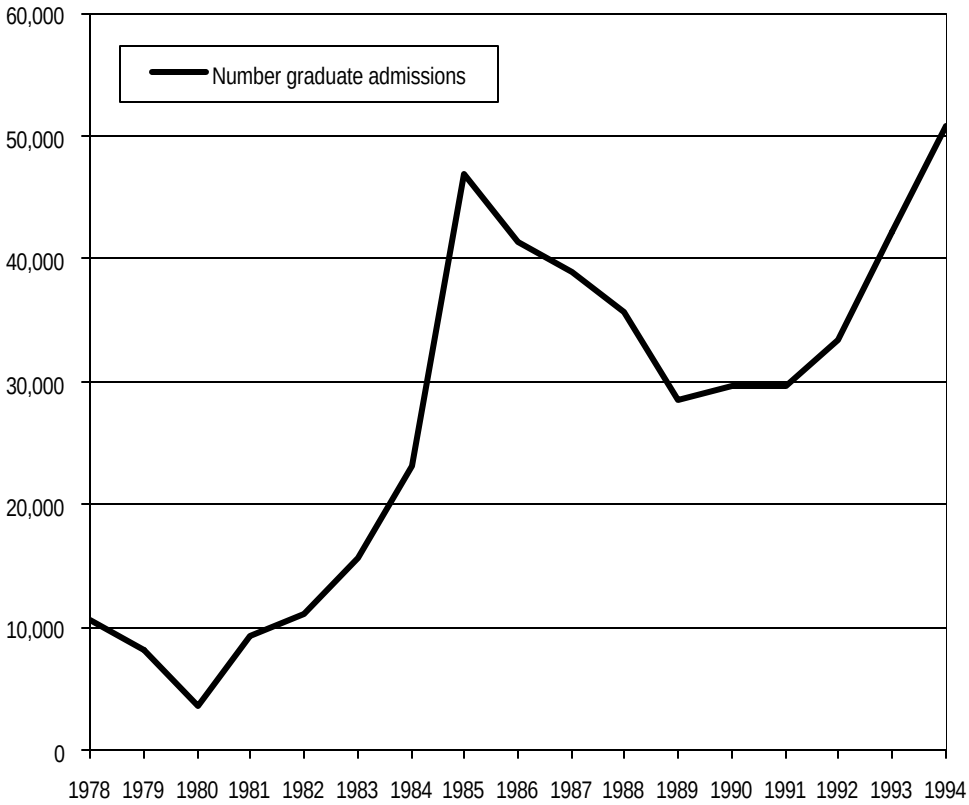
Since its resumption in China in 1978, graduate education has experienced a development that merits particular attention because it is not only unprecedented in China in terms of its speed and scale, but also rare in the history of graduate education internationally. According to available statistics, China spent 17 years increasing its graduate enrollment from 10,900 to 128,000 during the 1978-94 period; concurrently, America, Britain, Japan, and the former Soviet Union respectively spent 20, 29, 34, and 31 years reaching the same or similar developmental scale in their respective histories (Z. Wu 1995).

Figure 1 shows a number of significant fluctuations in Chinese graduate admissions. The admission decrease in graduate students from 1978-80 was related to the resumption of 4-year undergraduate education in China in 1977, following its suspension for 11 years. Before 1981, the main source of eligible applicants was from among those who had been admitted into 4-year undergraduate programs prior to the Cultural Revolution. As a great number of these students had matriculated in 1978-79, the number of qualified applicants in 1980 remained limited.

Between 1981-85, graduate education in China experienced a very rapid expansion due to a number of social, economic, educational, and scientific and techno-

[4]Usually the length for engineering and science programs is 2 to 2.5 years, while that for social science and humanities programs is 3 years.

Figure 1. Graduate recruitment in China, 1978-94



SOURCE: *Academic Degrees and Graduate Education,* 71 (6): 17, 1996. *Academic Degrees and Graduate Education,* 72 (1): 51, 1997.

logical factors. These changes occurred during a period when the Chinese government extended its new policy of reform and of opening its doors to the outside world beyond the economy and into many domains of society. The reflection of this first reform wave was clearly evident in the expansion of graduate education.

The total number of admitted graduate students in 1981 was 9,363—2.6 times as many as in 1980. This increase in admissions was due to two primary reasons: first, the establishment and implementation of the academic degree system in 1981 encouraged and attracted more people to pursue graduate studies; second, the first 4-year undergraduate program students who had entered college in 1977 graduated in 1981, thus adding to the pool of eligible and qualified graduate candidates.

Another big jump in graduate admissions occurred in 1984 and 1985. In 1985, 46,871 students were recruited, twice as many as in 1984. In turn, the accepted total in 1984 was 23,181, or 1.5 times as many as in 1983. This rapid growth was driven by landmark reforms in the economy, science and technology, and education:

- In 1984, a major reform document modifying the Chinese economic system was adopted—the "Resolution of the CPC [Communist Party of China] on the Reform of the Economic Structure," whose central argument was that the economy is activated only by relying on scientific and technological progress. Needless to say, a mammoth force of high-level specialized personnel would be needed to fulfill this task.

