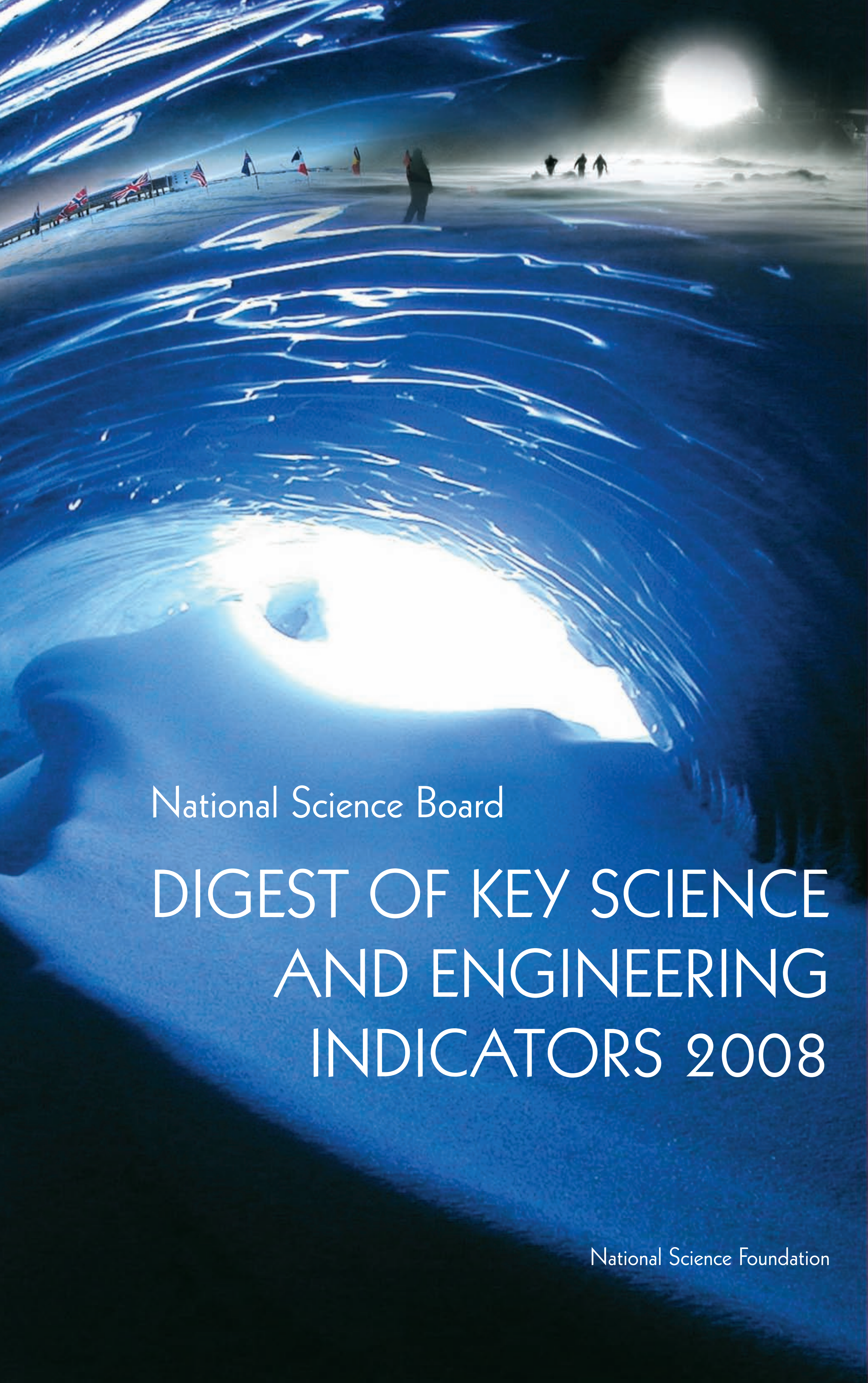

National Science Board

DIGEST OF KEY SCIENCE AND ENGINEERING INDICATORS 2008

National Science Foundation

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DIGEST OF KEY SCIENCE AND ENGINEERING INDICATORS 2008

January 15, 2008

Preface

The National Science Board (Board) is required under the National Science Foundation (NSF) Act, 42 U.S.C. § 1863 (j) (1) to prepare and transmit the biennial *Science and Engineering Indicators (SEI)* report to the President and to the Congress by January 15 of every even-numbered year.[1] The report is prepared by the NSF Division of Science Resources Statistics (SRS) under the guidance of the Board, and is subject to extensive review by Board Members, outside experts, interested Federal agencies, and SRS internal reviewers for accuracy, coverage, and balance.

SEI is first and foremost a volume of record comprising the major high-quality quantitative data on the United States and international science and engineering (S&E) enterprise. *SEI* is factual and policy-neutral; it neither offers policy options nor makes policy recommendations.

The science and engineering indicators included in the report are intended to contribute to the understanding of the current environment, and every effort is made to publish the most recent, highest quality data. However, statistical measures are unavoidably retrospective in nature, making it difficult to depict phenomena that may vary considerably after relatively short periods of time. Although every effort has been made to capture the most recent data available at the time of publication, interpretations of indicators should be made with the understanding that even recent indicators may fail to capture important changes in the phenomena they measure.

This digest of key S&E indicators draws primarily[2] from the Board's *Science and Engineering Indicators 2008*, the 18th volume of this biennial series. The digest serves two purposes: (1) to draw attention to important trends and data points from across the chapters and volumes of *SEI 2008*, and (2) to introduce readers to the data resources available in the main volumes of *SEI 2008* and its associated products. The Board expects that the structure and content of this digest will evolve over time.

The Board hopes that readers will find this digest useful and will take advantage of the wide range of data resources provided in the complete *SEI 2008*. Other paper, electronic, and Web resources associated with *SEI 2008* include:

- The Board Companion Piece to *Science and Engineering Indicators 2008*, ***Research and Development: Essential Foundation for U.S. Competitiveness in a Global Economy***,
- Presentation graphics available for downloading and modification for presentation needs,
- Figures by chapter,
- Tables by chapter (Volume 1 and Volume 2), and
- InfoCards.

The Appendix of this digest provides a detailed catalog of topics included in *Science and Engineering Indicators 2008* Volumes 1 and 2.

[1] Indicators are quantitative representations that might reasonably be considered as summary information bearing on the scope, quality, and vitality of the science and engineering enterprise.

[2] In addition to data from *SEI 2008*, the *Digest of Key Science and Engineering Indicators 2008* includes related data from other sources and special tabulations prepared for the Board by the IDA Science and Technology Policy Institute, Washington, DC.

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DIGEST OF KEY SCIENCE AND ENGINEERING INDICATORS 2008

Introduction

The United States holds a preeminent position in science and engineering (S&E) in the world, derived in large part from its long history of public and private investment in S&E research and development (R&D) and education. Investment in R&D, science, technology, and education correlate strongly with economic growth, as well the development of a safe, healthy, and well-educated society.

Many other nations, recognizing the economic and social benefits of such investment, have increased their R&D and education spending. This trend could potentially challenge the world leadership role of the United States.

Key S&E Indicators

The National Science Board (Board) has selected twenty S&E indicators for inclusion in this digest and grouped them into three categories. The first category represents general S&E indicators that the Board believes will yield important and readily understandable insights into the health of the U.S. S&E enterprise when regularly monitored by planners and policymakers. The second and third categories are carefully selected measures in the areas of education and the global marketplace. Taken together, these measures address an emerging set of trends of particular interest to planners and policymakers. The Board anticipates that these topical indicators may vary in successive volumes of the *Science and Engineering Indicators (SEI)* series as contemporary S&E policy issues emerge.

The category of general indicators has been further divided into three subcategories reflecting important areas of the S&E enterprise: patterns of R&D investment (six indicators), S&E workforce development (three indicators), and knowledge output (three indicators). The first subset tracks spending patterns of the United States as well as relative R&D spending patterns of selected countries and regions around the world. Notably lacking at this time are indicators measuring investments in education, as well as investment activities in physical infrastructure. The Board believes that both of these are necessary for a complete assessment of the S&E enterprise of the United States. Future editions of the Board's S&E digest will seek to include such indicators. The second subset reflects the fact that a vital S&E workforce is a critical component of a strong S&E infrastructure. For that reason, this set of indicators characterizes the patterns of S&E degree production and workforce development. The third and final subset of general indicators measure knowledge output. These examine trends in publishing and patenting.

What These Key S&E Indicators Tell the Nation

By selecting a set of general and topical indicators, the Board seeks to contribute to the assessment of the state of U.S. S&E – the Board's mandate for producing the biennial series of *SEI* – and also to point out issues of current opportunity or concern. The general and topical S&E indicators presented in this digest will provide valuable guidance and important feedback to planners and policymakers at all levels whose decisions affect our national S&E enterprise.

General Science and Engineering Indicators

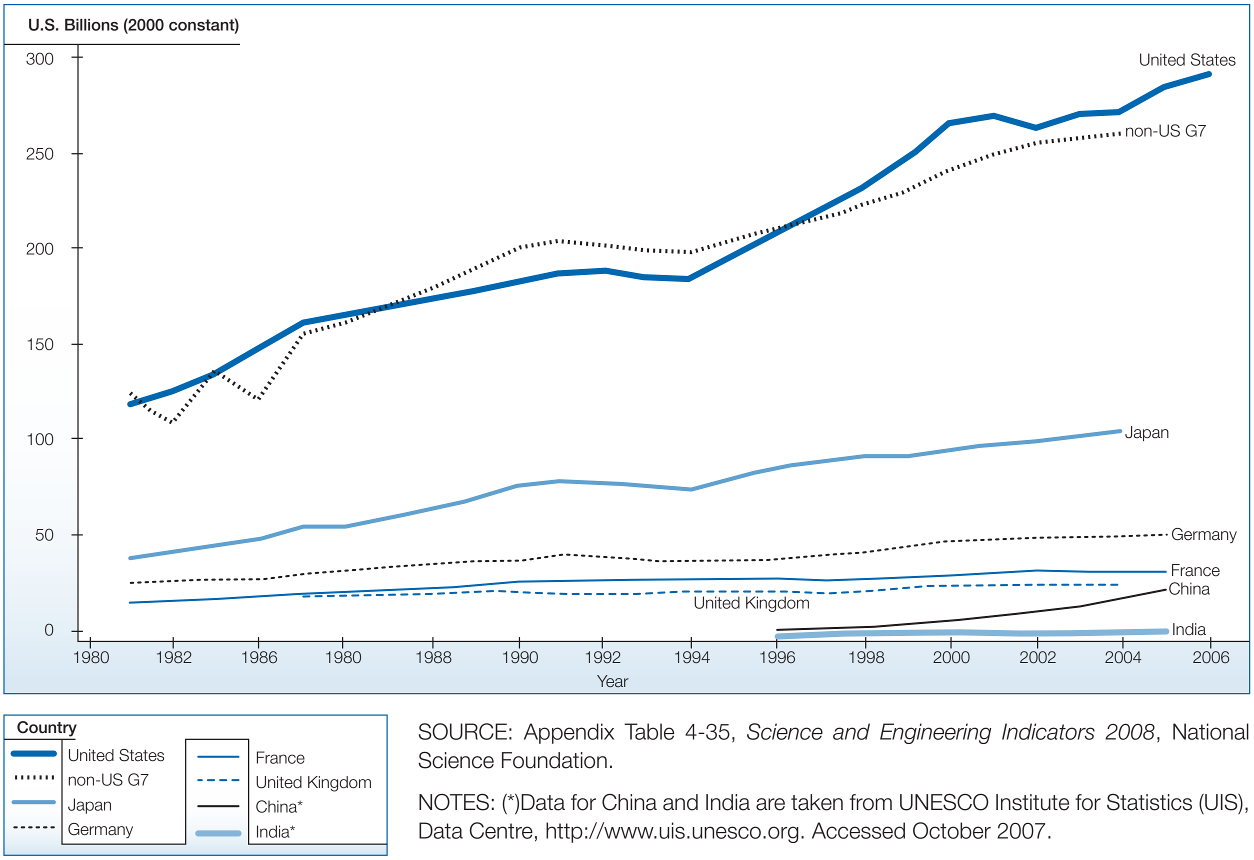
R&D Investment Patterns

S&E Workforce Development

Knowledge Output

U.S. R&D investment totaled nearly $293 billion in 2000 constant dollars (or $340 billion in current dollars), more than any other nation and more than all other G7 countries combined.

