CHAPTER TWO

THE GLOBAL AND DOMESTIC CONTEXTS

GLOBAL COMPETITION FOR THE SCIENCE AND ENGINEERING WORKFORCE

Governments throughout the world recognize that a high-skill S&E workforce is essential for economic strength. Countries beyond the United States have been taking action to increase the capacity of their higher education systems, attract foreign students and workers, and raise the attractiveness to their own citizenry of staying home or returning from abroad to serve growing national economies and research enterprises.

Many countries have substantial capacity in their higher education systems for advanced S&E study, including doctoral degrees. Global data grouped by broad world regions indicate that European universities produce the largest number of natural science doctorates, while Asian universities produce the most engineering doctorates.[12] Some major industrial countries with substantial educational capacity are experiencing a decline in college-age populations. To use their capacity for advanced education and sustain academic research, they are aggressively recruiting graduate students from countries with growing student populations, in competition with the United States.[13]

Countries compete for their own educated citizens through attractive living standards and job opportunities. One mechanism many countries use to spur job growth is to increase investment in research and development (R&D). A measure of the impact of R&D investment is the number of researchers in a country. Growth in the number of researchers in many countries of the Organisation for Economic Co-operation and Development (OECD) has outstripped that in the US. From 1993 to 1997, the number of reported researchers in OECD countries increased by 23.0 percent, while reported US researchers increased 11.8 percent. The greatest growth, 120.0 percent, was in OECD countries other than the United States, Japan, and the European Union.[14] Another indicator of a country's commitment to growth in scientific knowledge and technology development is the ratio of R&D spending to gross domestic product (GDP). The United States ranked fifth among OECD countries in reported ratio of total R&D to GDP for the 1996-98 period.[15]

[12] Jean M. Johnson, "International Mobility of Doctoral Recipients from U. S. Universities," SRS data.
[13] Johnson, SRS data: SEI-2002, O-4.
[14] SEI-2002: 3-28.
[15] Total R&D includes defense and nondefense. SEI-2002: 4-4.

Some economies have been particularly successful in enticing scientists and engineers to return after advanced training and research experience abroad; for example, Taiwan, Korea, and Ireland.[16] China pursues the strategy, introduced as policy in 1992, of supporting study abroad and encouraging return with free movement in and out of the country.[17] A growing strategy is to treat educated citizens living abroad as a distributed resource to be networked for knowledge exchange and entrepreneurial partnering in service to national economic development.

Increased competition for S&E workers comes at a time when demand for their skills is projected to rise significantly – both in the United States and throughout the global economy.[18] Growing demand for technical skills can be met in several ways. One mechanism is for a country to increase immigration; however, as discussed above, competition for scientific talent is intensifying. Alternatively, a country can induce people engaged in non-S&E occupations or degree programs to switch to S&E. For the United States, this approach has not been a significant source of S&E workers. In fact, the direction of flow is from S&E degrees into non-S&E occupations.[19]

Finally, a country can meet skill needs by enticing a larger share of its domestic college-age population to attain a first university degree in natural science and engineering (NS&E).[20] Economies beyond the United States are building up the NS&E capabilities at a greater rate than the US has been able to achieve, as shown in Figure 3.[21] Indeed, thirteen economies now outrank the United States in the ratio of NS&E first university degrees to the 24-year-old population, while in 1975, the United States ranked third. Clearly, this enticement strategy is underused by the United States. Indeed, S&E degree attainment by domestic students has dropped in many areas of the physical sciences and engineering and in mathematics and computer science, both at the undergraduate and graduate levels.[22]

