INFOBRIEF SRS

REASONS FOR INTERNATIONAL CHANGES IN THE RATIO OF NATURAL SCIENCE AND ENGINEERING DEGREES TO THE COLLEGE-AGE POPULATION

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Recent reports have expressed concern that other countries are surpassing the United States in science and engineering education, particularly in the natural sciences and engineering (Freeman 2006, NAS 2006).[2] Data examined for 23 countries/economies where such data are available show that the ratios of first university degrees in natural sciences and engineering (NS&E) to the college-age population have increased substantially in recent decades (tables 1, 2).[3] In 1975 only Japan had a higher ratio than the United States of NS&E degrees per hundred 20–24-year-olds (the college-age population).[4] By 1990, a few of these locations had surpassed the U.S. ratio, and by 2005, nearly all had done so. This report examines the relative influence on this ratio of increasing degree completions, increasing share of NS&E degrees, and the interaction of these two factors. It finds that the rising ratio of NS&E degrees to the college-age population in the locations compared with the United States can primarily be attributed to increased university degree completion, not to an increased emphasis on NS&E education; however, the relative importance of these components varies substantially by location.

Components of a Changing Ratio

Although the ratio of first university NS&E degrees to the college-age population has been examined previously (NSB 2004, 2006), these analyses have not tried to differentiate the two components responsible for changes in the ratio over time: increased university degree completion relative to the college-age population and NS&E degrees as an increasing share of all degrees. A change over time in the ratio of first university NS&E degrees to the college-age population can be due to a change in the number of first university degrees relative to the college-age population with no increase in the share of NS&E degrees (referred to here as the university degree completion component), a change in the share of NS&E degrees with no increase in overall degrees relative to the college-age population (referred to here as the NS&E share component), or the interaction of both (referred to here as the interaction component). Each of these components can be positive or negative, but the university degree completion component tends to be positive in almost all cases, whereas the NS&E share component and the interaction component are often negative. This InfoBrief looks at the contribution of these components separately and interactively.

Study Methodology

This study examines the increase in the ratio of first university NS&E degrees to the college-age population from 1975 to 2005 in the United States and 22 other countries/economies where such data are available (listed in tables). It focuses on differences in two periods: 1975–90 and 1990–2005. The analysis does not focus on when the changes actually occurred during the

TABLE 1. Population of 20–24-year-olds, all first university degrees, and first university degrees in NS&E, by selected country/economy: 1975, 1990, 2005

Country/economy	1975			1990			2005		
	Population (hundreds)	All degrees	NS&E degrees	Population (hundreds)	All degrees	NS&E degrees	Population (hundreds)	All degrees	NS&E degrees
Austria	5,160	4,246	726	6,530	10,457	2,499	5,180	21,908	6,065
Belgium	7,390	15,781	1,592	7,310	25,064	6,253	6,330	24,682	6,533
China	907,080	NA	NA	1,291,250	273,684	144,953	1,008,930	1,465,786	715,720
Denmark	3,750	10,344	1,550	3,960	12,267	3,472	2,880	31,222	5,217
Finland	4,210	9,496	2,656	3,490	12,463	4,703	3,340	36,506	11,761
France	42,470	36,000	16,702	42,850	96,548	30,400	38,910	273,523	73,435
Germany	55,500	97,399	31,056	63,910	147,607	51,138	49,020	226,530	66,342
Greece	6,390	12,821	2,808	7,840	18,840	5,203	7,470	35,219	9,698
India	566,790	629,336	117,718	774,700	750,000	175,774	1,046,120	NA	NA
Ireland	2,440	3,794	1,008	2,680	9,481	3,364	3,410	26,486	4,839
Italy	38,180	69,987	17,864	45,300	84,036	19,204	31,160	291,304	73,265
Japan	91,550	313,072	85,496	88,000	400,103	106,508	75,420	551,016	133,206
Netherlands	11,310	10,842	3,586	12,650	19,841	5,290	9,610	90,033	15,070
Norway	3,020	8,148	946	3,380	18,486	2,406	2,740	24,987	3,559
Portugal	7,350	12,323	NA	7,750	11,630	3,126	7,270	50,319	13,811
Singapore	2,500	2,380	702	3,100	6,000	2,498	2,650	10,031	5,556
South Korea	30,880	34,725	13,063	42,890	165,916	51,266	37,310	268,833	103,790
Spain	25,590	26,460	9,171	32,390	121,899	21,492	29,350	195,946	51,579
Sweden	5,650	13,469	2,630	6,070	15,628	3,978	5,270	46,046	12,630
Switzerland	4,620	5,661	1,438	5,350	8,580	2,154	4,480	21,259	5,338
Taiwan	17,568	26,498	9,253	19,021	42,952	15,483	18,645	210,763	78,131
United Kingdom	38,810	55,450	22,650	45,190	77,160	27,940	38,710	306,360	76,160
United States	197,430	931,663	150,408	195,000	1,062,151	169,726	210,410	1,437,200	235,619