Figure 1. R&D investment by selected country: 1981-2006



SOURCE: Appendix Table 4-35, *Science and Engineering Indicators 2008*, National Science Foundation.

NOTES: (*)Data for China and India are taken from UNESCO Institute for Statistics (UIS), Data Centre, http://www.uis.unesco.org. Accessed October 2007.

Why is this indicator important?

- One measure of a nation's level of commitment to innovation is the amount of money invested in R&D activities by all sectors.

Key Observations

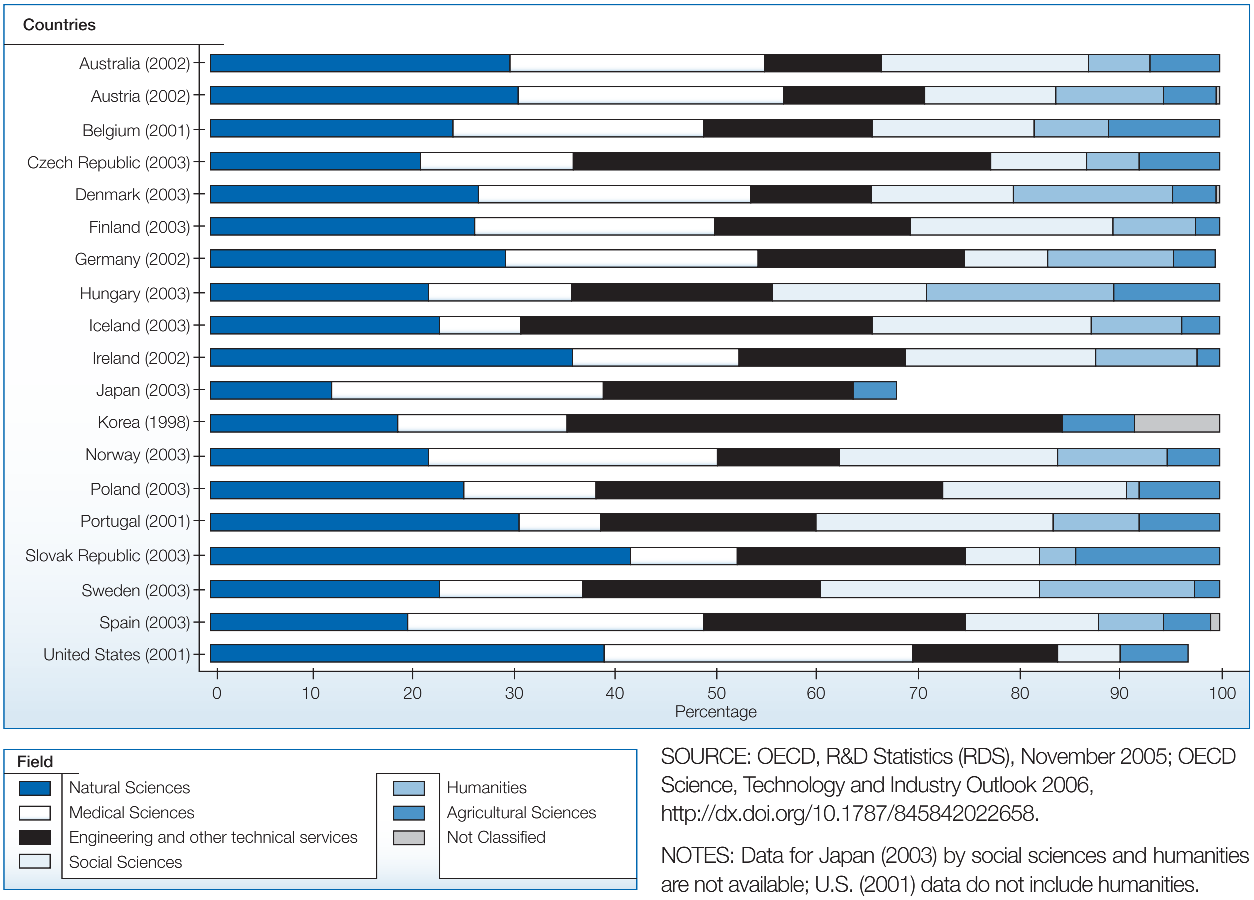
- The United States has led all nations in R&D expenditures for the past two decades. There has been a steady increase of R&D expenditures for the United States over time, with a rate comparable to that of Japan and exceeding all others except for the recent acceleration of China.
- After a worldwide slowing in R&D expenditures in the early 1990s, R&D spending rebounded in the late 1990s in several G7 countries, with the United States experiencing the most robust growth.

Related Discussion

- The United States ranks second among G-7 countries in the share of gross domestic product (GDP) devoted to R&D. (See Figure 17 in this *Digest* for details.).
- When adjusting to factor-in the lower costs of performing R&D in the developing world (using Purchasing Power Parity values, PPP), China is approximately the third largest R&D performer in the world after the US and Japan. (*SEI 2008* Appendix Table 4-2, Figure 4-15; UIS).

The United States allocates a larger share of its higher education R&D investment to the natural sciences than most other Office of Economic Co-operation and Development (OECD) countries.

Figure 2. S&E field shares of investment in academic R&D by selected country



SOURCE: OECD, R&D Statistics (RDS), November 2005; OECD Science, Technology and Industry Outlook 2006, http://dx.doi.org/10.1787/845842022658.

NOTES: Data for Japan (2003) by social sciences and humanities are not available; U.S. (2001) data do not include humanities.

Why is this indicator important?

- Academic R&D investment is a leading indicator of national capacity across the S&E fields, signifying not only the conduct of R&D across fields but also the support of graduate students who will comprise the next generation of scientists and engineers.

Key Observations

- Not all countries are equally engaged in all fields of science and engineering; nations differ in their choices for academic R&D investments.

- Compared to other major industrialized nations, the United States allocates a larger share of its higher education R&D expenditures to the natural sciences and a smaller share to engineering and to social sciences and the humanities.

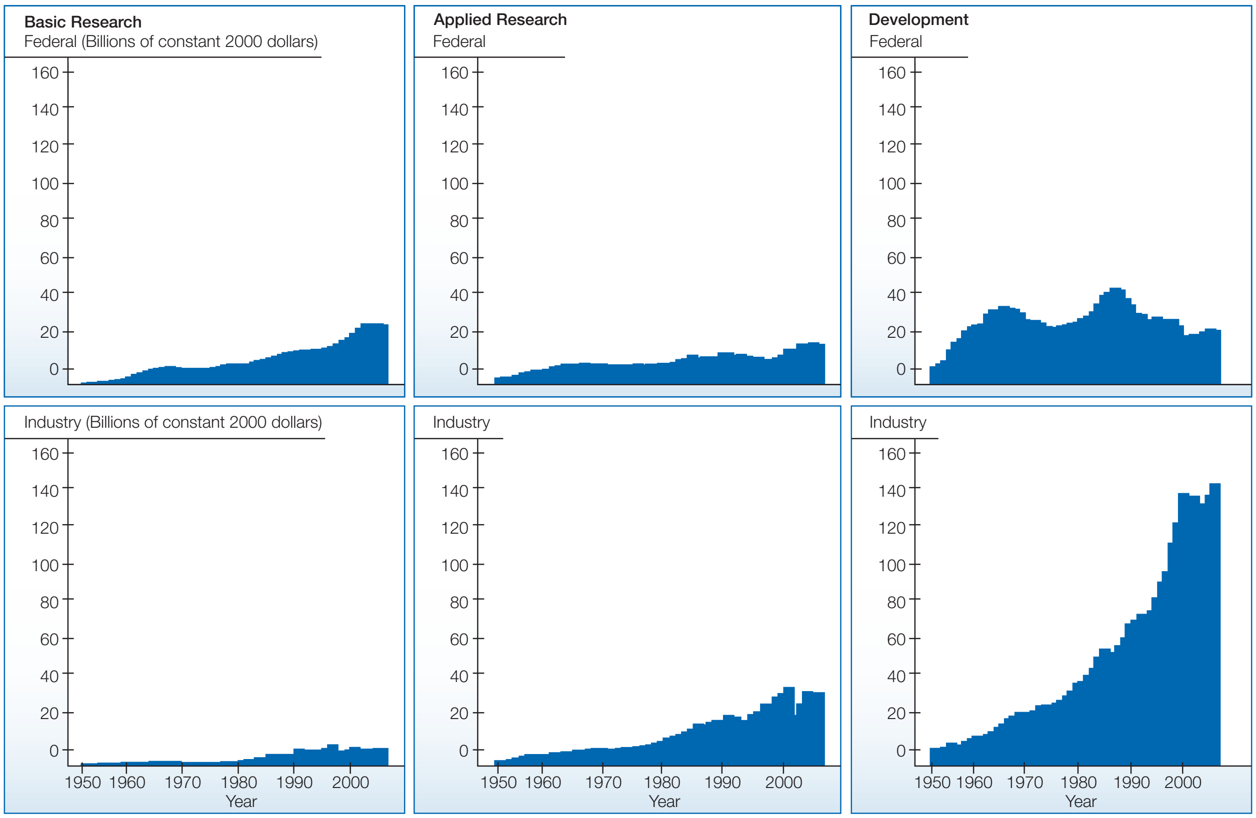
Related Discussion

- Countries differ in how data for the humanities and social sciences is defined, collected and reported.

- Note that these data are sporadic and, for some countries, quite old.

The federal government funds the majority of basic research in the United States, while industry funds the majority of development.

Figure 3. R&D investment patterns by the federal government and industry for basic and applied research and development: 1950-2006



SOURCE: Appendix Tables 4-10, 4-14, and 4-16, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- The outcomes and benefits of R&D investments depend not only on the amount of funding but also on the sources of support and the type of R&D those sources support.

