

# GRADUATE EDUCATION REFORMS AND INTERNATIONAL MOBILITY OF SCIENTISTS AND ENGINEERS IN TAIWAN

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## HISTORICAL REVIEW

Taiwan, an island off the southeast of mainland China, is one of the most densely populated areas in the world: 35,873 square kilometers in size with more than 21 million inhabitants. Taiwan was part of China before it was ceded to Japan in 1895. During the 50 years of Japanese occupation, a Western-style system of education was first introduced into Taiwan via the Japanese (Chen 1997). One university, one high school, and three junior colleges were established during that time. The enrollment was very small, and the function of these institutions was to provide a research capability and high-level manpower in support of Japan's policies of colonization and expansion.

At the end of World War II in 1945, Taiwan was restored to China. The island's educational system was soon replaced by the one adopted on the mainland since 1922, which mainly follows the American prototype (Chen 1997). After the Chinese National Party moved its seat to Taiwan in 1949, Chinese educational policy was imposed on the island more thoroughly than before and Japanese influence diminished further.

Since then, Taiwan has developed rapidly. To meet the needs of immediate economic development and the growing demand for skilled human resources, higher education expanded rapidly between the 1950s and 1980s. Tables 1 and 2 show that, during this interval, the number of tertiary institutions increased by a factor of 15 (from 7 in 1950-51 to 107 in 1987-88), while enrollment swelled 54 times (from 6,665 in 1950-51 to 362,001 in 1987-88). Graduate enrollment increased from almost nothing in 1950-51 to 15,121—including 12,426 master's degree students and 2,695 doctoral students—in the 1987-88 academic year. This rapid expansion in higher and graduate education was driven by many forces, including the development of secondary education; the needs of a growing college-age population for higher and advanced education; and, most important, the takeoff of the economy since the 1970s. This last gave a great impetus to higher and graduate education in Taiwan.

**Table 1. Number of tertiary institutions in Taiwan (1950-88)**

Academic year	Type of Institution		Total
	Universities and colleges	Junior colleges	
1950-51.....	4	3	7
1960-61.....	15	12	27
1970-71.....	22	70	92
1980-81.....	26	77	103
1987-88.....	39	68	107

SOURCES: Ministry of Education, *Educational Statistics of the Republic of China*, 1997, pp. 2-5. Shun-fen Chen, "Taiwan," in Philip G. Altbach, Editor, *International Higher Education: An Encyclopedia* (Garland Publishing, Inc., 1991), pp. 550-51.

**Table 2. Enrollment at tertiary institutions in Taiwan (1950-88)**

Academic year	Master's	Doctorate	Undergraduate	Junior college <sup>a</sup>	Total
1950-51....	5		5,374	1,286	6,665
1960-61....	426	11	26,737	7,888	35,060
1970-71....	2,129	166	92,850	55,301	150,446
1980-81....	5,633	673	153,088	105,246	264,640
1987-88....	12,426	2,695	192,933	153,947	362,001

<sup>a</sup> First-, second-, and third-year students at 5-year junior colleges are excluded.

SOURCES: Ministry of Education, *Educational Statistics of the ROC*, 1997, pp. 2-5. Shun-fen Chen, "Taiwan," in Philip G. Altbach, Editor, *International Higher Education: An Encyclopedia* (Garland Publishing, Inc., 1991), pp. 550-51.

## CURRENT SYSTEM

Higher and graduate education in Taiwan have witnessed a remarkable development since the mid-1980s. This development has been coupled with a series of political, economic, and social reforms that emerged with and were affected by changes in domestic and international contexts.

Higher education in Taiwan is offered by three types of institutions: (1) junior colleges, (2) independent colleges, and (3) universities. By 1997, there were a total of 67

junior colleges, 44 independent colleges, and 26 universities. Junior colleges provide 2- to 3-year programs leading to a diploma (similar to the American associate degree in terms of academic standards). Those with only one or two schools are called independent colleges. Universities consist of at least three colleges (or schools). Both independent colleges and universities offer 4-year programs leading to a bachelor's degree. Many of them also offer master's-level programs, and some offer doctoral-level programs, depending on the academic performance of the department concerned. In the 1996-97 academic year, 67 independent colleges and universities offered bachelor's-level training. There were 536 master's programs and 116 doctoral programs in these universities and independent colleges. Four-year undergraduate enrollment has increased by 75 percent over the past 9 years (from 192,933 to 337,837), while enrollment in master's and doctoral degree programs has risen to 35,508 and 9,365—2.6 times and 3.5 times the figures for the 1987-88 academic year, respectively.

One of the characteristics of the Taiwan higher education system is that there are more private institutions than public ones. In 1997, out of 137 colleges and universities, 51 are public and 86 are private (Li 1997). However, of 24 universities, 16 are public and 8 are private; out of 43 independent colleges, 21 are public and 22 are private (Ministry of Education 1997). The universities are all comprehensive in nature, while the independent colleges generally focus on specific disciplines such as fine arts, medicine, technology, and teacher training. Among the 4-year institutions, public institutions are preferred over private by most students because the faculty qualifications of the former are usually better. In addition, tuition rates in the public sector are one-third those in the private sector. For example, in the 1996-97 academic year, the public institutions enrolled 25,423 master's degree students and 8,288 doctoral degree students, while the private sector institutions enrolled 10,084 master's degree students and 1,077 doctoral degree students. Recently, the Ministry of Education proposed that private universities with limited resources concentrate their efforts on the teaching of undergraduate students. This can be interpreted as a governmental intention to develop a policy of stratification, with public institutions emphasizing both graduate programs and research activities, and private institutions emphasizing undergraduate teaching.

## GOVERNANCE AND FINANCE

According to the constitution of Taiwan, the state has the power to supervise educational institutions at all levels. Thus, higher education in Taiwan has for a long time been marked by strong centralization. The institutions of higher learning are regulated with little flexibility. Almost every policy regarding higher education is made by the central government.

The Ministry of Education not only approves the establishment of new institutions, departments, and programs, but also controls the size of enrollment, tuition rates, required courses, minimum graduation credits, and other factors at all institutions, both public and private. Presidents of public institutions are chosen and appointed by the Ministry of Education. Those of private ones are appointed by their board of trustees with the approval of the Ministry of Education. As most of Taiwan's university presidents are closely connected with the ruling party, and many of them were former government officials, the government's control of the presidency often results in a degree of politicization on campus.

All public colleges and universities receive government funding. Public institutions receive their annual budgets from the government with specific amounts for each budget category, and tuition collected from students must be returned to the government. For private institutions, the major source of income is tuition. Government subsidies to them are limited, usually up to 15 to 20 percent depending on the efficiency of education and overall accreditation each year. In 1997, the total expenditure of government on education reached US\$15.3 billion, more than 5 percent of the gross national product (GNP).