- The National Science Conference was held in March 1985, which advocated the promotion of strong linkages between research and teaching and led to the establishment of a new science fund—the National Fund of Natural Sciences—for which researchers in both universities and research institutes of the national academies are eligible to apply and with award decisions based on peer review. This reform legally and, to a certain degree, financially guaranteed higher education institutions a new role in research.

- In May 1985, the document "Decision on the Reform of the Education System" was approved by the CPC at the National Education Conference. Among the many policy changes set out in this document, the following two are of special importance concerning the development of graduate education: first, institutions were to be allowed to admit additional students on the basis of contracts with enterprises and other employers, and also to enroll fee-paying students; second, the credit system and double-degree studies were to be introduced.

- Starting in 1981, the World Bank undertook a 5-year program under which it would offer a loan of US$200 million, together with US$95 million from the Chinese government, to "strengthen science and engineering programs in 28 key higher education institutions by increasing graduate and undergraduate enrollments, improving the quality of graduate and undergraduate education and the ability to do university based research." This program played a significant role in improving the conditions and quality of both teaching and research and, especially, in expanding graduate enrollment in that period, for these key universities enrolled a large share of China's graduate students.

With strategic priority being given to education and research and relatively more financial investment coming in from the government and the World Bank in this period, approximately 379 new institutions of higher education were created between 1980-86—from 675 to 1,054; undergraduate student enrollment increased from 1,140,000 to 1,880,000. Graduate enrollment increased more than fivefold during the same period, rising from 21,600 to 110,371 (IAP and CRC 1991, DFA 1994).

With little experience in conducting graduate education, the Chinese government was confronted with a number of issues after 8 years of rapid development (1978-85). The phase between 1986-91 was characterized by frequent readjustment and various reforms in policies concerning the developmental scale and quality of Chinese graduate education. The total enrollment of 120,191 in 1987 transcended the capacity and resources available. Starting in 1986, following the SEdC's new directive on stabilizing scale, graduate admissions were gradually reduced to 35,645 in 1988, with a further large decline in graduate admissions in 1989, when only 28,569 were accepted—20 percent less than in 1988. This admission stabilization policy was continued by the SEdC in the subsequent 2 years. The reasons for the decline in graduate recruitment were complex. According to World Bank research findings, students' changing career goal patterns (more and more students wanted to go abroad or into joint ventures), the economic retrenchment policies of 1988, and the aftermath of the June 1989 events all had negative effects on graduate recruitment (IAP and CRC 1991).

Distribution Across Graduate Degree Levels

In general, the distribution of levels of graduate degrees in a nation is determined and affected by a variety of societal factors. An ideal distribution of graduate degrees—the ratio between doctoral and master's degrees—should remain in accordance with the level of the country's national economic, scientific, and cultural development; population density; degree of universal schooling; and developmental status of its national education system. The appropriate ratio between these two degrees varies from nation to nation and from time to time. Some countries deliberately plan their ratio; others let market demand drive it.

In China, the government sets an annual ratio between doctoral and master's degree enrollment. During the 14-year period from 1982-95, China granted only 22,162 doctoral degrees, which is not commensurate with the country's vast population and the demands of rapid economic development. During this period, the number of doctoral degrees accounted for a very small share of the total graduate degrees awarded (table 1); the average ratio between master's and doctoral degrees over the period is about 14:1.

The rapid national economic development and the competition and challenge of science and technology in the 21st century call for high-level scientific and technical personnel. It is imperative that China pay more attention to doctoral education in the future. In view of China's current situation and future development, the ratio between master's and doctoral degrees should be raised to around 5:1 for a time. Such a ratio would seem reasonable given the existing circumstances in China, i.e.:

- In 1994, only 2.2 percent of full-time teachers in regular higher education institutions in China had earned doctor's degrees (Guo 1998).

Table 1. Doctoral and master's degrees awarded and their ratio, 1982-94

Year	Master's	Doctorate	Ratio
1981	8,665	0	0
1982	5,773	13	444.0:1
1983	3,548	19	187.0:1
1984	7,798	91	85.7:1
1985	12,618	234	53.9:1
1986	14,938	307	48.7:1
1987	20,831	622	33.5:1
1988	36,501	1,682	21.7:1
1989	35,442	1,904	18.6:1
1990	32,557	2,127	15.3:1
1991	30,675	2,556	12.0:1
1992	25,276	2,540	10.0:1
1993	24,129	2,114	11.4:1
1994	26,166	3,590	7.3:1
1995	28,098	4,363	6.4:1

SOURCE: *Academic Degrees and Graduate Education,* 71 (6): 73, 1996. *Academic Degrees and Graduate Education,* 72 (1): 51, 1997.

- The former vice minister of the SEdC pointed out that as early as 1993 China had about 1 million senior specialized personnel; 80 percent of them will be retired by the year 2000, and the vacancies left by them will require a younger generation with advanced degrees.

- Due to the Cultural Revolution, China lost 1.5 million specialists. This resulted in an "inverse peak" in the 40- to 50-year range in the age structure of the faculty of higher education institutions. Those in their 40s are the smallest group, constituting only 14 percent of faculty members (Guo 1998).