Key Observations

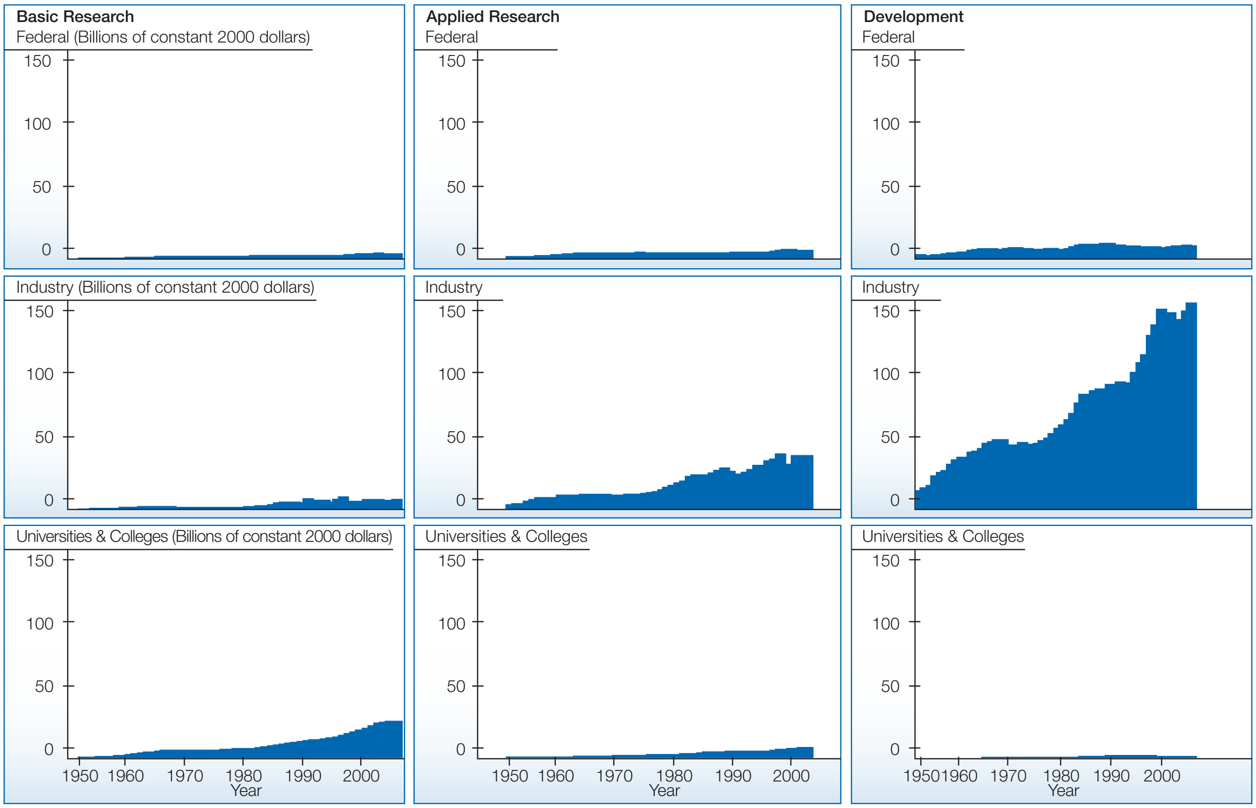
- Industry funds about 83% of development, while the federal government funds about 16%.
- The federal government funds about 59% of basic research, while industry funds 17% (*SEI 2008* Appendix Table 4-10).

Related Discussion

- Industry surpassed the federal government as the largest source of R&D funding overall in 1980.
- Following an economic slowdown in the United States in 2001 and 2002, the business activities of many R&D-performing firms were curtailed.
- The federal share of R&D funding first fell below 50% in 1979 and dropped to a low of 25% in 2000. Reflecting increased research spending on health, defense and counterterrorism, the federal share of R&D funding is projected at 28% of the R&D funding total in 2006.

Universities and colleges perform the majority of basic research in the United States, while industry performs the majority of applied R&D.

Figure 4. Patterns of funding for basic and applied R&D conducted by universities and colleges, industry and the federal sector: 1950-2006



SOURCE: Appendix Tables 4-10, 4-14, and 4-16, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- The innovation enterprise in the United States includes R&D performed in many sectors, each contributing to the national effort.
- Understanding how the S&E roles of academia, government and industry help to identify complementarities and gaps in the national S&E effort.

Key Observations

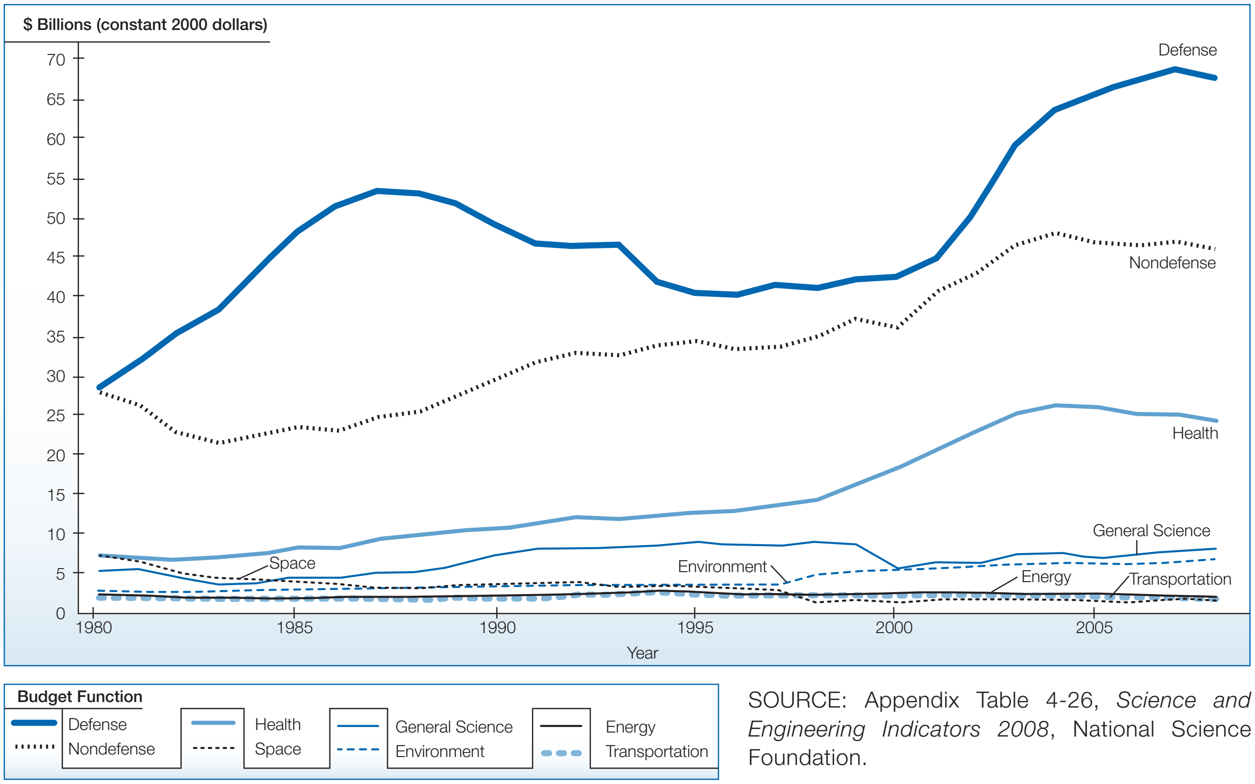
- The growth of basic research performed by the academic sector has slowed in recent years, while the level of applied research performed by that sector is estimated to be growing.
- There is evidence for some recovery in industrial performance of applied research and development after a brief downturn around 2000.

Related Discussion

- Scientists and engineers working for non-profit organizations and federally funded research and development centers (FFRDCs) also represent important performers of R&D in the United States.
    - FFRDCs grew at the rapid rate between 2000 and 2003, although that rate has slowed in recent years (*SEI 2008* Appendix Tables 4-10, 4-14, and 4-16).

More than half of all U.S. federal R&D investment is spent in support of defense, although investment in space research and in general science has grown more recently.

Figure 5. Federal R&D budget authority by budget function: FY 1980-2008



SOURCE: Appendix Table 4-26, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- Budget authority is the initial budget parameter for congressional action on the President's proposed budget, and imposes a ceiling on obligations and outlays.

Key Observations

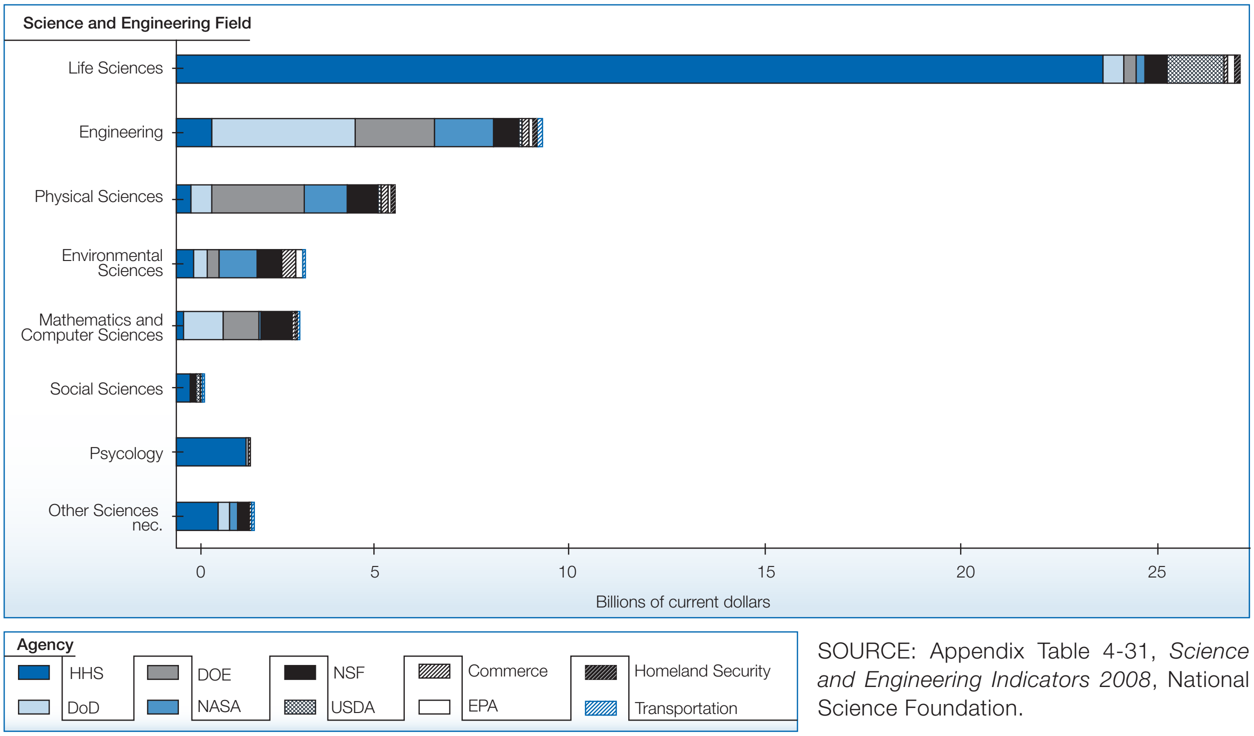
- The large majority of Federal R&D investment is mission oriented, that is, spending to achieve government goals. Increases in Federal R&D funding in recent years reflect, initially, increased spending on health related research and, since 9/11, on development in national security areas.
- Largely as a result of increased defense spending following 9/11, expenditures for R&D conducted by federal agencies and FFRDCs grew at the rapid rate of almost 6.6% per year in real terms between 2000 and 2003.
- Space R&D includes increased investments in the National Aeronautics and Space Administration's (NASA) Vision for Space Exploration to return humans to the Moon and Mars.
- Note that in FY 1998 many Department of Energy (DOE) programs were reclassified from energy to general science.

Related Discussion

- FY 2008 Federal R&D budget highlights are available online at http://ostp.gov/html/budget08.html.

The Department of Health and Human Services (primarily the National Institutes of Health, or NIH) accounts for most federal support for research and chiefly in the life sciences, while the Department of Defense (DoD) accounts for much of the federal research investment in engineering.

Figure 6. US federal research investment by selected agency and S&E field: FY2007



SOURCE: Appendix Table 4-31, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- Patterns of research funding by federal agency reflect government priorities and influence the development of specific fields of science and engineering.