The reason that all public schools are entitled to full support derives from the constitution. Article 164 of Taiwan's constitution states: "Expenditures of educational programs, scientific researches and cultural services shall not be, in respect of the Central Government, less than 15 percent of the total national budget; in respect of each province, less than 25 percent of the total provincial budgets, and 35 percent in the level of municipality or county" (Li 1997). This provision financially and legally guarantees the development of higher education.

The centralized character of the higher education system has been widely criticized; beginning with the political reforms of 1986—especially since the lifting of martial law in 1987—Taiwan’s higher education system has gradually been transformed. The promulgation of the newly revised University Act in early 1994 further laid a legal foundation for decentralization and depoliticization. According to this new act, the relationship between the government and universities has been changed, with more autonomy granted to universities. The three major reforms are as follows (Li 1997):

- **University autonomy.** Under the newly implemented educational reform policy, the main function of the Ministry of Education is to “oversee” and “guide” universities instead of “governing” them, and all public universities have been granted the right of self-governance. Specifically, university presidents will no longer be appointed by the Ministry of Education, but selected either by a search committee or by votes from all faculty members in the university. However, the University Act still specifies that the Ministry of Education holds final power over the appointment of presidents of national universities (Law 1995). Deans, chairpersons, and new faculty members to be employed are also determined by the faculty. Original core courses are no longer mandatory, depending on the decision of the curriculum committee of the faculty senate of the university.
- **Diversifying budgets.** The Ministry of Education will no longer allocate the complete budget to each public university. Instead, support will be limited to an allocation of a ceiling of up to 80 percent of the total overall budget requested for a given fiscal year. Each institution must undertake efforts to raise funds and find resources from the society at large, rather than being solely dependent on the government.
- **Transfer of credits.** A new policy on the transfer of credits has also been approved under the current reform campaign. Students do not have to restrict themselves to a single university, but are now allowed to take courses at other universities, if time permits. They are even allowed to transfer credits earned overseas during summer programs on the condition that the corresponding university is an accredited institution of higher learning.

These reforms have reflected the trends of decentralization, democratization, and internationalization of higher education in Taiwan in the past several years. As a result, the higher education system is becoming decentralized to a large extent, although all institutions still receive budgets from the Ministry of Education. As the budget of a public institution is to come from diversified sources, there will be a greater chance for institutional autonomy. Allowing students to travel overseas to take a few courses as part of their university studies will broaden their international perspective and better enable them to fulfill their educational goals.

## DEGREE STRUCTURE AND GRADUATE TRAINING

The degree structure and model of graduate training in Taiwan were introduced from the United States. The levels of academic degrees are connected with the different phases of Taiwan’s higher education. The academic degrees are divided into three categories: bachelor’s degree, master’s degree, and doctorate degree (Ministry of Education 1995 and 1997).

### BACHELOR’S DEGREE

After taking the highly competitive Joint Entrance Examination set each year by a board composed of university presidents, successful high school graduates are assigned to a university based on their preference and examination results. Once they are admitted to universities, they have to take 128 credits over 4 years, which is the minimum requirement for completion of a bachelor’s degree. Though course content generally tends to be closely focused on a student’s major subject, there is a current trend toward a wider choice of electives. The bachelor of medicine degree requires 7 years, the bachelor of dentistry 6. Some law and architecture departments require 5 years.

### MASTER’S DEGREE

Master’s degree programs admit university/college graduates, including 3-year junior graduates with 2 years of job experience and 2-year and 5-year junior graduates with 3 years of job experience, to receive education for 2 to 4 years. For the master’s degree, 24 credits and a the-

sis are generally the minimum requirements, followed by a written examination and an oral defense. A minimum residence of 2 years is required.

## DOCTORATE DEGREE

The doctoral degree programs admit those having a master's degree and university/college graduates majoring in medicine who have received professional medical training for a minimum of 2 years. At least 18 credits and a dissertation are the minimum requirements, together with a written examination and an oral defense. The doctoral degree usually takes 4 to 6 years to complete. To achieve the goal of life-long education, many universities and graduate institutes create advanced education opportunities by offering various in-service training programs.

The current degree structure and graduate training are undergoing two important changes. The Ministry of Education is planning to establish an associate degree for graduates of junior colleges and to create master's degree programs for in-service employees in 1999 (Cultural Division of Taipei 1998, pp. 24 and 28). These reforms will encourage more people to pursue college studies and increase enrollments in both junior colleges and master's degree programs.

In Taiwan, students wishing to enter a doctoral degree program must pass an entrance examination conducted by the university. Since 1990, a special program has also been available through which students in master's degree programs may apply for direct admission to the doctoral program in their respective institute. They must have earned a grade point average of 85 or higher for their first year of study,<sup>1</sup> be ranked in the top one-third of their class, and have shown a strong capacity for independent research. In addition to the regular full-time students, some qualified students from government and industry are enrolled in doctoral programs through on-the-job training programs sponsored by their respective employers. Most of them are part-time students. Like the regular full-time students, they must pass the entrance examination to become eligible for enrollment in the graduate programs and must successfully complete the graduate program requirements to earn the degree.

To become formal candidates for the doctoral degree, graduate students must pass a qualifying examination. In most universities, students who do not pass the qualifying examination within 2 or 3 years after entering a doctoral program are dismissed from the university. In addition to their coursework, graduate students are also involved in research projects sponsored by the National Science Council, other government entities, or industry. These research projects are carried out under the supervision of advisors, and usually serve as an exploratory or feasibility study that sometimes is a potential framework for the students' doctoral dissertations.

For each doctoral enrollment, the Ministry of Education subsidizes about US\$150 for operating expenditures and US\$1,200 for expenditures on books, equipment, and facilities; these go directly to the institution. Thus, graduate students only pay part of their overall educational cost by meeting the tuition and miscellaneous fees, which amount to about US\$550 per semester. Furthermore, all full-time doctoral students receive a monthly stipend of about US\$300, and the top 10 percent are awarded a scholarship of US\$550 for the first 3 years, which is provided by the Ministry of Education (Chang and Hsieh 1997). The doctoral degree awarded by universities in Taiwan is a research degree certifying that the recipient has the capability and training needed to engage in independent scholarly work.