- The rapid national economic development and competition and challenge of science and technology in the 21st century will doubtless require a mammoth force of high-level scientific and technical personnel.

- In China's ambitious development plan of higher education, a number of universities are to be transformed into world-class universities in the next century. One important feature of world-class universities is that they annually grant a large number of doctorate degrees and that the percentage of their faculty members with doctorates is very high—in some universities, as high as 100 percent. This can be clearly seen in a recent issue of *Asiaweek* (1997) which, based on its own evaluation, ranks Asia's top 50 universities. One important lesson from the ranking is that the relatively low percentage of faculty members with graduate degrees holds Chinese universities back.

Given these circumstances, it is imperative to pay more attention to doctoral education in the future. According to the Chinese development plan of graduate education, in the year 2000, graduate enrollment will be around 200,000. If 70,000 of these students graduate annually, given a ratio of 5:1 between master's and doctoral degrees, only about 14,000 will be doctorate recipients. In view of the current Chinese situation and the country's future development—as well as in comparison with the United States, where the corresponding ratio between annual master's and doctoral degrees is around 3:1—this number of doctoral degrees is far from what is really needed. China, aware of this situation, has already begun a "self-reliant" effort to generate doctoral degrees at home since the early 1990s.

Field Distribution of Graduate Education

The current disciplinary distribution of graduate education in China is basically a reflection of the existing base, including graduate supervisors' academic specialties and expertise (Z. Wu 1997). One of its deficiencies is an asymmetry in major fields of study, primarily characterized by two features (tables 2 and 3). First, the proportion of traditional and basic disciplines such as history, literature, natural science, engineering, and medicine is too large—combined, these fields account for 82.2 percent and 78.9 percent of all doctoral and master's degree programs, respectively. Moreover, the master's and doctoral degrees awarded in these major fields of study from 1981-95 account for as much as 82.7 percent and 88.1 percent, respectively, of degree awards. Second, the proportion of newly emerging and applied disciplines, such as economics and law, which are badly needed in a market economy is too small—combined, these account for only 7.3 percent and 8.8 percent, respectively, of total doctorate and master's degree programs. Between 1981 and 1995, degree awards in these fields accounted for only 9.3 percent and 5.9 percent, respectively, of all master's and doctoral degrees awarded. This structure of major fields of study is aimed to serve the centrally planned economy; it by no means can respond to the grow-

ing demands for various types of high-level specialized personnel from a market economy. Thus, the Chinese government should strive to readjust the structure of major fields of study in its graduate education so as to develop a structure that is both internally coherent as well as externally responsive to labor market changes in the transition from a planned economy to a market economy.

Table 2. Percent distribution of graduate programs by field of study, 1995

Field	Doctorate granting programs	Percent	Master's degree granting programs	Percent
Total	2,398	100.0	8,467	100.0
Philosophy	41	1.7	170	2.0
Economics	109	4.5	374	4.4
Law	67	2.8	374	4.4
Education	40	1.7	214	2.5
Literature	115	4.8	599	7.1
History	75	3.1	224	2.7
Sciences	465	19.4	1,345	15.9
Engineering	863	36.0	2,906	34.3
Agriculture	161	6.7	598	7.1
Medicine	454	18.9	1,571	18.9
Military science	8	0.3	92	1.1

SOURCE: *Academic Degrees and Graduate Education,* 72 (1): 50, 1997.

Future Trends in Graduate Expansion: 1995-2020

Graduate enrollment is affected primarily by the growth rate of both the national economy and the relevant age cohort. In China, to a great extent, it is also affected by public policy determinations to either set enrollment quotas to restrict growth or to let enrollment be driven by demand. The projection here is mainly based on the first two factors: the growth rate of the economy and the relevant age group.

The demand for high-level educated personnel depends to a large extent on how fast the economy grows. According to the newly issued long-term development target for the year 2010, the Chinese government's target for gross domestic produce (GDP) in 2000 is to quadruple that of 1980, and for GDP in 2010 to double that of 2000. This requires an average annual growth rate of 8 percent between 1995 and 2000, and of over 7 percent between 2000 and 2010.

Given the momentum of China's economic growth rate in the period between 1978 and 1994, it is realistic to expect GDP to continue to grow at an average annual rate of 7 to 9 percent in real terms over the next 25 years.