Key Observations

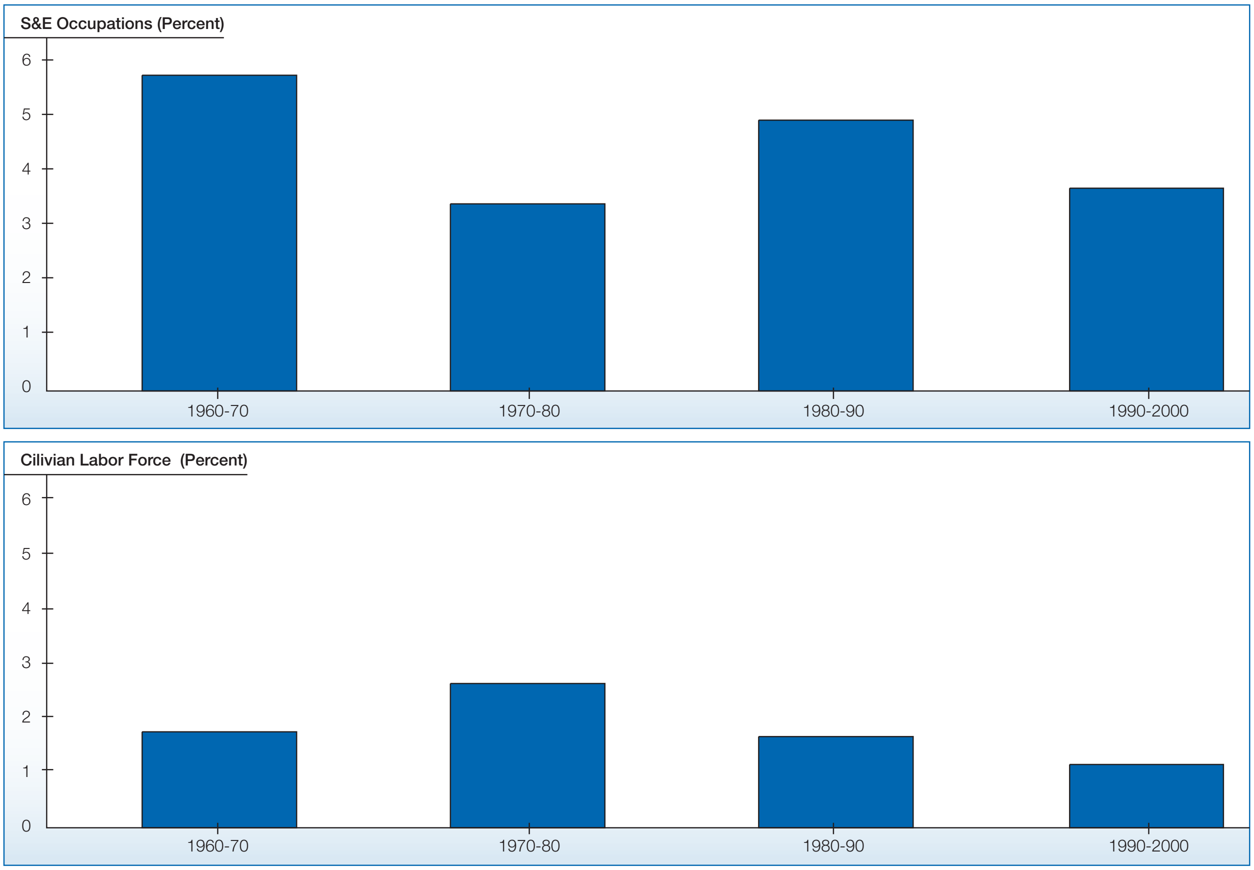
- Federal investment in life sciences research totaled about $27.8 billion in FY 2007, largely related to support provided by the National Institutes of Health (NIH).
- Federal investment in engineering research totaled about $9.5 billion that year, largely due to support provided by DoD.
- Funding from DOE largely accounts for the level of federal research investment in the physical sciences, which reached about $2.4 billion in FY 2007.

Related Discussion

- Most recently, patterns of U.S. federal R&D investment have reflected renewed focus in national security areas (*SEI 2008* Figure 4-11).

Since 1960, the U.S. science and engineering workforce has grown faster than the full workforce.

Figure 7. Average annual growth rates of S&E occupations versus all workers: 1960 - 2000



SOURCE: Figure 3-2, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- A growing S&E workforce is an indicator of increased capacity for innovation.

Key Observations

- S&E employment grew at an average annual rate of 3.6% between 1990 and 2000, compared with an average annual rate of 1.1% for the U.S. workforce as a whole.

Related Discussion

- Today, S&E workers make up approximately 4% of the total U.S. civilian labor force, up from 2.6% in 1983.
- Growth in the S&E workforce in the United States was made possible by three factors:

  (1) Increases in S&E degrees earned by both native and foreign-born students,

  (2) Both temporary and permanent migration to the United States of those with foreign S&E education, and

  (3) The relatively small number of scientists and engineers old enough to retire (*SEI 2008* Chapter 3).

The number of degrees awarded in science and engineering by U.S. colleges and universities continues to grow, although recent declines are evident in computer science degrees at the bachelor's and master's degree levels.

Figure 8.1. Earned bachelor's degrees by field: 1985–2005

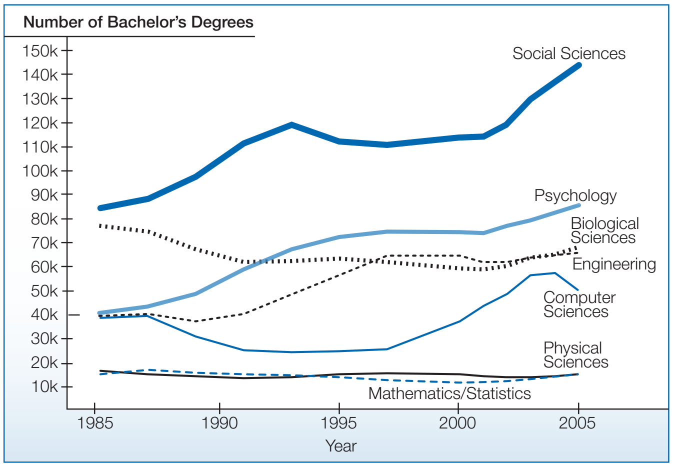


Figure 8.2. Earned master's degrees by field: 1985–2005

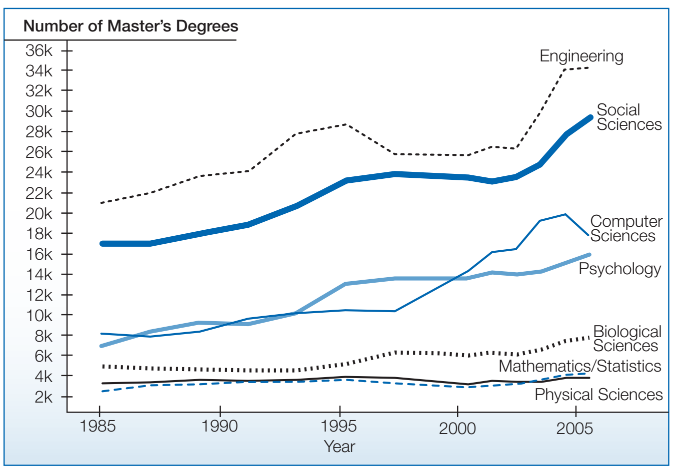
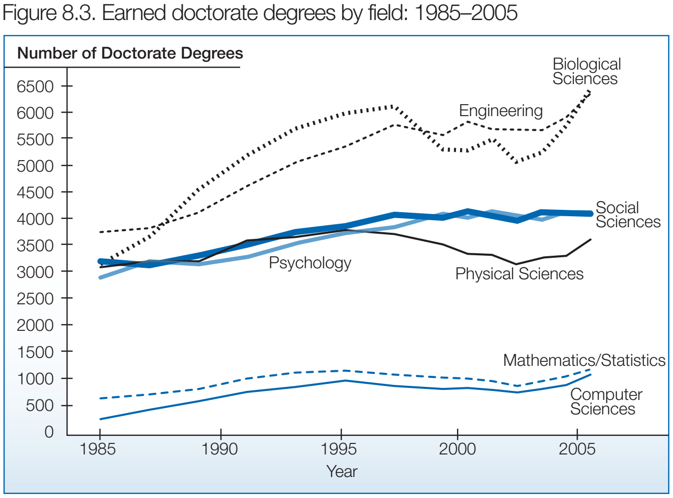


Figure 8.3. Earned doctorate degrees by field: 1985–2005



Why is This Indicator Important?

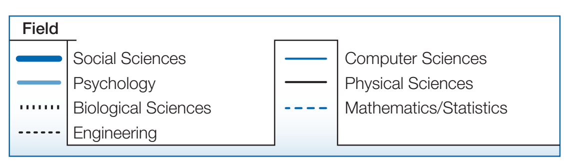
- Trends in the number of graduates in each S&E field reflect changes in the supply of qualified candidates for S&E occupations.

Key Observations

- The social sciences and psychology continue to dominate S&E degree patterns at the bachelor's degree level, although significant growth is also evident in the biological sciences.
- While engineering continues to represent the most prevalent type of master's degree awarded in the United States, a dip occurred between 1995 and 2002 followed by a period of rapid recovery.
- The number of master's degrees awarded in the social sciences, psychology and the biological sciences continues to grow.
- The number of master's degrees awarded in the computer sciences recently declined.
- Sharp increases are evident in doctoral degrees awarded in the biological sciences and engineering – two broad fields which dominate S&E doctoral degree patterns in the United States.

Related Discussion

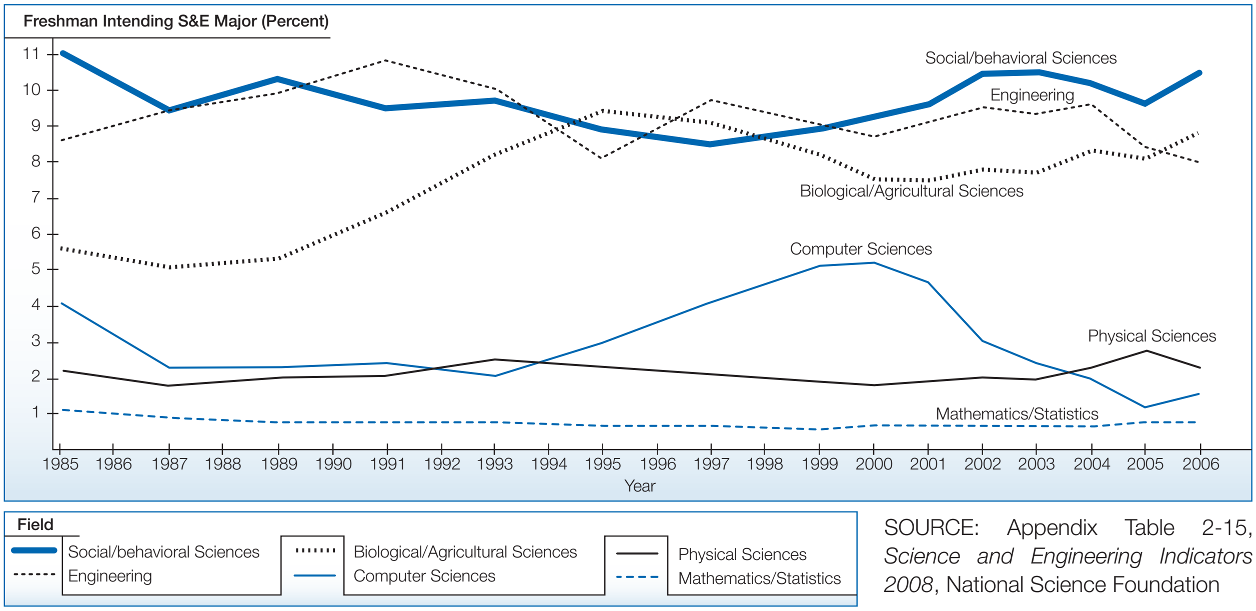
- The number of S&E research doctorates conferred annually by US universities reached a new peak of almost 30,000 in 2006, chiefly driven by a growing number of doctorates awarded to non-U.S. citizens (SRS InfoBrief: NSF 08-301).



SOURCE: Appendix Tables 2-27, 2-29, and 2-31, *Science and Engineering Indicators 2008*, National Science Foundation.

Of those college freshmen who intend to major in science or engineering, the share expressing interest in majoring in computer sciences or engineering has declined in recent years.

Figure 9. Freshmen intending S&E major by field: 1985-2006



SOURCE: Appendix Table 2-15, *Science and Engineering Indicators 2008*, National Science Foundation

Why is this indicator important?

- The intended major of college freshmen is a leading indicator of the relative number of bachelor's degrees awarded several years later.