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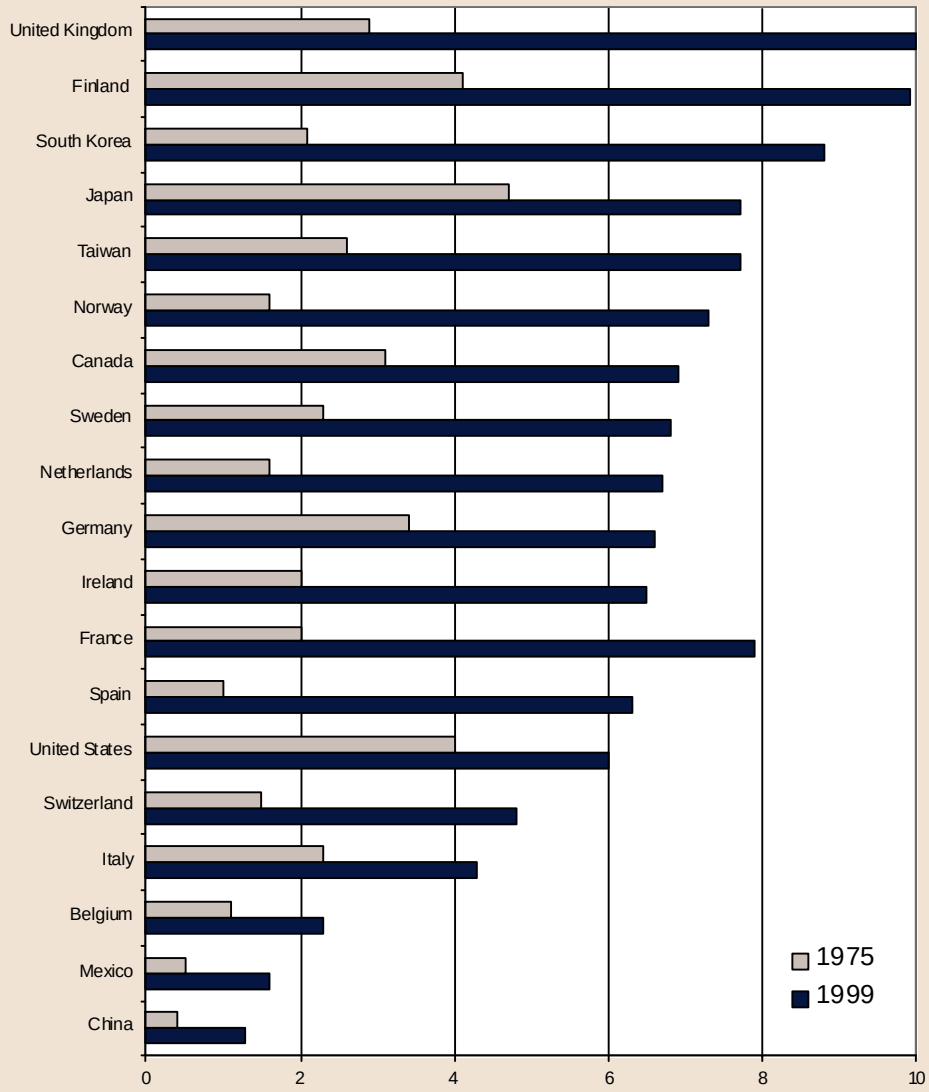
[16] Johnson: 8.
[17] Yugui Guo, paper prepared for NWP Workshop, June 2002: 11.
[18] SEI-2002: 3-27, 28, 29.
[19] In 1999, of the approximately 8 million employed persons whose highest degree was in science or engineering, only 3 million were employed in occupations classified as S&E. The majority of those in occupations classified as non-S&E reported that the skills demanded on the job were closely or somewhat related to their field of study. Members of the workforce educated in science and engineering are mobile among occupations, with large numbers employed as managers, teachers, and marketing personnel. (SRS InfoBrief, NSF 02-325).
[20] NS&E is the natural sciences and engineering, where natural sciences include physics, chemistry, astronomy, and earth, atmospheric, ocean, biological, and agricultural sciences, as well as mathematics and computer sciences. (SEI-2002: 2-39, Figure 2-27).
[21] SEI-2002: O-3.
[22] SEI-2002: Figure 2-11 and Appendix Table 2-25.

FIGURE 3.

RATIO OF NS&E FIRST UNIVERSITY DEGREES TO 24-YEAR-OLD POPULATION, 1975 AND 1999



NOTES: Natural sciences include physics, chemistry, astronomy, earth, atmospheric, ocean, biological, agricultural, as well as mathematics and computer sciences. The ratio is the number of natural science and engineering degrees to the 24-year-old population. China's data are for 1985 and 1999. Other locations' data are for 1975 and 1998 or 1999.[23]

[23] SEI-2002: Figure 2-27.

DOMESTIC HUMAN RESOURCES FOR SCIENCE AND ENGINEERING

Greater success in attracting and preparing US students for S&E careers will require that policymakers have an understanding of the Nation's domestic student population and their record of participation in S&E. Table 1 provides data on the college-age population by race/ethnicity.[24] Table 2 details bachelor's degree attainment by sex and by race/ethnicity. In the coming decades, an increasing proportion of US students – and an increasing proportion of college graduates – will come from demographic groups that have not heretofore participated in S&E careers at a rate commensurate with their share of the US 24-year-old population.