NA = not available. NS&E = natural science and engineering (natural sciences in this table are agricultural; biological; computer; earth, atmospheric, and ocean; physical; and mathematical sciences).

NOTES: Data are compiled from many national and international sources; degree fields may not be strictly comparable. First university degrees differ among countries in duration and may not be academically equivalent. 1990 data for Germany include East and West Germany; 1975 data include West Germany only. Netherlands and United Kingdom data do not include open universities. United Kingdom data for 2005 include polytechnics. Degree data labeled 1975 are 1976 for Belgium, Greece, India, South Korea, Taiwan, and 1977 for Denmark, Spain; complete earlier data were not available.

SOURCES: *Population data*—Population Division, Department of Economic and Social Affairs, United Nations Secretariat, *World Population Prospects: The 2006 Revision* and *World Urbanization Prospects: The 2005 Revision,* http://esa.un.org/unpp, 28 January 2008 11:03:27 AM; Taiwan, *Statistical Yearbook of the Republic of China 2006. Degree data*—Organisation for Economic Co-operation and Development, Center for Research and Innovation, *Education at a Glance,* 1994, and Online Education Database, http://www.oecd.org/education/database/; United Nations Educational, Scientific, and Cultural Organization, *Statistical Yearbook,* annual series and special tabulations; national sources for some countries for some years: Austria—Population Division, Austrian Central Statistical Office, unpublished tabulations; China—National Bureau of Statistics of China, *China Statistical Yearbook, 2005;* France—Ministère de l'Education Nationale, *Repères et Références Statistiques sur les Enseignements;* Germany—Federal Statistical Office, *Prüfungen an Hochschulen;* Japan—Government of Japan, Ministry of Education, Culture, Sports, Science and Technology, Monbusho Survey of Education, special tabulations; Singapore—Ministry of Education, *Education Statistics Digest;* Switzerland—Federal Office of Statistics, Education and Society Division, Universities and Science Section, unpublished tabulations; Taiwan—Ministry of Education, *Educational Statistics of the Republic of China* ; United Kingdom—University Grants Committee, University Statistics, Universities Statistical Record, Department of Education and Science, unpublished tabulations, and Higher Education Statistics Agency, special tabulations; United States—National Center for Education Statistics, Integrated Postsecondary Education Data System Completions Survey, and National Science Foundation, Division of Science Resources Statistics, WebCASPAR database, http://webcaspar.nsf.gov.

30-year period examined. Changes between periods in the ratio of NS&E degrees to the college-age population are decomposed into three component parts—the university degree completion component, the NS&E share component and the interaction of both (or interaction component).

The university degree completion component is calculated for each period as follows: the NS&E percentage of total first university degrees in the initial year of the period is multiplied by the ratio of all first university degrees to the college-age population in the final year of the period; the difference between that value and the

TABLE 2. All first university degrees and first university degrees in NS&E per hundred 20–24-year-olds, and NS&E share of all first university degrees, by selected country/economy: 1975, 1990, 2005