Key Observations

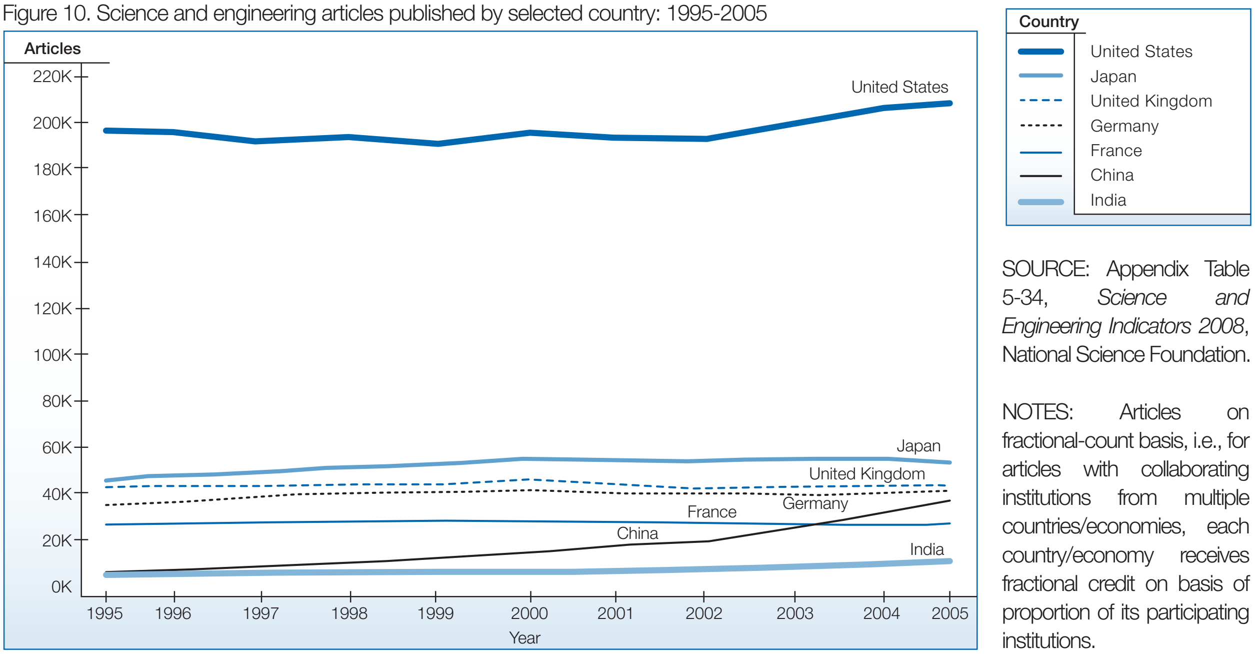
- The social sciences and the biological/agricultural sciences are currently the most popular majors among those freshmen who identify a major at the time of entering college.
- The share of entering freshmen intending to major in the computer sciences increased significantly from 1993 to 2000 and then declined sharply from 2001 to 2005, with some evidence for recovering in 2006.

Related Discussion

- About 30% of entering freshmen do not know in which field they will major.
  - 23% eventually major in the social and behavioral sciences, 9% in the physical or computer sciences, mathematics or engineering, and 11% in the biological or agricultural science (*SEI 2008* Table 2-6).
- Students actively change majors in succeeding years of college studies.
  - For example, about half of those who majored in the biological or agricultural sciences in 1995 reported in 2001 that they had switched to another major (although science and engineering majors in other fields in 1995 had higher persistence rates) (*SEI 2008* Table 2-6).
- While undergraduate enrollments in mathematics and statistics at 4-year colleges and universities declined slightly between fall 2000 and fall 2005, they increased 26% in public 2-year colleges (*SEI 2008* Table 2-4).

U.S. science and engineering article output increased at an average annual rate of 1.3% between 2000 and 2005, after remaining flat between 1995 and 2000.

Figure 10. Science and engineering articles published by selected country: 1995-2005



SOURCE: Appendix Table 5-34, *Science and Engineering Indicators 2008*, National Science Foundation.

NOTES: Articles on fractional-count basis, i.e., for articles with collaborating institutions from multiple countries/economies, each country/economy receives fractional credit on basis of proportion of its participating institutions.

Why is This Indicator Important?

- Publication of research results in the form of articles in peer-reviewed journals indicates contribution to the knowledge bases of nearly all scientific fields and disciplines.
- In recent years, international use of this and related indicators has become widespread, as countries seek to assess their relative research output.

Key Observations

- Between 1995 and 2005, world S&E article output grew at an average annual rate of 2.3%, reaching 710,000 articles in 2005.
- U.S. authors produced 205,000 articles in 2005, accounting for 29% of the world total.
  - The United States was followed by Japan with 8% and the United Kingdom, Germany, and China with 6% each.
- Chinese publications increased at an average annual rate of 16% between 1995 and 2005, surpassing France in 2003 and nearly equaling Germany and the United Kingdom in 2005.

Related Discussion

- Despite growing at an average annual rate of 4.5% between 1995 and 2005, India accounted for a small fraction of the world's total output and lost rank in the fields of engineering, mathematics, and medical sciences (*SEI 2008* Table 5-21).
- Between 1995 and 2005, the United States experienced gains on the index of highly cited articles (the share of the top 1% most frequently cited articles normalized by the share of all articles produced in the citation period) in all fields except chemistry and geosciences (*SEI 2008* Appendix Table 5-39).

With nearly 20,000 filings in 2003, the United States continued to be the leading source of triadic patent families.

Figure 11.1. Number of triadic patent families by nationality of inventor, selected countries: 1985-2003

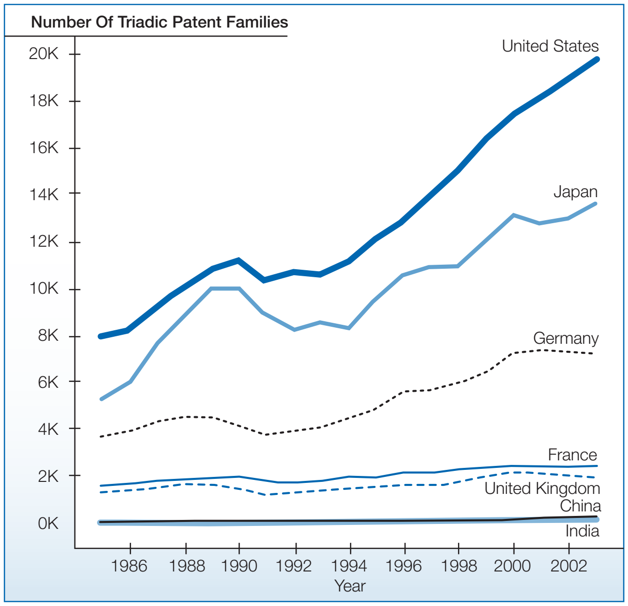
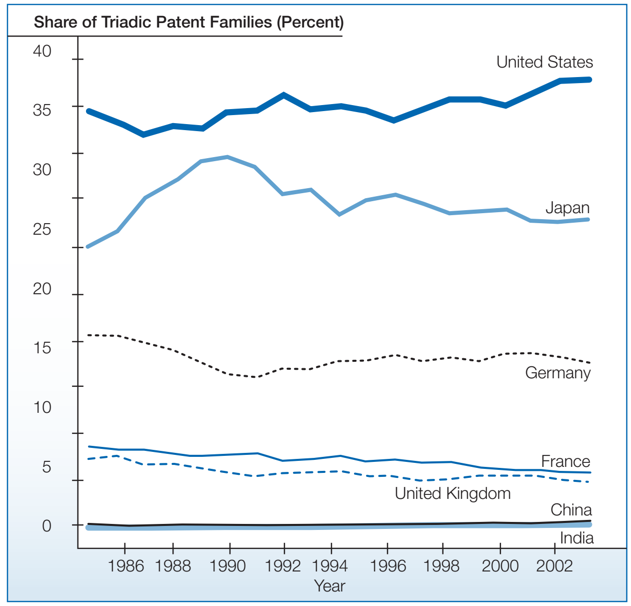
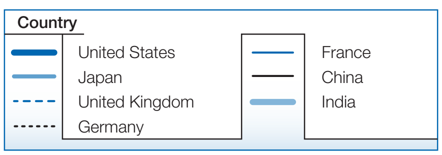


Figure 11.2. Share of triadic patent families by nationality of inventor, selected countries: 1985-2003





SOURCE: Appendix Tables 6-50 and 6-51, *Science and Engineering Indicators 2008*, National Science Foundation.

NOTES: Patents on fractional count basis, i.e., for patents with inventors from multiple countries, each country receives fractional credit based on proportion of its participating inventors. Number of patents estimated between 1998 and 2003 by OECD.

Why is this indicator important?

- The high cost of filing for patents from three separate patent offices representing the world's three largest markets makes triadic patent families a more valid measure than simple patent counts for identifying economically valuable inventions.

Key Observations

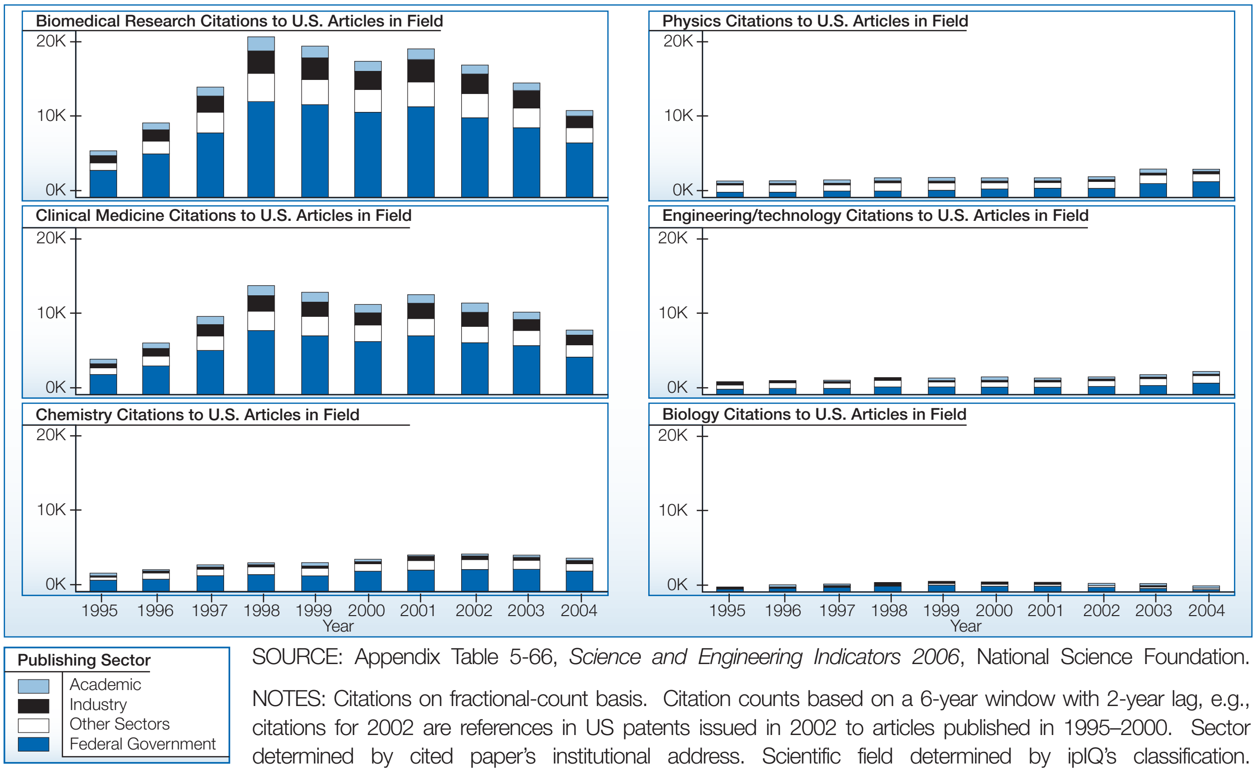
- The United States, Japan, Germany, France, and the United Kingdom were the top five filers of triadic patents in 2003, together accounting for 84% of the world's triadic patent families in 2003.
- The United States had the largest increase in world share between 1993 and 2003, increasing from 34 to 37% of the total.
- While their share of the world total remained small (less than half a percent each), China and India increased their filings of triadic patents from 33 to 225 and from 8 to 99, respectively, between 1993 and 2003.