Table 3. Percent distribution of master's and doctoral degrees awarded by field of study (1981-95)

Number and Percent	Total	Philosophy	Economics	Law	Education	Literature	History	Sciences	Engineering	Agriculture	Medicine	Military science
Master's degree	313,006	5,681	17,731	11,701	5,166	15,914	6,669	60,527	141,119	13,115	34,690	693
Percent	100.0	1.8	5.6	3.7	1.7	5.1	2.1	19.3	45.1	4.2	11.1	0.2
1981	8,665	178	163	56	21	530	209	2,387	3,949	198	974	0
1985	12,618	207	575	336	158	648	390	3,204	5,188	834	1,708	0
Percent	100.0	1.6	4.6	2.7	1.3	5.1	3.1	25.4	41.1	6.6	8.5	0.0
1986	14,938	260	654	607	133	611	316	3,104	6,609	798	1,846	0
1990	32,557	686	1,850	1,165	585	1,374	793	6,157	14,396	1,406	4,093	52
Percent	100.0	2.1	5.7	3.6	1.8	4.2	2.4	18.9	44.2	4.3	12.6	0.2
1994	26,166	418	2,024	1,321	517	1,477	437	4,592	11,672	884	2,689	135
1995	28,098	384	2,207	1,390	547	1,484	499	4,653	13,174	903	2,723	134
Percent	100.0	1.4	7.8	5.0	2.0	5.3	1.8	16.6	46.9	3.2	9.7	0.5
Doctorate degree	22,162	345	891	428	211	523	503	6,192	8,725	773	3,560	0
Percent	100.0	1.6	4.0	1.9	1.0	2.4	2.3	27.9	39.4	3.5	16.1	0.0
1981	13	0	0	0	0	0	0	12	1	0	0	0
1985	234	5	0	0	0	6	10	94	87	0	32	0
Percent	100.0	2.1	0.0	0.0	0.0	2.6	4.3	40.2	37.2	0.0	13.6	0.0
1986	307	7	3	1	1	10	7	119	122	2	35	0
1990	2,127	29	137	34	16	45	36	590	828	88	324	0
Percent	100.0	1.4	6.4	1.6	0.8	2.1	1.7	27.7	38.9	4.1	15.2	0.0
1994	3,590	53	170	98	43	92	68	918	1,389	125	634	0
1995	4,364	60	198	102	52	116	76	1,191	1,659	182	728	0
Percent	100.0	1.4	4.5	2.3	1.2	2.7	1.7	27.3	38.0	4.2	16.7	0.0

SOURCE: *Academic Degrees and Graduate Education,* 72 (1): 51, 1997. *Academic Degrees and Graduate Education,* 71 (6): 73, 1997.

Table 4 provides estimates per capita GDP based on three scenarios of average annual GDP growth rate: (1) slow growth at 7 percent, (2) medium growth at 8 percent, and (3) fast growth at 9 percent. According to these projections, China's per capita GDP would be US$600 to US$700 by 2000, US$1,100 to US$1,600 by 2010, and US$2,100 to US$3,500 by 2020.[5]

Table 4. Expansion trends of graduate education, 1994-2020 (in constant 1994 yuan)

Rate of Growth	1994	2000	2010	2020
	GDP per capita in yuan			
Slow growth (r=7%)	3,800	5,400	9,900	18,300
Medium growth (r=8%)	3,800	5,700	11,500	23,300
Fast growth (r=9%)	3,800	6,000	13,300	29,600
	In dollars (8. 5 Yuan=$1)			
Slow growth (r=7%)	447	630	1,200	2,200
Medium growth (r=8%)	447	670	1,300	2,700
Fast growth (r=9%)	447	710	1,600	3,500
	Enrollment ratio (%)			
r=7. 6%	0.11	0.15	0.43	0.81
r=9. 8%	0.11	0.19	0.64	1.47
	Enrollment (thousand students)			
r=7. 6%	128	186	387	805
r=9. 8%	128	224	571	1,455
Country income level	Low	Becoming lower-middle	Lower-middle	Becoming upper-middle

NOTE: The numbers are rounded.

SOURCE: The World Bank Report No.15573-CHA, pp. 61-62 and pp. 148-151. China Statistical Yearbook 1995, China Statistical Publishing House, 1995, p 62.

The population for graduate education in China is here referred to as the 25- to 29-year-old age cohort. The reason for choosing this age group is mainly that the average age of all recipients of master's degrees awarded between 1991 and 1994 is 27.5 years (table 5). Given the current system of Chinese graduate education, the time span for master's degree studies is between 2.5 and 3 years. That means that when they entered graduate school, students were around 25 years old. Though the average age of doctoral degree recipients for this period is 31, the real average time span for doctoral studies in China is about 3.5 years (ADC and SEdC 1995), which means these students entered doctoral programs at the age of 27.5.

The population of 25- to 29-year-olds in China is projected by the World Bank to decline gradually from 1994 to around 2005, when the generation born after the implementation of China's 1979 one-child policy comes of age. The size of the 25- to 29-year-old age cohort is projected to fluctuate between 90 million at the lowest point in 2010 and 115 million at the highest in 2015, and then to go down to 99 million in 2020.

Table 5. Average age of doctoral and master's degrees awarded through full-time studies, 1991-94 (number of persons)

Year	Doctoral degree		Master's degree	
	Total	Average age	Total	Average age
1991	2,519	31	29,112	27
1992	2,503	31	23,572	27
1993	2,082	31	23,029	28
1994	3,523	32	24,780	28

SOURCE: *Data of Academic Degrees and Graduate Education Statistics to 1991-1994,* China Archives Press, 1995.