TABLE 1:
U.S. POPULATION OF 18- TO 24-YEAR-OLDS, BY RACE/ETHNICITY: 2000–2025

Year	Number	Percent
Total		
2000	26,631,733	100%
2010	30,138,083	100%
2025	30,372,078	100%
White		
2000	17,555,265	66%
2010	18,880,000	63%
2025	16,785,000	55%
Asian/Pacific Islander		
2000	1,041,519	4%
2010	1,521,000	5%
2025	2,114,000	7%
Hispanic		
2000	3,965,297	15%
2010	5,101,000	17%
2025	6,560,000	22%
Black		
2000	3,827,679	14%
2010	4,354,000	14%
2025	4,609,000	15%
American Indian/Alaskan Native		
2000	241,888	1%
2010	282,000	1%
2025	304,000	1%

NOTE: Populations for 2010 and 2025 are projected.
SOURCE: U.S. Bureau of the Census, Population Division, Projections of the Resident Population by Age, Sex, Race and Hispanic Origin: 1999 to 2100 (Washington, DC, 2000). Available at <www.census.gov/population/estimates/nation>.

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As shown in Table 1, the 2000 census figures and projections for 2010 and 2025 indicate a college-age population that does not increase significantly after 2010. The proportion of whites (non-Hispanic) is projected to decrease significantly, while that of Hispanics will increase significantly. The minority

[24] SEI-2002 appendix table 2.2.

groups who are currently underrepresented in S&E careers — Hispanics, African-Americans, and American Indian/Alaskan Natives — are projected to increase as a share of the college-age population from 32 percent in 2010 to 38 percent in 2025. Hispanics account for 90 percent of the projected increase in underrepresented minorities.

As shown in Table 2, column A, the rates of bachelor's degree attainment per 100 24-year-olds for whites and Asian/Pacific Islanders are more than twice that of the underrepresented minorities. As shown in column B, the proportion of bachelor's degrees that are in NS&E is around 15 percent for both whites and underrepresented minorities, while over 30 percent for Asian/Pacific Islanders. The resultant participation rate in NS&E degree attainment per 100 24-year-olds, in column C, shows wide differences – from 14.7 per hundred for Asian/Pacific Islanders to 6.3 per hundred for whites to 2.6 per hundred for underrepresented minorities. Given the population shifts detailed above, if participation rates remain the same, the US will suffer a drop over the years in bachelor's-level NS&E degree attainment.

TABLE 2:
PARTICIPATION RATE IN NATURAL SCIENCES AND ENGINEERING BACHELOR'S DEGREES IN 1998

Race/ ethnicity and sex	Total 24-year-old Population	Total bachelor's degrees	Total NS&E degrees	A Bachelor's degrees per 100 24-year-olds	B NS&E % of bachelor's	C NS&E degrees per 100 24-year olds
Total	3,403,039	1,199,579	205,355	35.3	17.1	6.0
Sex						
Male	1,714,571	525,714	128,481	30.7	24.4	7.5
Female	1,688,468	673,865	76,874	39.9	11.4	4.6
Race/ethnicity						
White	2,251,292	878,018	142,500	39.0	16.2	6.3
Asian/Pacific Islander	149,413	69,988	22,003	46.8	31.4	14.7
Underrepresented minority	1,002,334	181,709	25,820	18.1	14.2	2.6
Black	473,402	95,878	12,731	20.3	13.3	2.7
Hispanic	497,620	78,125	12,006	15.7	15.4	2.4
American Indian/Alaskan Native	31,312	7,706	1,083	24.6	14.1	3.5

NOTE: Population data are for US residents only and exclude members of the Armed Forces living abroad
SOURCE: *Science and Engineering Indicators-2002*, from text table 2-9

The participation rates documented in Table 2 point clearly to underused resources – underrepresented minorities and women. For underrepresented minorities, the pressing need is for a higher overall rate of bachelor's degree attainment with the rate of participation in NS&E

ideally increasing. For women, the overall rate of bachelor's degree attainment is higher than for men, but the rate of NS&E degree attainment is half that of men. Most importantly, to meet projected growth in S&E jobs while growth in the college-age population levels off, the United States must devise a means to increase the rate of NS&E degree attainment from all population groups.

The issue is not only the number of degrees attained, but also the distribution of degrees among disciplines and the fit to job opportunities. In the 15-year period 1985-2000, the number of bachelor's degrees in all S&E fields rose by 15.3 percent. The number of bachelor's degrees in NS&E declined 1.1 percent. If biological sciences are excluded, the number of baccalaureates awarded in the remaining NS&E fields dropped by 18.6 percent. This drop in bachelor's degrees includes fields of engineering, mathematics and computer sciences, physical sciences, and geological sciences.[25] In many cases, openings in graduate study and the job market have been filled by foreign students and workers.

[25] SEI-2002 appendix table 2-17, Figure 1 of this report.