Related Discussion

- Patent shares by technology provide a more nuanced comparison of inventive output between countries and over time. Chapter 6 of *SEI 2008* discusses biotechnology and information and communications technology patenting trends.

U.S. patent citations to science and engineering articles rose rapidly through the late 1990s, with the largest increases seen in citations to academic articles in the biomedical and clinical medicine fields.

Figure 12. Number of citations to U.S. articles by patents issued by the U.S. Patent Office, by field and sector of article: 1995 - 2004



SOURCE: Appendix Table 5-66, *Science and Engineering Indicators 2006*, National Science Foundation.

NOTES: Citations on fractional-count basis. Citation counts based on a 6-year window with 2-year lag, e.g., citations for 2002 are references in US patents issued in 2002 to articles published in 1995–2000. Sector determined by cited paper's institutional address. Scientific field determined by ipIQ's classification.

Why is this indicator important?

- The citation of S&E literature in U.S. patents indicates the extent to which academic research across S&E fields fosters innovation across sectors.

Key Observations

- Academic-authored articles in biomedical research and clinical medicine accounted for 41% of the increase in total citations across all fields between 1995 and 2004.
  - Growth in citations to both biomedical and clinical medicine research occurred primarily in the late 1990s, and citations to research in both fields declined between 2001 and 2004.
- Citations to industry-authored papers, the second largest source, declined from 25% in 1995 to 21% in 2004.

Related Discussion

- Patents referencing S&E articles nearly tripled between 1990 and 2001, increasing from approximately 6,000 in 1990 to over 20,000 in 2003 (*SEI 2006* Table 5-26).
- The average number of citations per patent increased from 0.33 per patent in 1990 to 1.56 in 2003 (*SEI 2006* Appendix Table 5-65).
- The bulk of U.S. patents citing scientific literature were issued to U.S. inventors, who accounted for 65% of these patents in 2003, a share disproportionately higher than the 51% of all U.S. patents issued to U.S. inventors (*SEI 2006* Table 5-26).
- The counts in the above chart do not control for patents that cite the same S&E article(s) and may overestimate the degree of "transfer" from scholarly output to potential commercial application.

Selected Education Indicators

High School Completion Patterns

High School Graduates Enrolled in College

High School Teachers

Teaching Vacancies at U.S. Public Secondary Schools

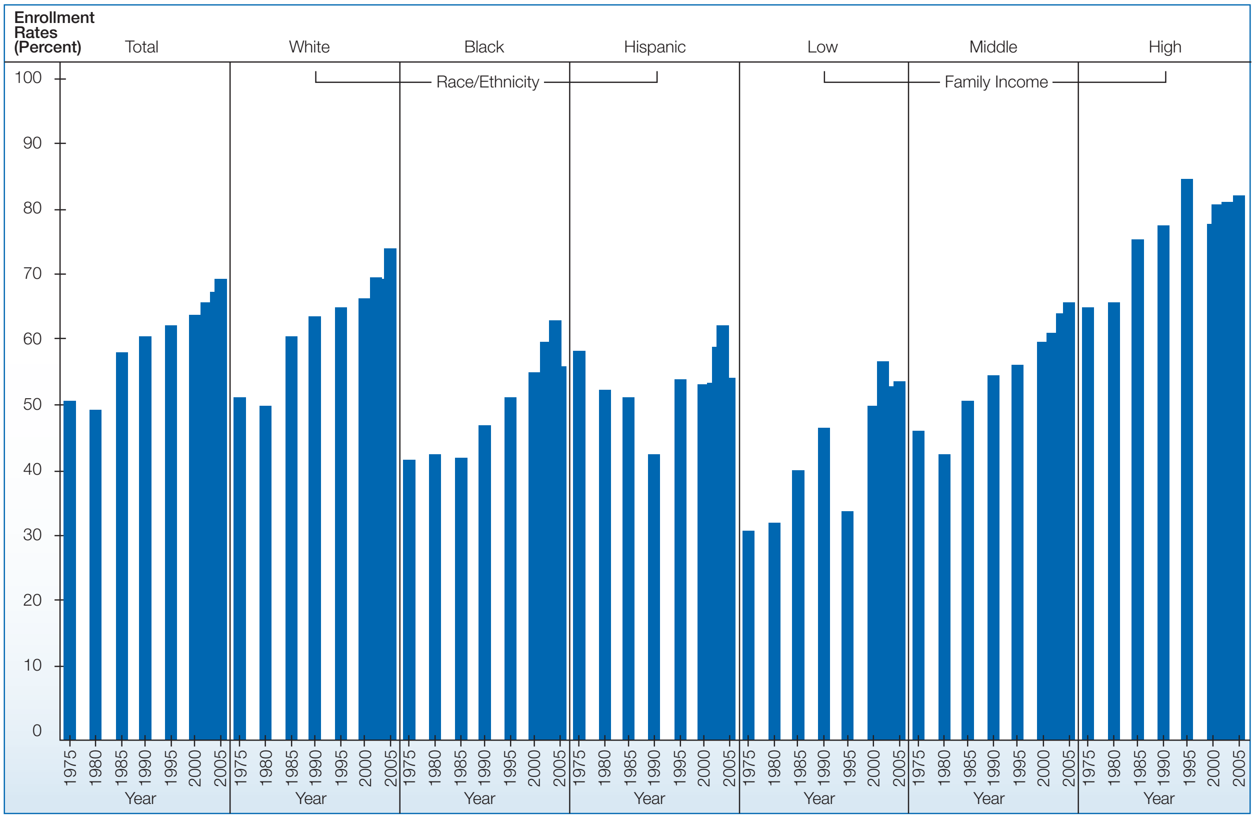
Median Annual Salaries of Teachers and Selected Other Professionals

Higher Education Enrollments

Share of Bachelor's S&E Degrees Awarded to Women and Minorities

Over two-thirds of all U.S. high school graduates enroll in postsecondary education immediately after graduation, although immediate enrollment rates for low-income families are lower.

Figure 13. High school graduates enrolled in college in October after completing high school, by race/ethnicity and family income*: 1975–2005



SOURCE: Appendix Table 1-22, *Science and Engineering Indicators 2008*, National Science Foundation.

NOTES: Data are only available for 1975, 1980, 1985, 1990, 1995, and 2000-2005.
(*)Family income categorized as: low income includes families in lowest 20% of income distribution, middle income includes families in middle 60%, and high income includes families in highest 20%.

Why is this indicator important?

- College enrollment rates influence the size of the future workforce qualified for certain occupations.

Key Observations

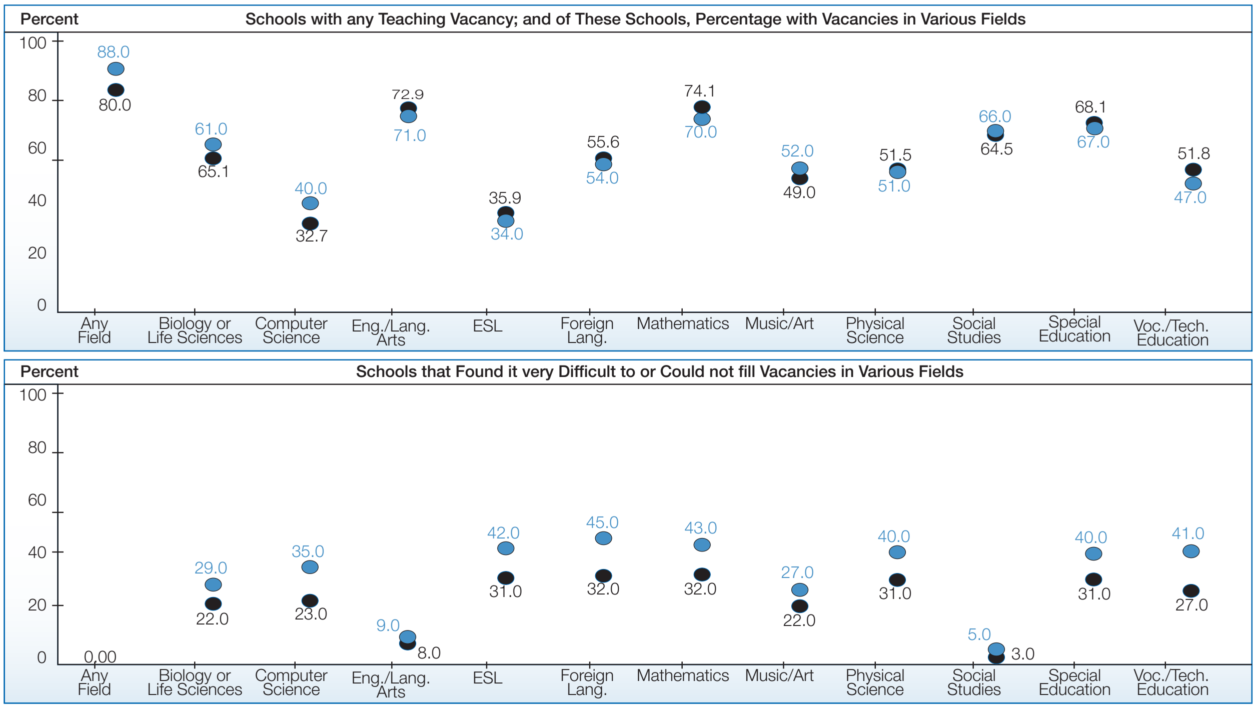
- Between 1975 and 2005, the percentage of students ages 16 to 24 enrolling in college immediately following high school graduation rose from 51 to 69%, with increases evident across all income levels.
- Over 80% of high school graduates from high-income families attend college immediately after graduation, compared with 54% from low-income families.

Related Discussion

- High school completion rates have been increasing gradually and the white-black gaps in completion rates have been narrowing. (*SEI 2008* Appendix Table 1-22).
- In 2005, 88% of 18 to 24 year olds not enrolled in high school had received a high school diploma or earned an equivalent credential such as a General Equivalency Diploma (GED) certificate, up from 84% in 1975. (*SEI 2008* Figure 1-22).

In academic year 2003-04, about 59% of the public secondary schools in the United States reported vacancies in mathematics teaching positions, and of these nearly one-third said that they found it "very difficult to" or "could not" fill those vacancies.

Figure 14. Teaching vacancies at public secondary schools, by field: Academic years 1999–2000 and 2003–04



SOURCE: Figure 1-16, *Science and Engineering Indicators 2008*, National Science Foundation.

NOTES: Teaching vacancies are teaching positions needing to be filled in current school year. Secondary schools had any of grades 7–12 and none of grades K–6.

Why is this indicator important?

- The teaching workforce plays a critical role in preparing graduates for careers in an increasingly technological labor market.
- Teacher vacancies in S&E fields may indicate that students will not receive adequate motivation and training to join the S&E workforce later on.