## EXPANSION OF GRADUATE EDUCATION

Graduate education in Taiwan has witnessed a rapid expansion in the past 20 years. Table 3 and figure 1 indicate that, from 1975-96, total enrollment increased 10 times while enrollments of master's students and doctoral students increased 9 times and 30 times, respectively. This striking development has been attributed to various factors, including rapid economic and scientific growth, universal secondary education, growing demand of college-age cohort for higher education, and other factors. However, the most important driving force is the political reform that occurred in 1987, which resulted in a quite remarkable growth in graduate enrollment over the next 9 years. In 1996, 35,508 master's students—2.5 times as many as in 1988 (14,119)—were enrolled; doctoral en-

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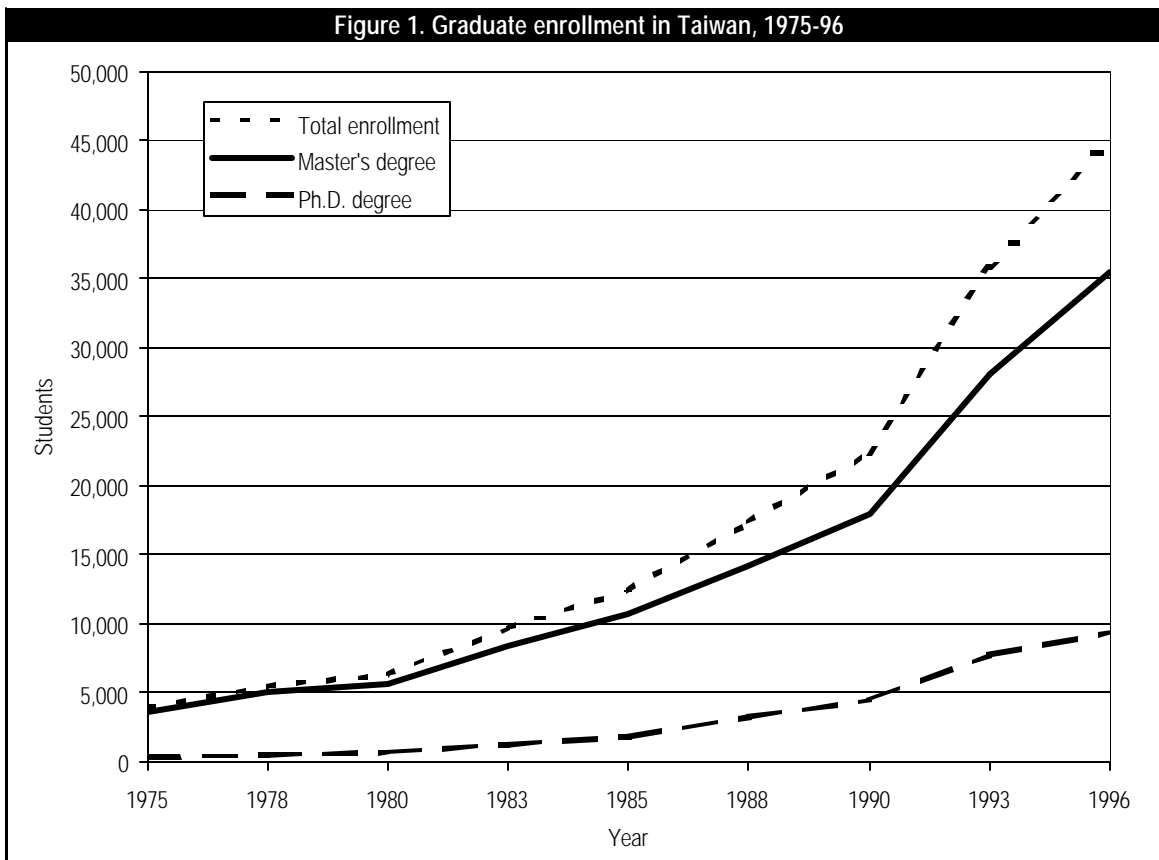
<sup>1</sup>The grading scale is from 0 to 100 at all levels. Many universities and colleges use the following scale on their English transcripts: 85-100 = A, 70-84 = B, and 60-69 = C. The minimum passing score is 60 for undergraduate students and 70 for graduate students.

rollment had almost tripled during the same period, rising from 3,222 to 9,365. Since doctoral enrollment showed even faster development, its proportion increased in the degree structure. Before 1988, the enrollment ratio of

master's to doctoral students was always more than 10 to 1. After 1988, the situation changed: in 1996, the ratio was only 3.5:1.

Table 3. Graduate enrollment in Taiwan, 1975-96									
Year	1975	1978	1980	1983	1985	1988	1990	1993	1996
Total enrollment.....	3,912	5,442	6,306	9,647	12,418	17,341	22,372	35,830	44,873
Master's students.....	3,614	4,974	5,633	8,427	10,638	14,119	17,935	28,117	35,508
Ph.D. students.....	298	469	673	1,220	1,780	3,222	4,437	7,713	9,365

SOURCE: Ministry of Education, *Educational Statistics of the Republic of China*, 1997, pp. 20-21.



SOURCE: Ministry of Education, *Educational Statistics of the Republic of China*, 1997, pp 20-21.

## HOME- AND U.S.-AWARDED DOCTORAL DEGREES

As in most other developing and newly industrializing economies (NIEs), graduate education in Taiwan, especially doctoral training, has been lagging behind the economy in terms of its rate and level of development. Graduate education needs a heavier investment than education at any other level. In addition to financial support, a higher development level of science and technology (S&T) is necessary to ensure the quality and standards of graduate education. Graduate education is closely linked with and conditioned by the development of the national economy. For example, before 1967, Taiwan had a per capita GNP of as low as about US\$260. There were no doctoral programs at Taiwan universities, only 170 master's programs. However, when Taiwan had a per capita GNP of US\$964 in 1975, 90 doctoral programs had already been created at Taiwanese universities, and 32 doctoral degrees were awarded in that year. Though doctoral education developed steadily in the following 20-year period—for example, in 1995, there were 578 doctoral programs nationwide, and 1,053 doctoral degrees were awarded—compared with some other developed countries, the establishment of doctoral training in Taiwan is still small and weak. Despite its growth, the number of students seeking graduate education abroad, and efforts to entice them to return, is evidence that doctoral education in Taiwan far from satisfies the needs of economic development and the demands of young people for advanced studies.

A majority of Taiwanese students go to the United States; table 4 and figure 2 show that the total number of doctoral degrees (9,847) awarded by American universities to students from Taiwan is as much as twice the number (4,481) awarded by Taiwanese universities in the past 20 years. The United States provides approximately 77 percent of Taiwan's doctoral degrees in natural science and engineering (S&E) (NSF 1993, p. 25). However, Taiwan built up its advanced degree capability and expanded its doctoral-level training in the mid-1980s. The recent trend shows that the number of home-awarded doctoral

degrees has been approaching that awarded in the United States. In 1995, the number of U.S.-awarded doctoral degrees decreased for the first time, dropping from 1,576 in 1994 to 1,485 in 1995.