Projected graduate enrollment is based on two different enrollment growth rates (table 4):

- **Gradual Growth.** If graduate enrollment follows the historical average annual undergraduate enrollment growth rate of 7.6 percent up to 2020, China would reach an enrollment ratio of 0.15 percent of the 25- to 29-year-old age cohort by 2000, 0.43 percent by 2010, and 0.81 percent by 2020. This growth rate lags behind historical GDP growth rates, but keeps pace with undergraduate enrollment—if the latter maintains its established

[5]The World Bank's definition of country income level is as follows: low-income countries are those with a per capita GNP of US$695 or less, lower middle-income countries are those with a per capita GNP between US$696 and US$2,784, and upper middle-income countries are those with a per capita GNP between US$2,784 and US$8,626 (World Bank 1995).

growth rate over the next 25 years. If both undergraduate and graduate enrollments grow at the same rate of 7.6 percent in the next 25 years, the ratio between them will be at the 1994 level: 100:4.57.

- **Fast Growth.** If graduate enrollment growth is to catch up with the historical average annual GDP growth rate of 9.8 percent, the enrollment ratio would reach 0.19 percent by 2000, 0.64 percent in 2010, and 1.47 percent in 2020. Although total enrollment by 2020 would be 1,455,000, the enrollment ratio would still only be 1.47. However, this enrollment could be considered enormous because, if 25 to 30 percent of the students graduate annually (the majority of graduate students in China study full time, so it is entirely possible for them to complete their studies within the prescribed 3-year time span), the number of graduate degrees awarded would be about 400,000. This is similar in scale to the United States—which has the largest graduate system in the world—where advanced degrees awarded annually number about 300,000 master's degrees; 35,000 Ph.D. degrees; and 70,000 first professional degrees (e.g., M.D., Ed.D., J.D., etc.).

Beyond the two principal factors discussed above—growth rate of the national economy and population of the relevant age cohort—are two other considerations.

Projection of GDP

To estimate the public resources available in the future, three scenarios are projected of average annual GDP growth rates between 1995 and 2020 at 7 percent, 8 percent, and 9 percent. The reason for choosing these average annual growth rates is that 7 and 8 percent fall within the Chinese government's own target, and 9 percent is close to the historical growth rate of 9.8 percent between 1978-94. Projected GDP forms the basis for projection of the Chinese government's expenditure on higher education.

Projection of Government Expenditure on Higher Education

The projection of government expenditure on higher education assumes that future government expenditure remains at 12.9 percent of GDP (the ratio in 1994), and that the government expenditure on higher education is about 2.6 percent of total government spending (the ratio of 1992). The reason for choosing the 1992 ratio instead of the 1994 ratio is that the government expenditure on higher education in 1994 increased considerably over previous years; this level might conflict with the overall objective of deficit reduction. The projection is based on a pessimistic assumption that the future growth of revenue remains unchanged and that the future growth of public spending on higher education will be constrained by the need to reduce the consolidated government deficit. Using these ratios for projection, total government expenditure on higher education would increase from about Y19 to 79 billion (in constant 1994 rates), if the GDP grows at 7 percent per year between 1994 and 2020; it would grow to Y100 billion if the GDP grows at 8 percent, and to Y128 billion if the GDP grows at 9 percent (World Bank 1996).

Overseas Study and International Mobility of Scientists and Engineers

Overseas Study

The Chinese government's decision to send thousands of students for overseas study represents a historical continuity rather than a radical departure in modern China's cultural policy. For over a century, with the sole exception of the period from 1967-74, Chinese students have been studying abroad, frequently in large numbers. The roles played by the generations of returned Chinese students educated abroad in social, economic, scientific, and political modernization in general, and educational modernization in particular, have been important historically. In fact, the modern higher education system in China is a direct result of China's contact with the outside world, both West and East, brought back by returned foreign-trained students. In contrast to earlier periods, today's overseas student situation has three striking features.

First is its vast scale and scope. During the period 1978-98, about 300,000 students—50 times as much as the figure (11,900) for the 28-year period 1950-77—went to more than 100 countries and areas for overseas study; the United States was the major host country (*China Spectrum* 1998). More than half of these students were enrolled in American universities. Table 6 clearly shows the dramatically increasing enrollment and ratio of Chi-

nese students among total foreign students in American universities from 1980-96: enrollment increased 14.3 times from 2,770 to 39,613, while the proportion rose from 0.9 percent to 8.7 percent. In comparison, the total number of foreign students in the United States increased from 311,880 to 453,787, or only 45.5 percent, in the same period. Therefore, students from China became by far the fastest growing community on American campuses. Although Chinese students have, during recent years, been the second largest foreign student population after Japanese students, during the period 1989-94, they took the lead in total foreign student enrollment in the United States. The relative decline of Chinese student enrollment after 1994 was affected by the situation in China, where the second reform tide after 1992 led to more opportunities in both the job market and graduate studies at home. As a result, the wave of overseas students slowed to some extent in recent years.