Key Observations

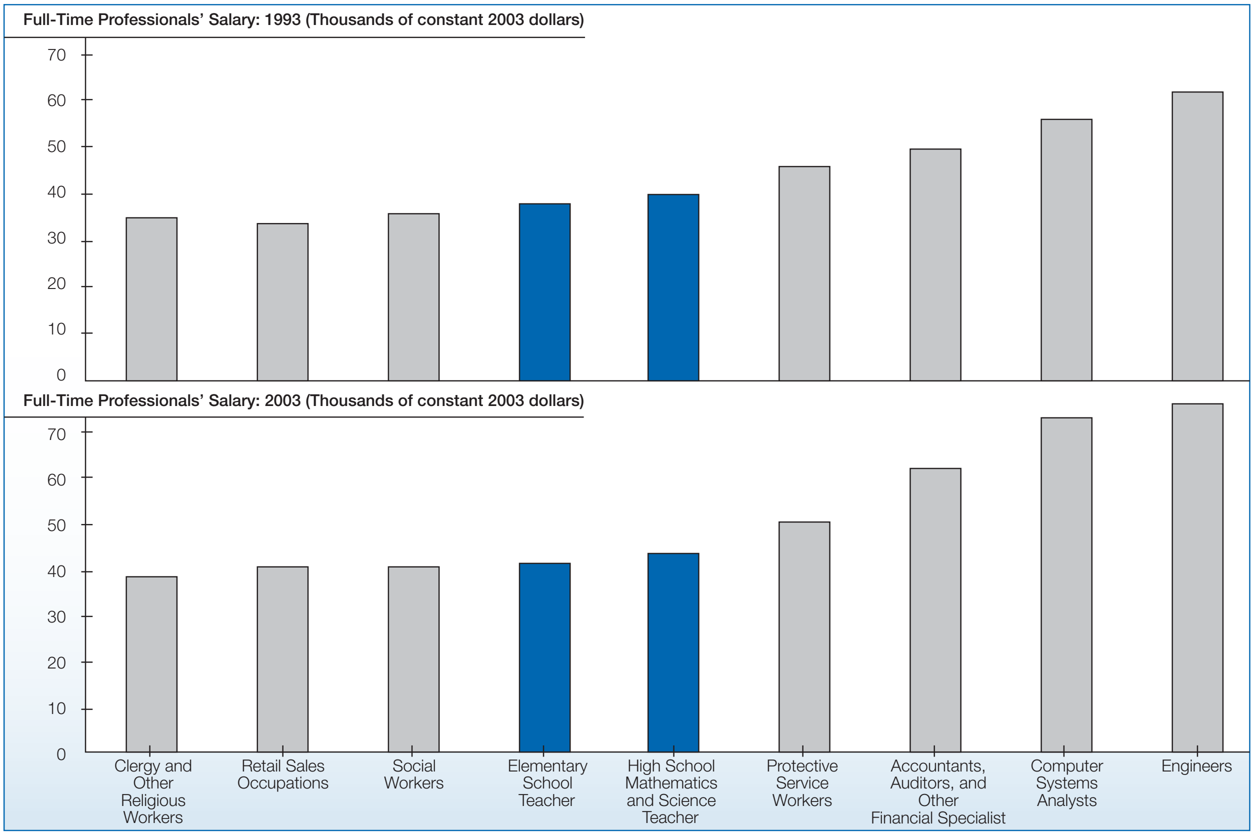
- About 80% of public secondary schools reported teaching vacancies (i.e., teaching positions needing to be filled) in one or more fields in academic year 2003.
  - Among these schools, 74% had vacant positions in mathematics and 52–56% had vacant positions in biology/life sciences and physical sciences.
  - About one-third of public secondary schools with vacancies in mathematics or physical sciences reported great difficulty in finding teachers to fill openings in these fields, whereas 22% of schools reported that this was the case in biology/life sciences.

Related Discussion

- Current research suggests that in recent years hiring difficulty was primarily caused by large numbers of teachers leaving the profession before regular retirement age (*SEI 2008* Chapter 1).
- Teacher shortages occurred more frequently in certain states where the population grew fast because of immigration and/or high rates of childbirth (e.g., CA, TX, and FL) (in certain fields, and in high-poverty areas) (*SEI 2008* Chapter 1).

Mathematics and science teacher salaries continued to lag behind salaries for other professions, and the gap has widened.

Figure 15. Median annual salaries of full-time school teachers and selected other professionals: 1993 and 2003



SOURCE: Table 1-12, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- Adequate compensation and supportive school environments attract and retain teachers.

Key Observations

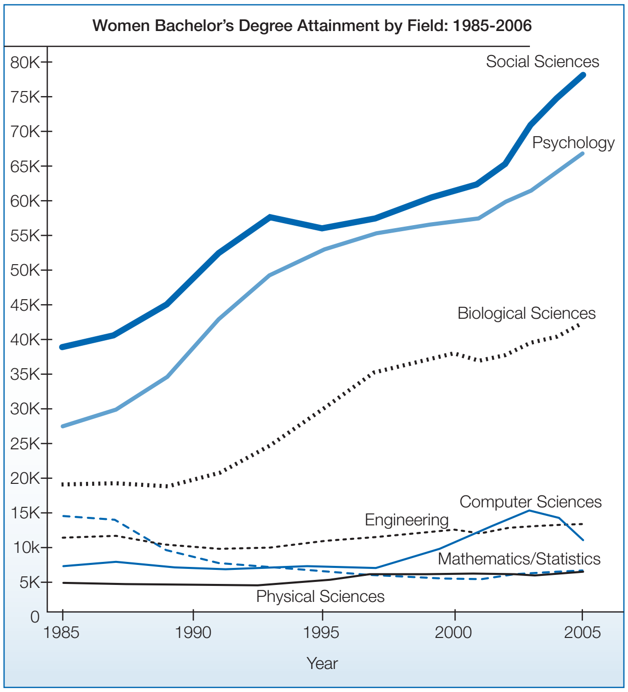
- From 1993 to 2003, full-time high school mathematics and science teachers had a real salary gain of 8%, compared with increases of 21 to 29% for computer systems analysts, accountants or financial specialists, and engineers.
- The median salary for full-time high school mathematics and science teachers in the United States in 2003 was $43,000.
  - Median salaries for accountants and other financial specialists, for computer systems analysts, and for engineers exceeded $60,000 that year.

Related Discussion

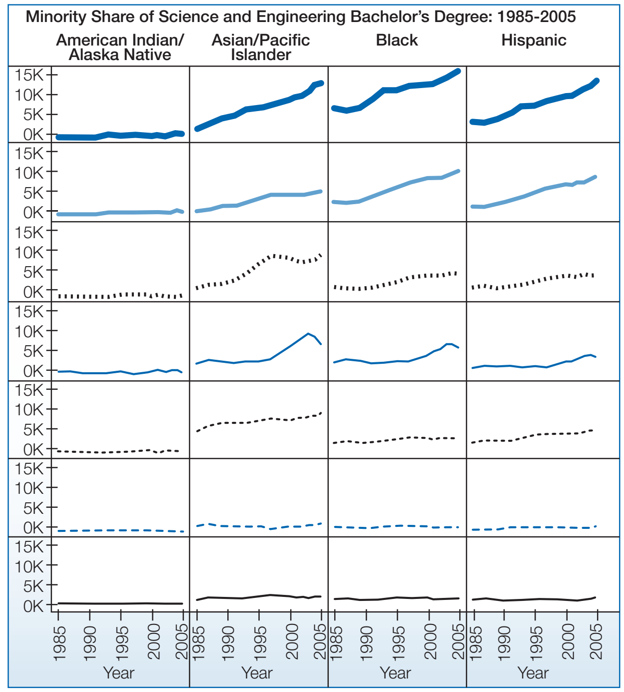
- Although public school teachers generally had favorable perceptions of their working conditions, those in schools with high concentrations of minority students or of students from low income families viewed their work environments as less satisfactory (*SEI 2008* Figure 1-20).
- About half of public middle and high school mathematics and science teachers were not satisfied with their pay in school year 2003-04 (*SEI 2008* Figure 1-17).

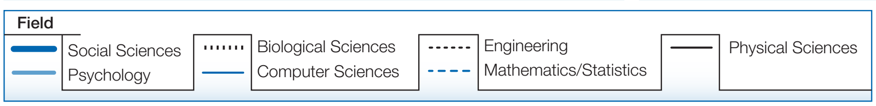
The number of S&E bachelor's degrees awarded to women and minorities has largely increased over the last two decades, but not in the physical sciences, engineering or mathematics.

Figure 16.1. Earned bachelor's degrees by sex: Selected years, 1985–2005



Figures 16.2. Earned bachelor's degrees by race: Selected years, 1985–2005





SOURCE: Appendix Table 2-27, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- Demographic trends and world events contributed to changes in both the numbers and types of students participating in U.S. higher education.

Key Observations

- The share of bachelor's degrees awarded to women increased in almost all major S&E fields during the past two decades.
- For all racial/ethnic groups (except white), the total number of bachelor's degrees, the number of S&E bachelor's degrees, and the number of bachelor's degrees in most S&E fields, except computer sciences generally increased over the past two decades.
- Women earned more than half of bachelor's degrees in psychology (78%), agricultural sciences (51%), biological sciences (62%), chemistry (52%), and social sciences (54%).

Related Discussion

- Despite considerable progress for underrepresented minority groups between 1985 and 2005 in earning bachelor's degrees in any field, the gap in educational attainment between young minorities and whites continues to be wide.

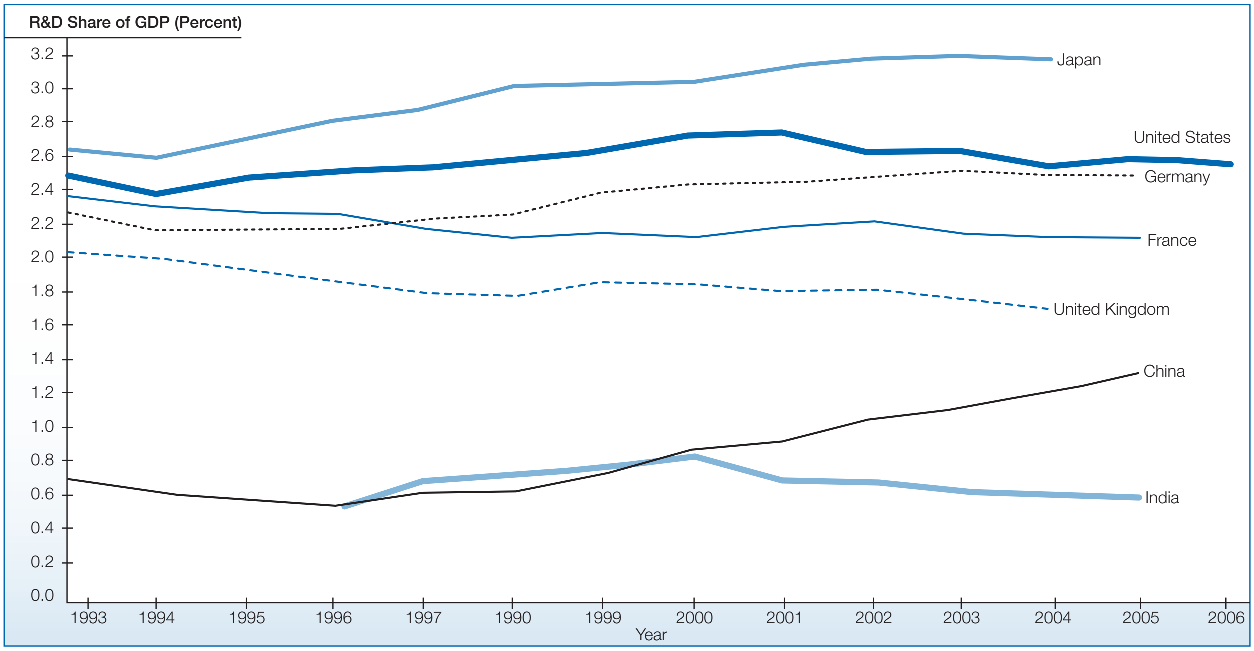
Selected Global Marketplace Indicators

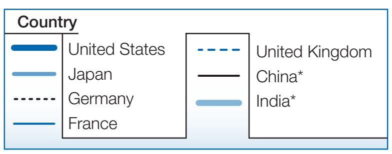
Competitiveness

R&D Share of GDP in Selected Countries
Annual Productivity Growth in Selected Countries
World Share of Value-Added Revenues of High-Technology Manufacturing
World Share of Value-Added Revenues for Market-Oriented, Knowledge-Intensive Services

The United States had the second largest R&D/GDP ratio among the G7 countries, spending about 2.6% of GDP on R&D activities in 2006.