## S&E FIELD-OF-STUDY STRUCTURE OF HOME-AWARDED GRADUATE DEGREES

As noted previously, centralization is one of the major features of Taiwan's higher education system. The government controls enrollments in each field and directs the development of higher education to meet the needs of society. As early as the 1950s and 1960s, the Taiwanese higher education structure was biased toward the humanities and social sciences rather than science and technology, as the economy in Taiwan was still labor intensive. The Ministry of Education was influenced by a 1962 Stanford report which suggested that in the 1960s there would be a surplus of graduates from the humanities and social sciences, but a shortage from S&T (Law 1996). Since then, the government has been channeling students into such marketable fields as engineering, natural sciences, and—more recently—business.

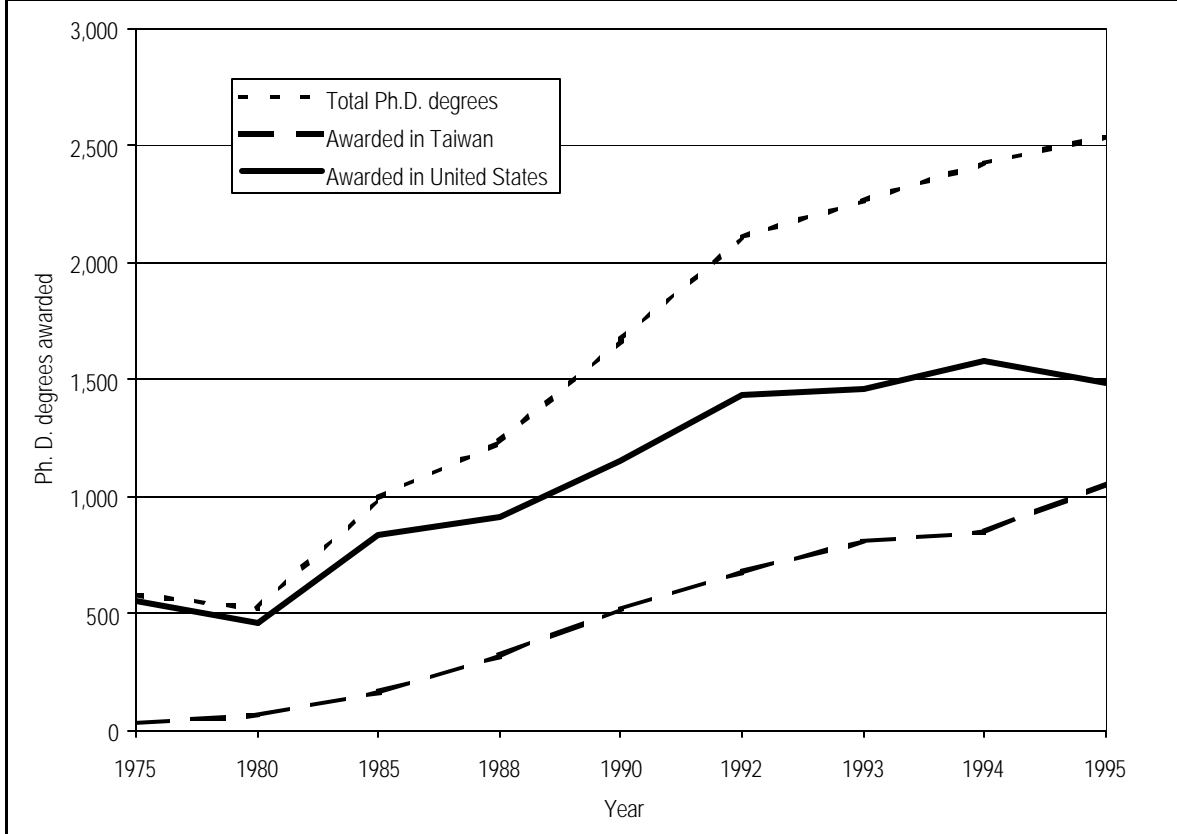
The statistics in table 5 and figure 3 show that the percentage of master's degrees awarded in the social sciences (out of all S&E fields) slowly decreased from 13 percent in 1975-80 to 10.1 percent in 1991-95, while that of doctorates dropped from 11.1 percent to 7.4 percent. On the other hand, the share of master's degrees awarded in the natural sciences and engineering (out of all S&E fields) slowly increased from 67.9 percent in 1975-80 to 71 percent in 1991-95, while that of doctorates rose from 70 percent to 74.4 percent. Within the five broad S&E fields, engineering has consistently had the largest degree population in the past 2 decades. During the period 1991-95, the proportions of master's and doctoral degrees in engineering reached 55 percent and 56.1 percent, respectively. Natural sciences ranked second after engineering, with proportions of master's and doctoral degrees of 16 percent and 18.3 percent, respectively. The

**Table 4. Ph.D. degrees awarded at home and in the United States, 1975-95**

Year	1975	1980	1985	1988	1990	1992	1993	1994	1995	Total
Total Ph.D. degrees.....	580	519	994	1,231	1,667	2,109	2,264	2,424	2,538	14,326
Awarded in Taiwan.....	32	64	161	319	518	678	808	848	1,053	4,481
Awarded in United States.....	550	455	833	912	1,149	1,431	1,456	1,576	1,485	9,847

SOURCE: Ministry of Education, *Educational Statistics of the Republic of China*, 1997, pp. 24-5; and National Science Foundation, Division of Science Resources Studies, Survey of Earned Doctorates.

**Figure 2. Ph.D. degrees awarded at home and in the United States, 1975-95**



SOURCE: Ministry of Education, *Educational Statistics of the Republic of China, 1997*, pp. 24-5; and National Science Foundation, Division of Science Resources Studies, Survey of Earned Doctorates.

proportions for agricultural science used to be higher before the mid-1960s. After Taiwan began industrializing in the late 1960s, the percentage of agriculture degrees gradu-