Table 6. Foreign students enrolled in American universities, 1980-81 to 1995-96

	Total foreign students	Country of origin	
		China	Japan
	1980-81		
Number	311,880	2,770	13,500
Percent	100.0	0.9	4.3
	1985-86		
Number	343,780	13,980	13,360
Percent	100.0	4.1	3.9
	1989-90		
Number	386,850	33,390	29,840
Percent	100.0	8.6	7.7
	1990-91		
Number	407,530	39,600	36,610
Percent	100.0	9.7	9.0
	1991-92		
Number	419,590	42,940	40,700
Percent	100.0	10.0	9.7
	1992-93		
Number	438,620	45,130	42,840
Percent	100.0	10.0	9.8
	1993-94		
Number	449,704	44,381	43,770
Percent	100.0	9.9	9.7
	1994-95		
Number	452,635	39,403	45,276
Percent	100.0	8.7	10.0
	1995-96		
Number	453,787	39,613	45,531
Percent	100.0	8.7	10.0

SOURCE: U.S. Department of Education, *Digest of Education Statistics 1996 and 1997,* p. 450 and p. 456.

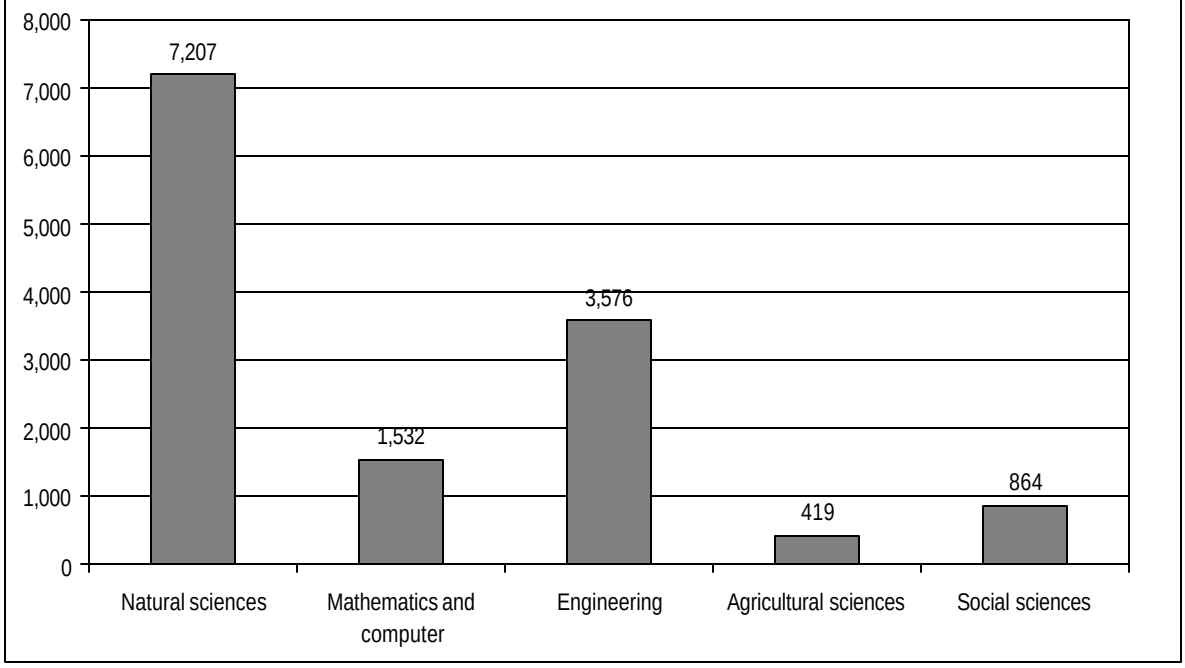
The second characteristic of the current situation is its advanced educational level. The majority of Chinese students go abroad for graduate rather than undergraduate studies. For example, among those Chinese students who were enrolled in American universities in the 1995-96 academic year, graduate students accounted for more than 80 percent (NSB 1998). Graduate training, especially at the doctoral level, is associated with research. The data in figure 2 show that, from 1988-95, American universities granted Chinese students 14,705 doctoral degrees; of these, 92.5 percent (13,598) were in science and engineering (S&E) fields. Many Chinese graduates continued their research activities as postdoctoral students after earning their Ph.D.s.

The third issue concerning overseas study is the serious problem of "brain drain": at least half of Chinese students are extending their stays or trying to seek permanent residency in foreign countries. According to incomplete statistics from the Chinese Embassy in the United States, in the past 20 years, about 160,000 Chinese students came to the United States to study; by 1998, only 30,000 of them had returned home. According to data from the U.S. National Science Foundation for the period 1990-96, the percentages of foreign S&E doctoral recipients planning to remain in the United States increased. Over 68 percent planned to locate in the United States, and nearly 44 percent had firm offers to do so. The data in table 7 show that, in 1990, 41 percent of over 1,000 Chinese S&E doctoral recipients in U.S. universities had firm plans to remain in the United States. By 1996, about 56 percent of the nearly 3,000 Chinese S&E doctoral recipients from U.S. universities had firm plans to remain in the United States. The underlying cause for this shift is the large number of Chinese students granted permanent residence status in the United States in 1992 following China's response to student demonstrations (NSB 1998).