Country/economy	1975			1990			2005		
	All degrees	NS&E degrees	% NS&E	All degrees	NS&E degrees	% NS&E	All degrees	NS&E degrees	% NS&E
Austria	0.82	0.14	0.17	1.60	0.38	0.24	4.23	1.17	0.28
Belgium	2.14	0.22	0.10	3.43	0.86	0.25	3.90	1.03	0.26
China	NA	NA	NA	0.21	0.11	0.52	1.45	0.71	0.49
Denmark	2.76	0.41	0.15	3.10	0.88	0.28	10.84	1.81	0.17
Finland	2.26	0.63	0.28	3.57	1.35	0.38	10.93	3.52	0.32
France	0.85	0.39	0.46	2.25	0.71	0.32	7.03	1.89	0.27
Germany	1.75	0.56	0.32	2.31	0.80	0.35	4.62	1.35	0.29
Greece	2.01	0.44	0.22	2.40	0.66	0.28	4.71	1.30	0.28
India	1.11	0.21	0.19	0.97	0.23	0.24	NA	NA	NA
Ireland	1.55	0.41	0.26	3.54	1.26	0.36	7.77	1.42	0.18
Italy	1.83	0.47	0.26	1.86	0.42	0.23	9.35	2.35	0.25
Japan	3.42	0.93	0.27	4.55	1.21	0.27	7.31	1.77	0.24
Netherlands	0.96	0.32	0.33	1.57	0.42	0.27	9.37	1.57	0.17
Norway	2.70	0.31	0.11	5.47	0.71	0.13	9.12	1.30	0.14
Portugal	1.68	NA	NA	1.50	0.40	0.27	6.92	1.90	0.27
Singapore	0.95	0.28	0.29	1.94	0.81	0.42	3.79	2.10	0.55
South Korea	1.12	0.42	0.38	3.87	1.20	0.31	7.21	2.78	0.39
Spain	1.03	0.36	0.35	3.76	0.66	0.18	6.68	1.76	0.26
Sweden	2.38	0.47	0.20	2.57	0.66	0.26	8.74	2.40	0.27
Switzerland	1.23	0.31	0.25	1.60	0.40	0.25	4.75	1.19	0.25
Taiwan	1.51	0.53	0.35	2.26	0.81	0.36	11.30	4.19	0.37
United Kingdom	1.43	0.58	0.41	1.71	0.62	0.36	7.91	1.97	0.25
United States	4.72	0.76	0.16	5.45	0.87	0.16	6.83	1.12	0.16

NA = not available. NS&E = natural science and engineering (natural sciences in this table are agricultural; biological; computer; earth, atmospheric, and ocean; physical; and mathematical sciences).

NOTES: Data are compiled from many national and international sources; degree fields may not be strictly comparable. First university degrees differ among countries in duration and may not be academically equivalent. 1990 data for Germany include East and West Germany; 1975 data include West Germany only. Netherlands and United Kingdom data do not include open universities. United Kingdom data for 2005 include polytechnics. Small differences in changes and ratios may not be meaningful because in many cases year examined is not a country's census year and population data are estimated.

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ratio of NS&E degrees to the college-age population in the initial year is then calculated. This difference represents the change that would result if the NS&E share of degrees remained the same but the number of first university degrees relative to the college-age population changed.

The NS&E share component is calculated for each period as follows: the NS&E percentage of first university degrees in the final year of the period is multiplied by the ratio of all first university degrees relative to the college-age population in the initial year of the period; the difference between that value and the ratio

of NS&E degrees to the college-age population in the initial year is then calculated. This difference represents the change that results from only a change in the NS&E share of degrees. The NS&E share component will be positive if the NS&E percentage is higher in the final year of the period than in the initial year and negative if it is lower.

The sum of the university degree completion component and the NS&E component is then compared to the actual change; any difference is the result of the interaction between the two components. The interaction component is the product of the change in NS&E share of degrees and the change in the number of degrees relative to the population and thus represents the change that would result if both the NS&E share of degrees and the number of first university degrees relative to the college-age population changed. The interaction component is negative when the NS&E share of degrees decreases as the number of degrees relative to the college-age population increases.

Values for each component (derived from unrounded data) are shown in table 3. As a concrete example, between 1975 and 1990, the number of NS&E first university degrees per hundred 20–24-year-olds in Sweden increased by 0.19 (from 0.47 to 0.66) and the number of all first university degrees per hundred 20–24-year-olds increased from 2.38 to 2.57. In 1975 NS&E degrees were 20% of all first university degrees. If the share of NS&E degrees did not change between 1975 and 1990, the number of NS&E first university degrees per hundred 20–24-year-olds would have increased to 0.51 (20% × 2.57). The difference between this value and the ratio of NS&E first university degrees to the college-age population in 1975 (0.51 – 0.47 = 0.04) is referred to here as the university degree completion component, which indicates an increase in the ratio of NS&E first university degrees to the college-age population that was due to an increase in the number of degrees in all fields relative to the college-age population.