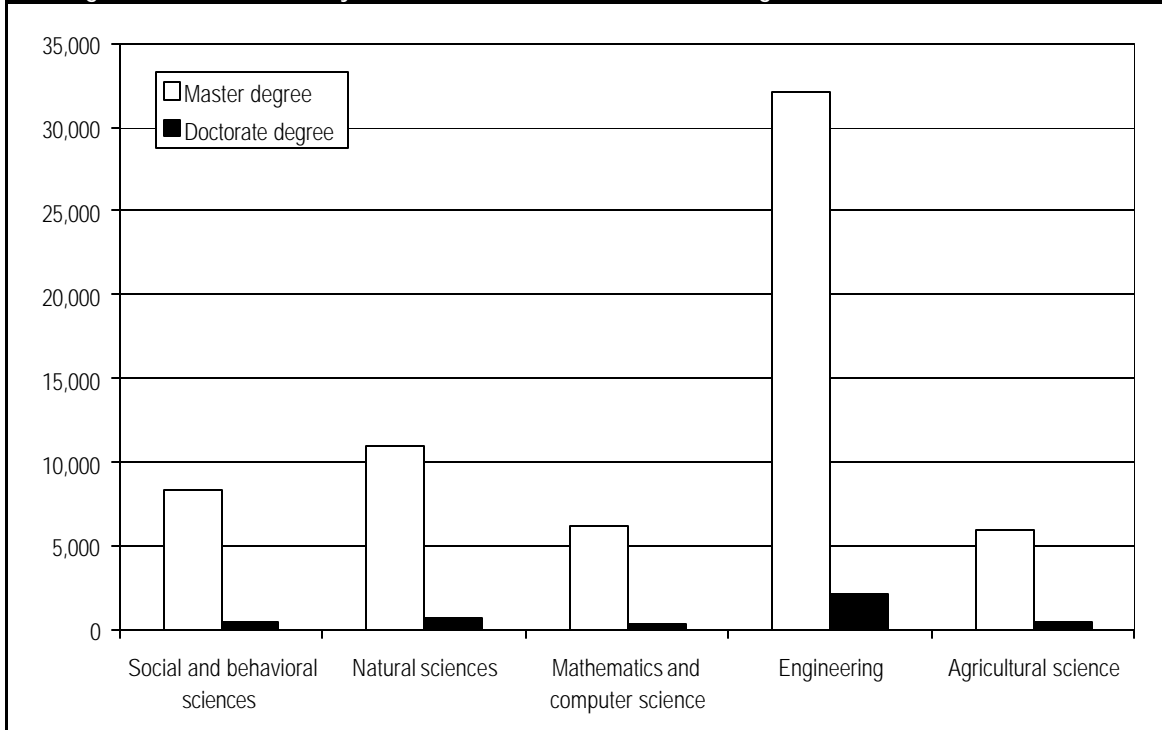
ally dropped. In the period 1991-95, the shares of master's and doctoral degrees in agriculture were 8.4 percent and 9.6 percent, respectively.

**Table 5. S&E field-of-study structure of master's and doctorate degrees awarded in Taiwan, 1975-95**

Year	Total S&E degrees		Social and behavioral sciences		Natural sciences		Math. and computer science		Engineering		Agricultural science	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Master's degree												
Total.....	63,399	100.0	8,276	13.0	10,930	17.2	6,141	9.7	32,148	50.7	5,904	9.3
1975-80.....	6,333	100.0	1,304	20.6	1,478	23.3	548	8.6	2,127	33.6	876	13.8
1981-85.....	9,404	100.0	2,083	22.1	1,780	18.9	646	6.7	3,988	42.4	907	9.6
1986-90.....	17,175	100.0	1,817	10.6	2,796	16.3	1,740	10.1	9,259	53.9	1,563	9.1
1991-95.....	30,487	100.0	3,072	10.1	4,876	16.0	3,207	10.5	16,774	55.0	2,558	8.4
Doctorate degree												
Total.....	4,164	100.0	464	11.1	732	17.6	322	7.7	2,183	52.4	463	11.1
1975-80.....	139	100.0	43	30.9	25	18.0	2	1.4	40	28.8	29	20.8
1981-85.....	345	100.0	77	22.3	55	15.9	14	4.0	134	38.8	65	18.8
1986-90.....	1,105	100.0	154	13.9	181	16.4	83	7.5	564	51.0	123	11.1
1991-95.....	2,575	100.0	190	7.4	471	18.3	223	8.7	1,445	56.1	246	9.6

SOURCE: National Science Foundation, Division of Science Resources Studies, Survey of Earned Doctorates.

Figure 3. S&E field-of-study structure of master's and doctorate degrees awarded in Taiwan, 1975-95



SOURCE: Ministry of Education, *Educational Statistics of the Republic of China, Annual Series*.

The issue of governmental intervention in the development of higher education has been controversial. Since economic development has been at the top of the government's agenda, it has been an important factor in determining graduate enrollment in different fields. Although many people in Taiwan believe that higher education should be geared to the nation's economic development, the government has been criticized for being too involved in the projected technical manpower needs of society, and thus overlooking the importance of the social sciences and humanities. Critics argue that policies regarding changes in higher and graduate enrollments need to be made on a broad basis, taking the social and cultural development of the nation into consideration (Chen 1991).

## OVERSEAS STUDY AND INTERNATIONAL MOBILITY OF SCIENTISTS AND ENGINEERS

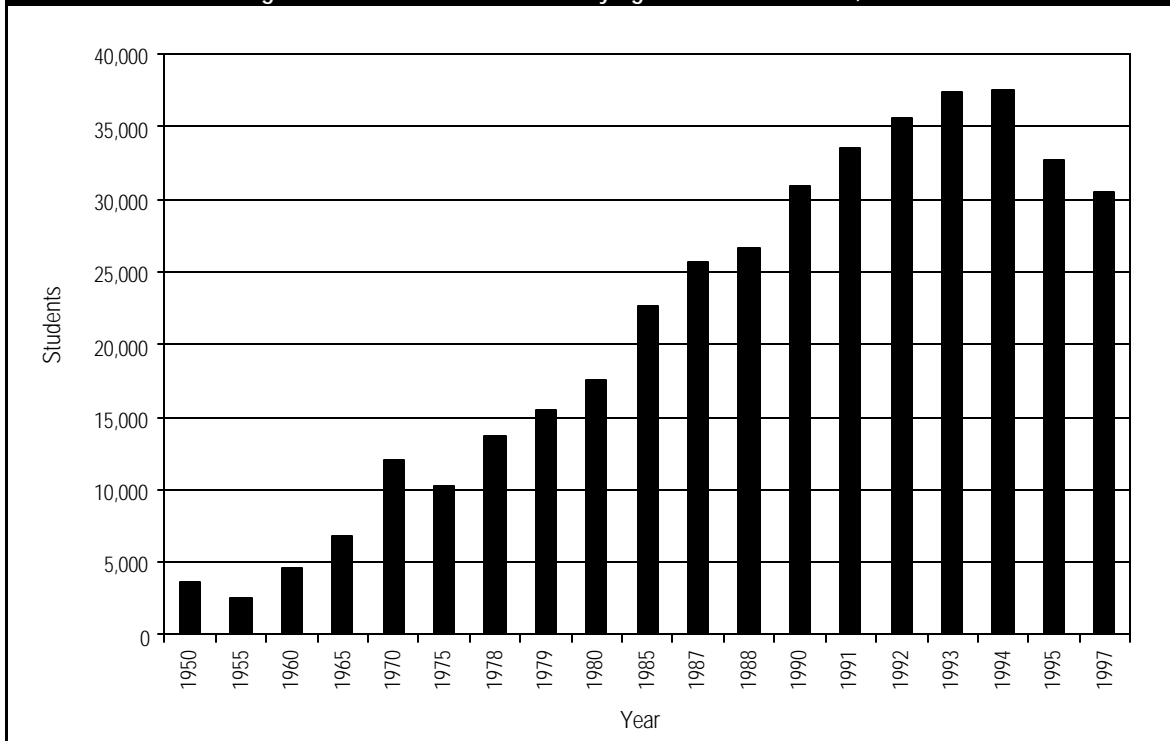
The phenomena of study abroad and international mobility of scientists and engineers in Taiwan are correlated and have been affected by many societal factors. For example, it is a Chinese tradition that parents are respected and honored if they avail their children of ad-