Beyond clearly political factors, the reasons behind the rapidly growing number of nonreturning Chinese students include the relatively poor working and living conditions in China. This whole phenomenon of overseas students who do not return has severely damaged domestic teaching, research, and research and development. Given the scarcity of human resources in the country and its ambitious economic development program, such a large outflow of high-level specialized personnel represents a severe brain drain problem for China (Cao 1996).

The Chinese government has made efforts to reduce brain drain in the past 20 years. These efforts have varied over time. In general, before the mid-1980s, the

Figure 2. Chinese S&E Ph.D. degrees recipients from U.S. universities, by major field, 1988-95



SOURCE: National Science Foundation, Division of Science Resources Studies (SRS), Survey of Earned Doctorates, 1998.

Table 7. Chinese Ph.D. recipients from U.S. universities who plan to stay in the U.S. (1990-96)

Year	All fields				
	Total Ph.D. recipients	Plan to stay in U.S.		Firm plans to stay in U.S.	
	Number	Number	Percent	Number	Percent
1990.....	1,225	725	59.2	502	41.0
1991.....	1,919	1,523	79.4	920	47.9
1992.....	2,238	1,980	88.5	1,080	48.3
1993.....	2,416	2,134	88.3	1,077	44.6
1994.....	2,772	2,548	91.9	1,223	44.1
1995.....	2,979	2,744	92.1	1,341	45.0
1996.....	3,201	2,896	90.5	1,788	55.9

SOURCE: National Science Board, *Science and Engineering Indicators 1998,* (NSB 98-1), pp. A-89-A90, Arlington, VA, 1998.

policies on study abroad were considered "fairly liberal" by foreign experts (Altbach 1991). For example, in 1984, the State Council announced: "All Chinese citizens who are able to secure financial support in foreign currency or foreign scholarships through proper means and who have gained admission to foreign educational institutions can apply for undergraduate or graduate studies at their own expense regardless of former education, age, or length of employment" (Du 1992). After the mid-1980s, the Chinese government became conscious of the fact that over 95 percent of the students sponsored by the government did not show any sign of coming back (Zhao 1996). As a result, the state gradually limited the number of government-sponsored students and set more and more rules to restrict their numbers.

Two important rules aimed to reduce the ratio of those going abroad and those not returning. According to the first rule, a bachelor's degree-holder had to work in China for at least 5 years, and a master's or doctoral degree-holder for at least 2 years, before going abroad. Since the majority of Chinese students were seeking their permanent residency in the United States, the second rule was set to reduce the ratio of emigration. The Chinese government planned to send the majority of students to countries that were capable of accepting more, but that had taken few so far. Of the government-sponsored students, about 20 percent would be sent to the United States, 50 percent to Europe, 20 percent to Australia, and 10 percent to Japan (Reed 1988).[6] After the June 4 event in 1989, due to some restrictions, the number of going abroad was further reduced. However, this picture has begun to change since 1992, when more relaxed and liberal policies on overseas study were formulated.

[6]The real intention of the Chinese government was to send more students to European countries whose immigration laws are very strict.

International Mobility of Scientists and Engineers

In 1996, the Chinese government strategy started to shift from concentrating on the return of overseas Chinese students and professionals, as well as blocking the outflow of scholars and students, to tolerating their migration, optimizing their contributions, and improving the home environment (Cao 1996). A new policy of supporting study abroad, encouraging return and free movement in and out of the country was introduced in 1992; and the government made a clear connection between supporting study abroad and the nation's strategic development in the next century. This new policy represents the most relaxed policy on study abroad in China since 1978. To some degree, this has encouraged China's high-level specialized personnel to join in the international scientific community, generating greater international mobility of scientists and engineers in and out of China. This is demonstrated in several ways, including the following.

Reform in Overseas Study Policies. In 1996, the State Overseas Study Foundation was established to select and sponsor qualified scholars nationwide for overseas study. Most of them are visiting scholars, and the length of stay is usually 1 year. Each candidate has to sign a contract with the foundation, along with a guarantor. If the candidate fails to return on schedule, the guarantor has to help the foundation get the candidate to return or pay fines stipulated in the contract. In 1998 alone, 1,709 scholars were selected and sponsored for overseas study. The data show that the return ratio of those sponsored by the foundation since 1996 is 85.7 percent. All those who remained have paid off the fines (*Chisa* 1998).

New Policies on Attracting Students. Since 1992, many educational and research institutions and organizations in China have formed career delegations that have visited the United States, Britain, Germany, Japan, and other developed countries to recruit overseas Chinese students and professionals. Since then, an increasing number of Chinese students and professionals are going back to China for either long-term work assignments or short-term academic and business visits. For example, between 1993-94, more than 10,000 overseas Chinese students and scholars made such visits. In 1994, 65 Ph.D.s returned to China from France alone.

Many institutions in China have taken measures to improve the home environment in attempts to attract overseas Chinese students and professionals. The Chinese Academy of Sciences is seeking an extra Y2 billion (US$240 million) a year for recruiting 600 bright young researchers from overseas in 1998 to 2000 (*Nature* 1998). The Ministry of Education announced in August 1998 that it would establish a special professorship system. Within the next 3 to 5 years, 300 to 500 outstanding young researchers would be selected from both home and abroad and granted the rank of specially appointed professors by key Chinese universities (*Chisa* 1998).