If instead no change occurred in the ratio of all first university degrees relative to the college-age population between 1975 and 1990 but the percentage of NS&E degrees had changed to the 1990 value (25.5%), the number of NS&E degrees per hundred 20–24-year-olds in 1990 would have increased to 0.61 (25.5% × 2.38). The difference between this value and the ratio

of NS&E first university degrees to the college-age population in 1975 (0.61 – 0.47 = 0.14) is referred to here as the NS&E share component, which indicates an increase in the ratio of NS&E first university degrees to the college-age population that was due to an increase in the percentage of all first university degrees in NS&E fields.

The interaction component is the remainder of the difference between the actual 1975–90 increase and the sum of the university degree completion and NS&E share components (0.19 – (0.04 + 0.14) = 0.01).

Results

The Period 1975 to 1990

Between 1975 and 1990, the ratio of NS&E first university degrees to the college-age population increased in all 21 countries for which data were available, and in a few countries, the ratio surpassed that of the United States (table 2). The increase in the ratio of NS&E first university degrees to the college-age population was due solely to a university degree completion component (more overall first university degrees per hundred 20–24-year-olds) rather than to an increasing percentage of NS&E degrees in 9 of 21 locations, including the United States (data were not available for China or Portugal in this period). In 11 of the remaining 12 locations, increased university degree completion and an increasing share of NS&E degrees both occurred, with the university degree completion component greater than the increased share of NS&E degrees in 7 of them. Among those in which the university degree completion component was greater, 3 countries (Finland, Ireland, Singapore) had substantial positive (0.1 or higher) interaction components, indicating that the growth in the number of NS&E first university degrees per hundred 20–24-year-olds was due to an interaction between an increase in the number of first university degrees per hundred 20–24-year-olds and an increased NS&E share of those degrees above and beyond the individual components. In only one location (India) among the 21 for which data were available was the increase in the ratio of NS&E first university degrees to the college-age population due solely to an increased share of NS&E degrees. There the university degree completion component was negative (fewer overall first university degrees per hundred 20–24-year-olds). In Italy the decline in

TABLE 3. Change in NS&E degrees per hundred 20–24-year-olds and decomposition of components affecting change, by selected country/economy: 1975–1990 and 1990–2005

Country/ economy	1975–1990				1990–2005			
	Total change	University degree completion component	NS&E share component	Interaction component	Total change	University degree completion component	NS&E share component	Interaction component
Austria	0.24	0.13	0.06	0.05	0.79	0.63	0.06	0.10
Belgium	0.64	0.13	0.32	0.19	0.18	0.12	0.05	0.01
China	NA	NA	NA	NA	0.60	0.66	-0.01	-0.05
Denmark	0.46	0.05	0.37	0.05	0.93	2.19	-0.36	-0.90
Finland	0.72	0.37	0.22	0.13	2.17	2.78	-0.20	-0.41
France	0.32	0.65	-0.13	-0.21	1.18	1.50	-0.10	-0.22
Germany	0.24	0.18	0.05	0.02	0.55	0.80	-0.12	-0.12
Greece	0.22	0.09	0.11	0.02	0.63	0.64	0.00	0.00
India	0.02	-0.03	0.05	-0.01	NA	NA	NA	NA
Ireland	0.84	0.53	0.14	0.18	0.16	1.50	-0.61	-0.73
Italy	-0.04	0.01	-0.05	0.00	1.93	1.71	0.04	0.17
Japan	0.28	0.31	-0.02	-0.01	0.56	0.73	-0.11	-0.07
Netherlands	0.10	0.20	-0.06	-0.04	1.15	2.08	-0.16	-0.77
Norway	0.40	0.32	0.04	0.04	0.59	0.48	0.07	0.04
Portugal	NA	NA	NA	NA	1.50	1.46	0.01	0.03
Singapore	0.53	0.29	0.12	0.12	1.29	0.77	0.27	0.25
South Korea	0.77	1.03	-0.08	-0.18	1.59	1.03	0.30	0.26
Spain	0.31	0.95	-0.18	-0.46	1.09	0.51	0.33	0.25
Sweden	0.19	0.04	0.14	0.01	1.74	1.57	0.05	0.12
Switzerland	0.09	0.10	0.00	0.00	0.79	0.79	0.00	0.00
Taiwan	0.29	0.26	0.02	0.01	3.38	3.26	0.02	0.09
United Kingdom	0.03	0.11	-0.07	-0.01	1.35	2.25	-0.19	-0.70
United States	0.11	0.12	-0.01	0.00	0.25	0.22	0.02	0.01

NA = not available. NS&E = natural science and engineering (natural sciences in this table are agricultural; biological; computer; earth, atmospheric, and ocean; physical; mathematical).