vanced education or overseas study. Thus, the demand for higher education in Taiwan has been growing in the past 4 decades. However, due to the small and limited higher education establishment, as well as political restrictions, there are limited opportunities for higher and graduate study in Taiwan. Students mainly study abroad to fulfill their own and their parents' ambitions. American universities enroll a huge majority of them (over 90 percent) and account for approximately 77 percent of Taiwan's doctoral degrees in natural sciences and engineering (NSF 1993).

The steady annual increase of students from Taiwan between 1950 and 1997 is shown in figure 4. In the peak year of 1994, 37,581 Taiwanese students were enrolled in 921 accredited colleges and universities in the United States. In 1995 and 1996, enrollment dropped to 32,702 and 30,487, proportionally reflecting the decrease of advanced students coming to the United States. These students instead chose to study in Taiwan. A large number of Taiwanese students have chosen to stay and work in America upon successful completion of their studies. Some of them have become naturalized American citizens, taking challenging, well-paying positions in various sectors ranging from higher education and research organizations to well-recognized business corporations (Li 1995).



Figure 4. Taiwanese students studying in the United States, 1950-97



SOURCES: Cultural Division of Taipei Economic and Cultural Representative Office in the United States, *Cultural & Educational Digest*, January 1998, p. 28; Chen-ching Li, "Returning Home After Studying in the USA: Reverse Brain Drain in Taiwan," *Cultural & Educational Digest*, pp. 20-24. Cultural Division of Taipei Economic and Cultural Representative Office in the United States, *Cultural & Educational Digest*, 1995; and Chen-ching Li, "Toward a Rejuvenated National Goal: Reform and Internationalization of Higher Education in Taiwan, Republic of China," *Cultural & Educational Digest*, pp. 34 - 42, Cultural Division of Taipei Economic and Cultural Representative Office in the United States, 1997.

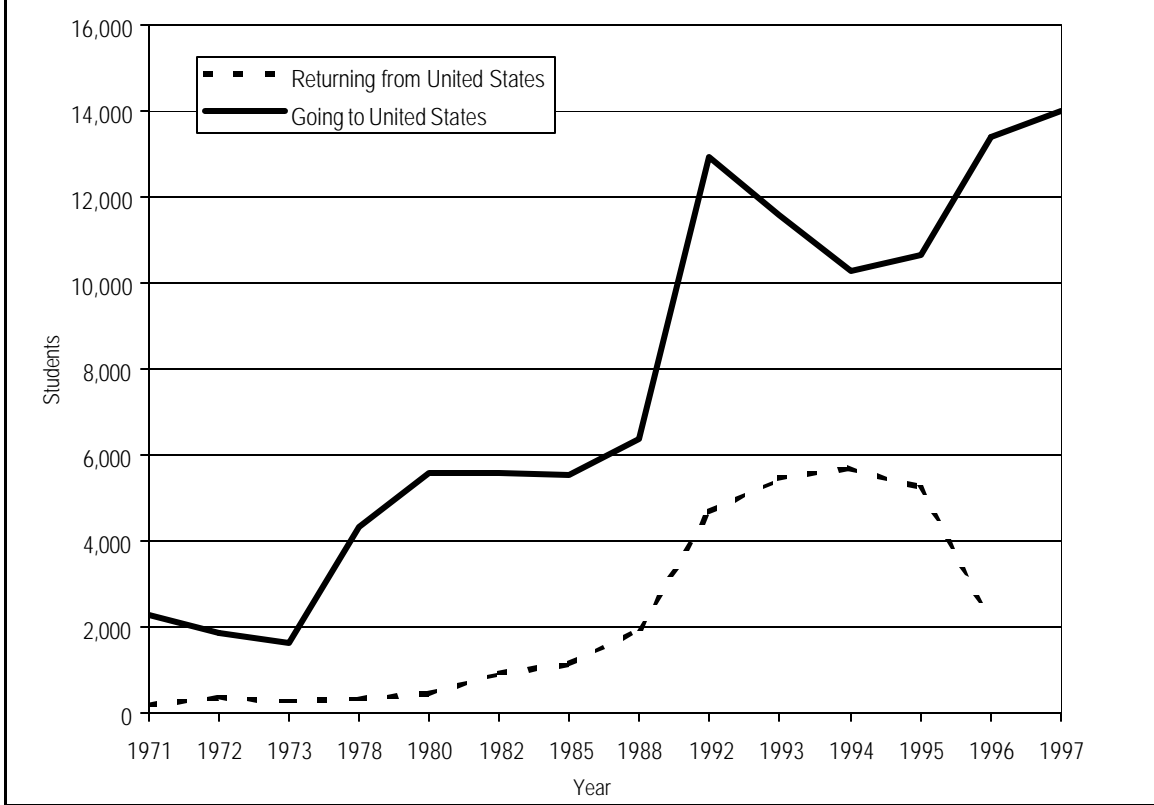
Figure 5 shows the historical trends of Taiwanese students entering and leaving the United States in the period between 1971 and 1997. Until the 1990s, Taiwan had suffered a serious "brain drain" for almost 40 years. It was reported that, between 1950 and 1980, the Ministry of Education issued approvals to 63,061 college graduates to study abroad; only 7,240 of them returned. During this period, the brain drain from students not returning from study abroad reached a high of 90 percent. The brain drain slowed gradually in the 1980s: it decreased to 80 percent between 1981 and 1987 (Chen 1991).

However, it was only at the end of 1980s that Taiwan started to benefit from its international students and their connection. A return flow of American-trained scientists and engineers has occurred in recent years. There are a number of societal variables that appear to account for this change. The most important variable is the economy. The statistics in figures 5 and 6 show a close correlation between economic development and return flow. The strong increase of per capita GNP since the late 1980s put Taiwan in the group of NIEs. Rapid eco-

nommic development has offered a great number of job opportunities for returning students with advanced degrees and professional expertise. The nationwide Ten Construction Project infrastructure development, together with the establishment of the Hsinchu Science-Based Industrial Park in 1980, has opened many new avenues for young returned students to start new challenging careers. According to the 1994 annual report of the Science-Based Industrial Park, 1.05 percent of the employees hold Ph.D. degrees, 10.08 percent have master's degrees, and 17.92 percent have bachelor's degrees. Of the total 34,564 employees hired to work in the Science-Based Industrial Park, a large number of junior professionals were from the United States (Li 1995).