Many local governments in China also have established special policies to attract overseas Chinese students. In Shanghai alone, according to a recent report, 16,000 students have returned as of August 1998. In addition, several thousand overseas Chinese scholars have arranged business visits with the municipal government, and 557 have registered and opened businesses. Most of these represent high-tech companies and consulting firms (*Chisa* 1998).

With their newly acquired knowledge and expertise, these returned students and scholars have been playing key roles in China's higher education, scientific research, and production management. For example, of the 36 institutions of higher learning directly administered by the SEdC, more than half were headed by returned scholars. In many universities, over 80 percent of the academic leaders and chairpersons have some overseas experience.

Acceptance of Foreign Students for Study in China. From 1978-97, more than 258,000 foreign students came from over 160 countries and regions to China for study at different levels, including baccalaureate, master's, and doctoral programs as well as short-term programs. In 1997 alone, over 43,000 foreign students—35.8 times as many as the number (1,200) in 1978—were studying in China. Of the 4,569 foreign students sponsored by the Chinese government in 1997, 4.9 percent were enrolled in doctoral programs, 14.5 percent in master's degree programs, and 33 percent in bachelor's degree programs. In addition, in the same year, 39,035 were self-financed, of which 2 percent were pursuing doctoral degrees, 4.6 percent master's degrees, 28 percent bachelor's degrees, and 0.3 percent short-term diplomas (*Chisa* 1998).

In addition to the foreign students studying in China, there are also more students from overseas regions of Hong Kong, Macao, and Taiwan coming to study in mainland China. During the 10-year period 1988-97, 403 students from these three regions were enrolled in Chinese universities. Most were graduate students (*Chisa* 1998).

International Exchange Activities. From 1979-96, according to incomplete statistics, the cumulative number of foreign scientists and engineers invited for various types of visits by China reached 570,000. In 1997 alone, more than 80,000 foreign experts and scholars were working in China (*Chinanews* 1998). In 1996, about 7,000 Chinese teachers and experts working in various fields were sent abroad to teach or give short-term lectures. During the period 1978-97, the number of Chinese scholars going abroad to attend international conferences and the number of foreign participants coming to China to attend international conferences hosted by Chinese institutions both exceeded 11,000 (Liu 1998).

Jointly Run Institutions. In addition to these international exchanges, some forms of international cooperation also took shape. An example of inter-institutional collaboration is the Nanjing-Johns Hopkins Center for Chinese and American Studies. Opened in the fall of 1986, it is jointly run by Nanjing University of China and Johns Hopkins University of the United States. The center offers a two-semester graduate-level curriculum in culture, economics, politics, foreign policy, international relations and law, modern history, and U.S.-China relations. The American students make up half of the total student body; Chinese students make up the other half. The author's personal experience in meeting American graduates from this center has been that they demonstrate substantial expertise on Chinese affairs and make contributions to the promotion of mutual understanding and friendship between China and America.

As early as 1993, some top Chinese universities, such as Beijing University, Shanghai Jiaotong University, and Nanjing University, started to offer 3-year Chinese master of business administration programs for Mandarin-speaking managers; these were offered first in Singapore and then in Malaysia. Xiamen University began offering a 6-year degree correspondence course in Chinese language and literature in Singapore in 1994 in collaboration with local institutions. This is the first time Chinese universities have offered Chinese degrees to individuals outside the country (Meng 1994).

CONCLUSION

It has been 20 years since graduate education was resumed in China in 1978. During this period, while Chinese graduate education has experienced remarkable development, many deficiencies remain in a course characterized by uneven development. Graduate education was resumed in a planned economy context and is being developed in a transition period toward a market economy. Thus, Chinese graduate education inevitably bears the dual imprints of the two periods. The current Chinese graduate education system is somewhat of a hybrid of the Soviet system and the American system, but it is tending to move toward the later. One of the main challenges faced by the Chinese government is to keep an appropriate growth rate for graduate education in accordance with future economic development and to readjust the disciplinary structure to meet the needs of a transition from an extensive-type (labor-type) economic growth to an intensive-type (knowledge-type) economic growth.

Chinese policies on overseas study have not been entirely successful. Although the situation in China has been improving, there are still many Chinese students and scholars going and remaining abroad. In recent years, China has started to participate in the international scientific community, but the scale is still limited in comparison to some other countries and regions. Of the many factors affecting the movement of overseas students and scholars, economics always plays a critical role. South Korea and Taiwan had a similar problem of brain drain before the mid-1980s. However, when their per capita GNP reached about US$4,000, their overseas students and scholars started to flow back home. Currently, China has a per capita GNP of nearly US$700. If the country continues to reform its economic structure, relying on scientific and technological progress in its transition to a market economy, the demand for specialized personnel will be high. Considering China's special circumstances, it seems likely that, when it has a per capita GNP of US$2,500 to US$3,000, China will turn brain drain to brain gain and benefit from the reverse flow of overseas Chinese students and scholars.

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