NOTES: Data are compiled from many national and international sources; degree fields may not be strictly comparable. First university degrees differ among countries in duration and may not be academically equivalent. 1990 data for Germany include East and West Germany; 1975 data include West Germany only. Netherlands and United Kingdom data do not include open universities. United Kingdom data for 2005 include polytechnics. Small differences in changes and ratios may not be meaningful because in many cases year examined is not a country's census year and population data are estimated.

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the NS&E share of degrees overwhelmed the positive university degree completion component, leading to an actual decline in the ratio of NS&E first university degrees to the college-age population between 1975 and 1990 (table 3).

The Period 1990 to 2005

In 2005 only China and Belgium had a lower ratio of NS&E first university degrees to the college-age population than the United States (table 2). Of the 19 locations with ratios that exceeded that of the United States, the increase in ratio in 10 countries (Denmark, Finland, France, Germany, Greece, Ireland, Japan, Netherlands, Switzerland, United Kingdom) between 1990 and 2005 was due solely to the university degree completion component. In the other 9 locations (Austria, Italy, Norway, Portugal, Singapore, South Korea, Spain, Sweden, Taiwan) the university degree completion component was larger than the NS&E share component (table 3) (data were not available for India in this period). In 6 of these 9 locations, the NS&E share component or the interaction component was substantial (more than 0.1).

Conclusions

The primary explanation for the increase in the ratio of first university NS&E degrees to the college-age population in most of the countries/economies examined was increased university degree completion relative to the college-age population. In both the 1975–90 and the 1990–2005 periods, the university degree completion component was either the only component or the larger component for the majority of countries/economies for which such data were available. Thus, the growth from 1975 to 2005 in the number of countries surpassing the United States in the ratio of NS&E degrees to the college-age population can be attributed primarily to increased university degree completion rather than to an increased emphasis on NS&E education. That is not to say that increased emphasis on NS&E was not an important factor in some countries. The NS&E share component was either the only component or the larger component for five countries in the 1975–90 period and for no countries in the 1990–2005 period. In another eight countries in which the university degree completion component was larger, the NS&E share component

was substantial or the interaction component was substantial in either the 1975–90 or 1990–2005 period.

Data Sources and Limitations

The ratio of first university degrees per hundred 20–24-year-olds is an indicator of educational attainment based on two separate sources of data—degrees awarded and population estimates—and can vary with changes in the number of degrees awarded and with changes in the population. The effect of nonsampling error in the degrees and/or population data may alter ratio values and could not be determined. Therefore, rankings may not be precise, small differences in ratios between countries are not meaningful, and the direction of the component in ratios close to zero may vary.

Data on first university degrees in this InfoBrief come from numerous national and international sources, and degrees and degree fields may not be strictly comparable. First university degrees in different countries are of different duration and may not be academically equivalent. First university degrees in this report refers to degrees classified as level 5A in the 1997 International Standard Classification of Education (ISCED), although individual countries use different names for the first terminal degree; for example, *laureata* in Italy, *Diplome* in Germany, *maitrise* in France, and bachelor's degree in the United States and Asian countries/economies. The ISCED classification system changed in 1997, so data on first university degrees from some countries/economies prior to 1998 are not strictly comparable to those for 1998 and beyond.

Population data for most countries are from the Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat. Population estimates were based on the most recent national population censuses updated with data on trends in fertility, mortality, and international migration. These estimates are subject to error from the models used and from the quality of the data. Generally, error is higher for smaller populations than for larger populations. Population data for Taiwan are from the *Statistical Yearbook of the Republic of China 2006*.

For more information on data and results presented here, please contact Joan Burrelli.

Notes

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2. Natural sciences in this InfoBrief are the agricultural; biological; computer; earth, atmospheric, and ocean; physical; and mathematical sciences.

3. First university degree refers to completion of a terminal undergraduate degree program. These degrees are classified as level 5A in the International Standard Classification of Education 1997 (UNESCO 1997; http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm.). See "Data Sources and Limitations" for information on degree comparability.

4. Actual ranks may vary slightly due to nonsampling error.

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