The political situation is the second important factor that has affected study abroad and the international mobility of scientists and engineers in Taiwan. As Taiwan's international status is unusual, its development has always been affected by the triangular relations among the People's Republic of China (PRC), the United States, and Taiwan itself. For example, in 1972 there were 367 stu-

Figure 5. Taiwanese students entering the United States versus returning to Taiwan, 1971-97



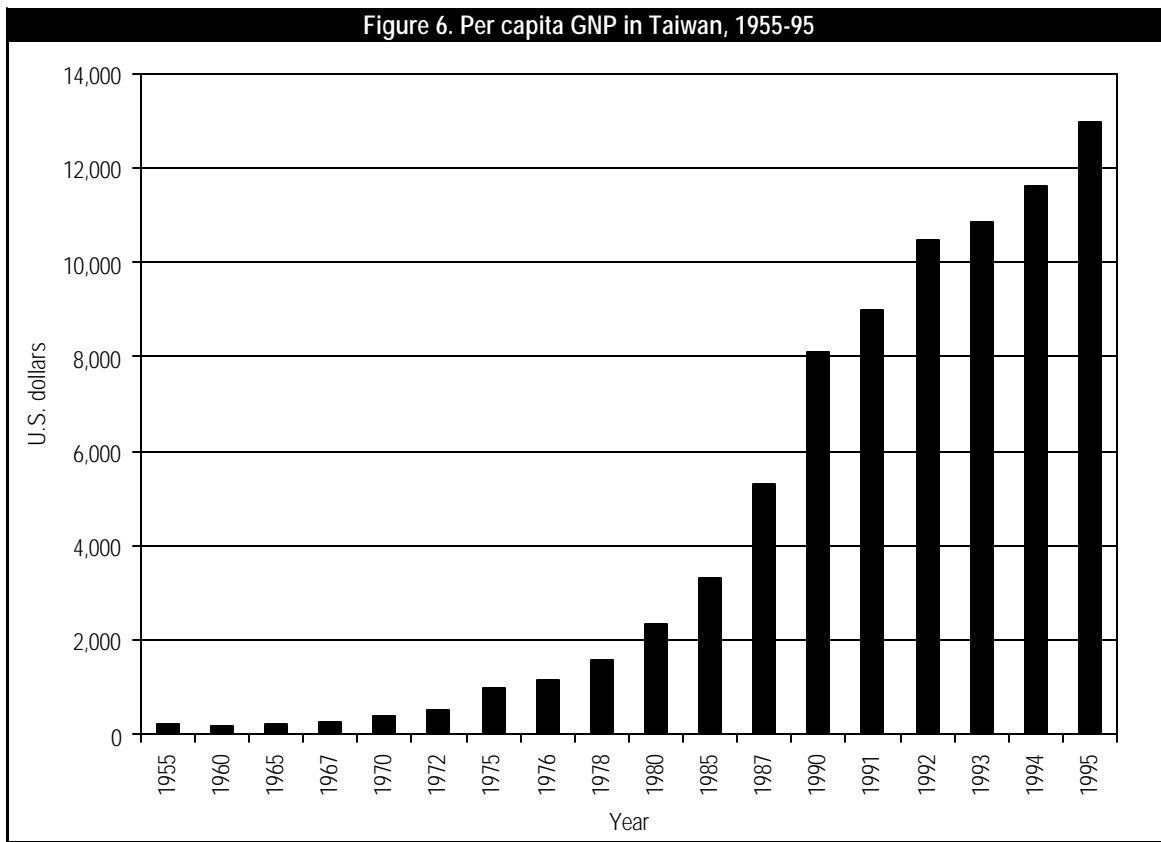
SOURCE: Ministry of Education, Educational Statistics of the Republic of China, 1997, pp. 54, 56-57, 60; Chen-ching Li, "Returning Home After Studying in the USA: Reverse Brain Drain in Taiwan," *Cultural & Educational Digest*, pp. 20-24 Cultural Division of Taipei Economic and Cultural Representative Office in the United States, *Cultural & Educational Digest*, 1995a; and Cultural Division of Taipei Economic and Cultural Representative Office in the United States, June 1998, p.11.

dents with advanced degrees going back home. However, the so-called "Nixon Shock"<sup>2</sup> of 1972 caused the number to drop from 367 to 276 the following year (Li 1995). The political impact lingered for almost a decade, continuing even when former president Carter announced normalization of relations between the United States and the PRC in 1978: this was followed by an immediate decline in the number of returning students from 431 to 331 in that year. Only when the U.S. Congress enacted the Taiwan Relations Act in 1979 did the number of returning students gradually begin to rise. In 1987, coupled with an economic boom, Taiwan lifted martial law and some other restrictions, and the number of returning students soared from 1,977 in 1988 to 4,674 in 1992. It later reached 5,700 in the peak year of 1994.

<sup>2</sup> Under the secret and careful arrangement of Dr. Henry Kissinger, former president Richard M. Nixon paid a visit to China in 1972 and signed the historic Shanghai Communiqué, stating that the United States acknowledged that there is only one China, and that Taiwan is part of China. The abrupt U.S. recognition of the PRC shocked the whole world - especially Taiwan - with an unpredictable political impact.

After 1995, however, the number of returning students dropped sharply to 2,185 in 1996. The reasons for this decline in returning students seem complex. There are three possible explanations. First, the job market in Taiwan for returning students is not as exciting as it was before 1992. The returnees had to compete for fewer jobs. Second, the economy in America has steadily improved in recent years, providing more job opportunities. Third, but not necessarily least, is the fact that the decline could be attributed to the military crisis on the Taiwan Strait in 1996.

At the same time that the return flow increased, the Taiwanese government lifted restrictions governing students going overseas and allowed high school graduates to go abroad to pursue undergraduate studies. As a result, the number rose from 6,382 in 1988 to 12,936 in 1992. After that, as Taiwan increased its internal capacity for graduate education in science and engineering, more and more students decided to stay home for graduate studies instead of traveling abroad. A recent rise is probably attributable to two factors. One is the growing number of graduates from junior colleges and high schools applying



SOURCE: Chen-ching Li, "Returning Home After Studying in the USA: Reverse Brain Drain in Taiwan," *Cultural & Educational Digest*, pp. 20-24 Cultural Division of Taipei Economic and Cultural Representative Office in the United States, 1995a.

for undergraduate programs, or only for summer sessions, in American universities. The other may be the affect of unstable relations with mainland China, especially during and after the military crisis on the Taiwan Strait in 1996.

Special mention should be made of the role of the Taiwanese government in attracting the return of students. The government has made a concerted effort to attract back S&T personnel educated in the United States. Its Manpower Planning Department assesses required manpower with advanced degrees for strategic industries, plans for recruitment from abroad, and expands S&T university education in Taiwan accordingly (NSF 1993). The government has also set up the National Youth Commission, affiliated with the Executive Yuan (which is like the cabinet) to recruit university graduates with Ph.D. and master's degrees to join in national development. The commission offers a subsidy in airfare for both the graduating student and his/her spouse, plus up to two children, if they decide to go back to Taiwan for career development. The commission has established channels of communication with overseas scholars so they can be recruited more easily when their services are needed. By the end

of January 1998, a total of 15,914 students and professionals abroad had joined the commission's database network (Cultural Division of Taipei 1998, p. 13).

Besides attracting foreign-educated students to return home, Taiwan also imports S&T through the recruitment of foreign scientists and engineers, particularly from developed countries, to work in Taiwan. Since the promulgation of the "Guidelines for Long-Range Development of Science" in 1959, overseas scientists and engineers have been brought into Taiwan's higher education system as special-chair lecturers, national research professors—to guide research work and hold research seminars on a yearly contractual basis—or as visiting professors to give lectures on a short-term basis. The demand for overseas scientists and engineers increased sharply when Taiwan began industrializing: 413 expatriate scientists were employed between 1963 and 1970, and 2,783 between 1971 and 1980. In 1987, 399 foreign experts were invited to teach or supervise research work in Taiwan's higher education institutions. Meanwhile, "several top mainland scientists and engineers were employed to do research in Taiwan after it resumed non-diplomatic (in-

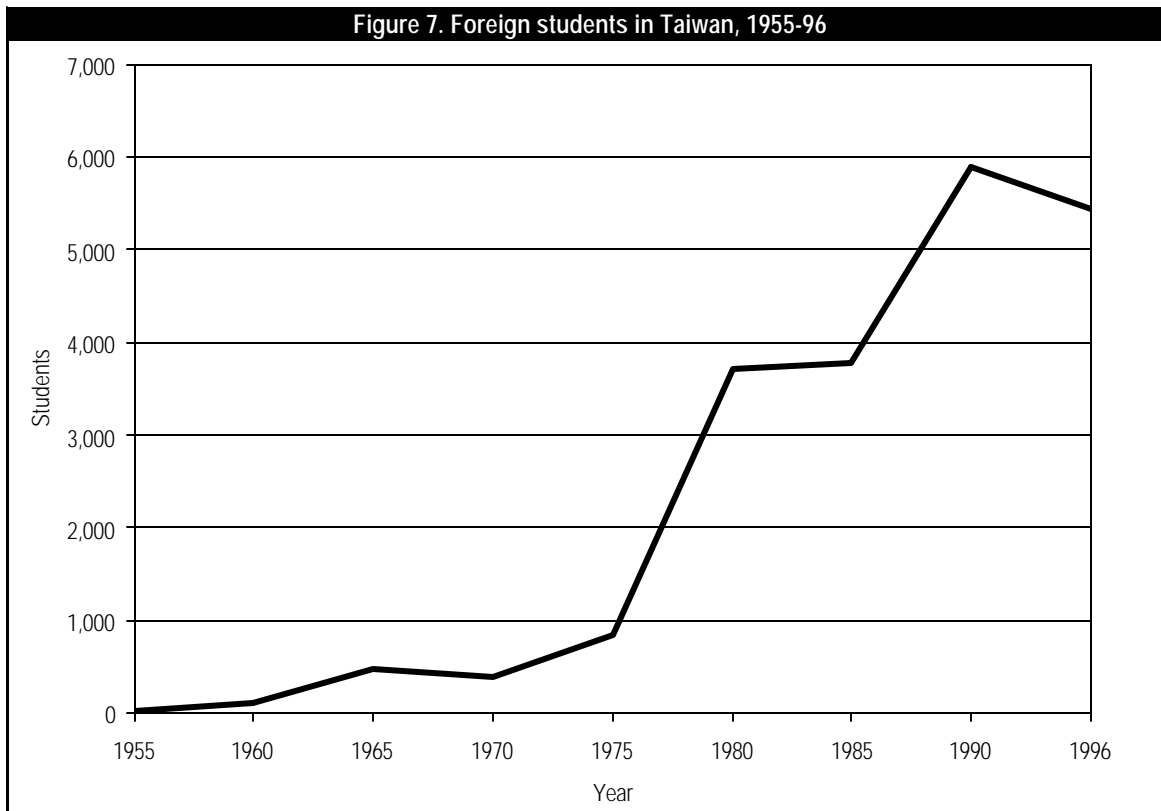
formal) relations with mainland China in the late 1980s” (Law 1996). According to the latest report, beginning July 1, 1998, Taiwan will lift more restrictions in order to import more scientists and engineers from abroad and from mainland China (Cultural Division of Taipei 1998, p. 15).

To increase its international involvement, Taiwan has also provided scholarships for international scholars, researchers, and students to study in Taiwan. The historical trend is shown in figure 7. Currently, over 5,000 foreign students are studying at Taiwan’s colleges and universities. Most of them are enrolled in the fields of the humanities, social sciences, and languages. Recently, the Ministry of Education has decided that, starting with the 1998-99 academic year, it will provide a scholarship (with each person receiving about US\$5,000 each month) to 20 foreign professors and researchers and 100 foreign students each year to encourage them to conduct research or study in Taiwan (Cultural Division of Taipei 1998, p.11).

Since the political reform that took place in the late 1980s, Taiwan’s higher education system has gradually turned to decentralization, democratization, and internationalization. However, the higher education system in Taiwan is relatively small, and it remains dependent on other countries for much of its advanced training. For economic and political reasons, many students remained abroad after they completed their studies for many years, and Taiwan used to suffer from a significant brain drain; things have changed, however, in recent years. The rapid economic development in Taiwan offers a great number of job opportunities for returning students with advanced degrees and professional expertise. More and more students return home, and Taiwan has benefited from the reverse flow of its overseas students and researchers in recent years. Countering this trend, however, have been international politics affecting overseas study and the international movement of scientists and engineers in Taiwan. This influence will continue as long as the issue of Taiwan’s relationship to the PRC remains unresolved. Finally, whether the Asian economic crisis of 1998 will affect patterns of overseas study and the movement of scientists and engineers in Taiwan should be monitored.

## CONCLUSION

In the past 40-plus years, higher and graduate education in Taiwan have experienced rapid development.



SOURCE: Ministry of Education, *Educational Statistics of the Republic of China*, 1997, pp. 44-46.

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