Figure 17. R&D share of GDP, by selected country: 1993-2006





SOURCE: Appendix Table 4-35, *Science and Engineering Indicators 2008*, National Science Foundation.

NOTES: (*) Data for China and India are taken from UNESCO Institute for Statistics (UIS), Data Centre, http://www.uis.unesco.org. Accessed October 2007.

Why is this indicator important?

- The ratio of R&D expenditures to GDP is often used to examine R&D as a proportion of a nation's overall economic activity.
- This ratio is a useful indicator of the "intensity" of R&D activity in relation to other economic activities and can be used to gauge a nation's commitment to R&D at different points in time.

Key Observations

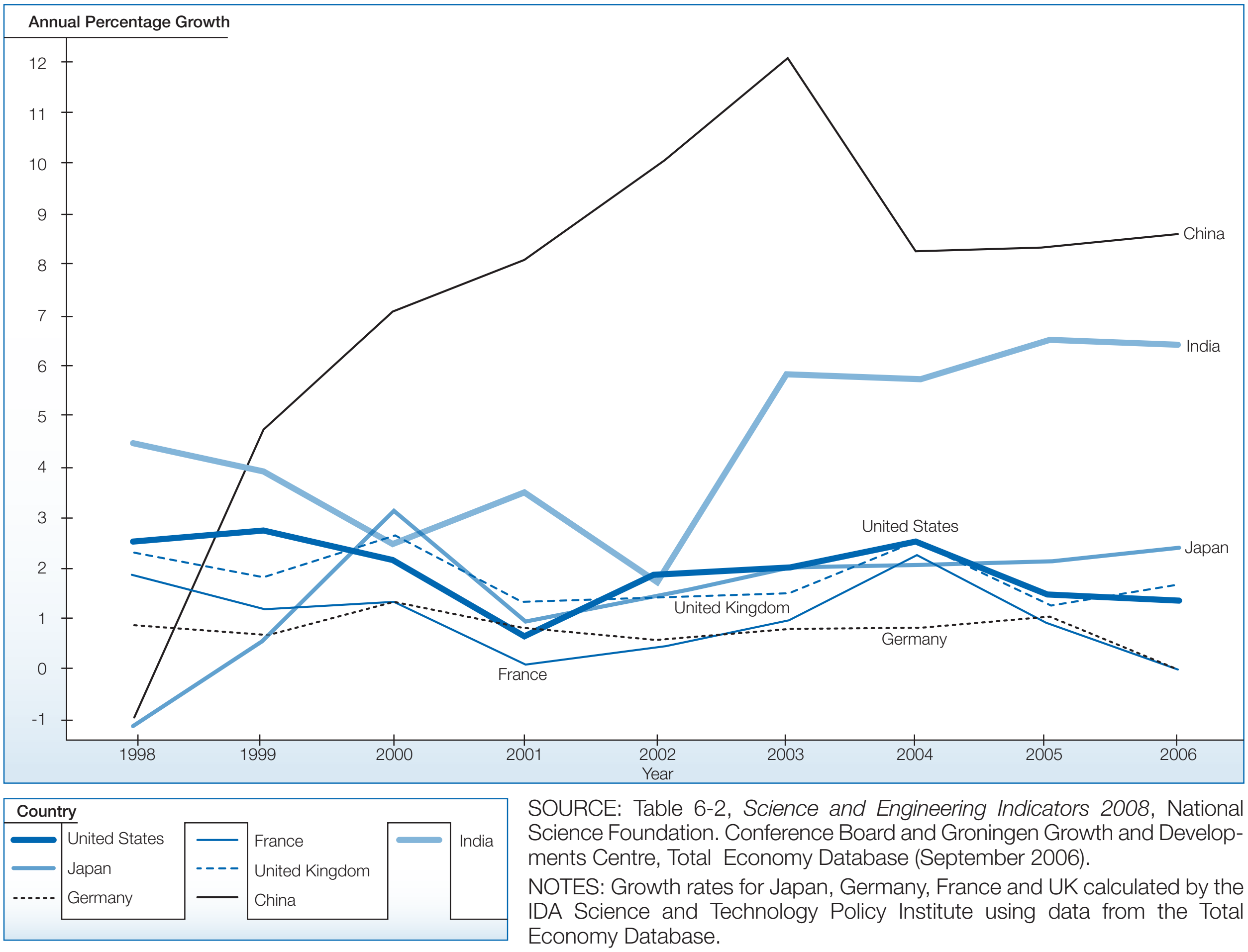
- Rate of growth for Germany increased by 0.33 from 1994 to 2005, while the United States increased by 0.20 during that same period.
- Since 2000, Japan continues to lead while China demonstrates the biggest growth.

Related Discussion

- The general growth in the U.S. R&D/GDP ratio since 1979 can be attributed to a steady increase in non-Federal R&D spending.
- Growth in the R&D/GDP ratio does not necessarily imply increased R&D expenditures. For an extended discussion on the R&D/GDP ratio see *SEI 2008* Chapter 4.
- In absolute terms, this indicator can mask significant R&D activity for countries with relatively large economies (e.g., China).

Productivity is growing faster in China and India than in many other countries including the United States.

Figure 18. Annual productivity growth by selected country: 1989-2006



SOURCE: Table 6-2, *Science and Engineering Indicators 2008*, National Science Foundation. Conference Board and Groningen Growth and Developments Centre, Total Economy Database (September 2006).

NOTES: Growth rates for Japan, Germany, France and UK calculated by the IDA Science and Technology Policy Institute using data from the Total Economy Database.

Why is this indicator important?

- Productivity growth occurs when there is growth in output not attributable to growth in inputs (such as labor, capital and natural resources).
- This type of growth is often associated with technological innovation, for example, the diffusion of information and communications technologies across industries and sectors of the economy.

Key Observations

- China has been the productivity growth rate leader for the past decade, with productivity growth of 8.7% per year, on average, since 2000, though India has increased to roughly 6.5% per year in 2005-2006.

Related Discussion

- While growth in productivity has slowed in the United States in recent years, growth in labor inputs has increased, in part offsetting productivity as a contributor to GDP growth.

The United States has the lead in 4 of the 5 high-technology manufacturing industries and has maintained a 35% share of world revenue of all high-technology manufacturing industries since 2001.

Figure 19.1. World share of value-added revenues for high-tech manufacturing, selected countries: 1985 – 2005

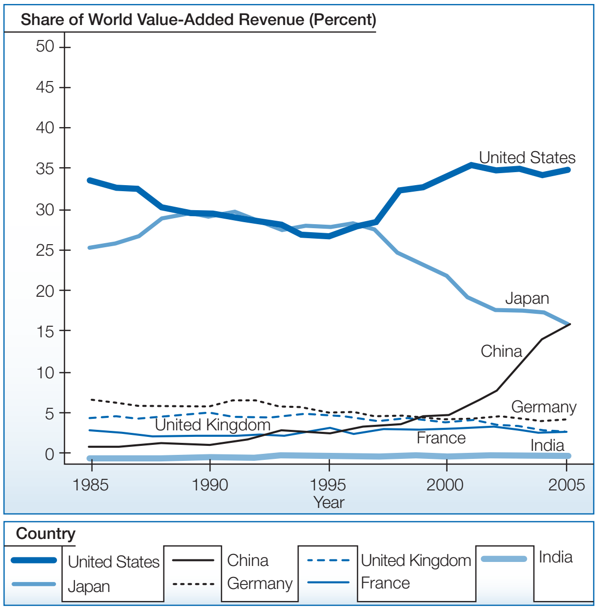
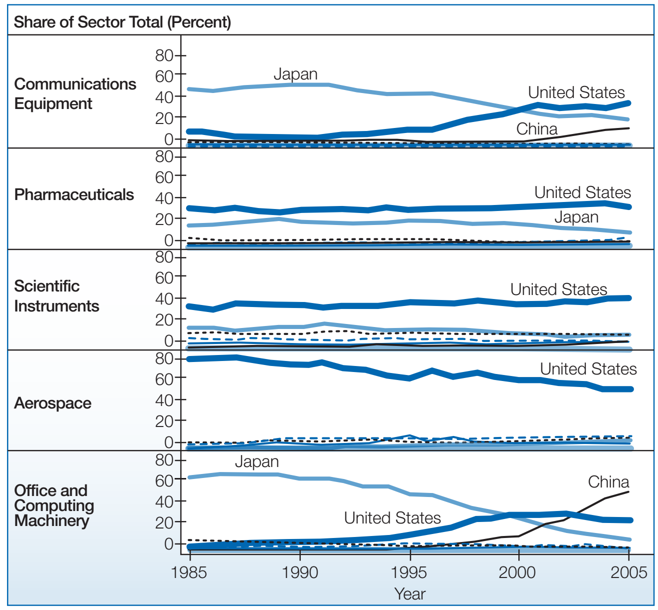


Figure 19.2. Value-added revenue in the five high-tech manufacturing sectors, selected countries: 1985 – 2005



SOURCE: Appendix Tables 6-10 and 6-11, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- Policies in many countries reflect beliefs that investment in science and technology (S&T) supports industry's competitiveness in international trade.
- The OECD has identified 10 industries that have a particularly strong linkage to S&T.

Key Observations

- The United States has the highest value-added revenue in all high-tech manufacturing sectors except office and computing machinery.
- China's share of high-technology manufacturing revenue has more than quadrupled during the past decade. Estimates for 2005 show China accounting for 16% of world value-added revenue, making it the third-ranked country globally.
- Japan is ranked second globally in high-technology manufacturing revenue, with 16.1% of world value-added revenue. Its world share in these industries fell sharply from 30% in 1989 to this 2005 estimate.

Related Discussion

- High-technology industries are driving growth in manufacturing activity worldwide. Between 1986 and 2005, the growth rate of high-technology industries was more than double the rate of other manufacturing industries (*SEI 2008* Chapter 6).
- U.S. manufacturing has become more technology-intensive, with the high-technology share of manufacturing industries increasing from 14% in 1990 to 24% in 2005 amidst rising overall manufacturing revenues (*SEI 2008* Figures 6-12 and 6-13).

The United States continues to lead in all three market-oriented, knowledge-intensive service industries.

Figure 20.1. World share of value-added revenues for market-oriented knowledge-intensive services, selected countries: 1985 – 2005

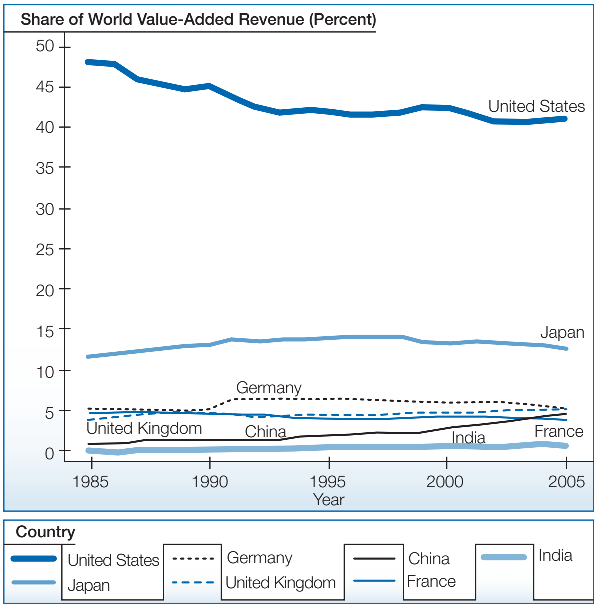
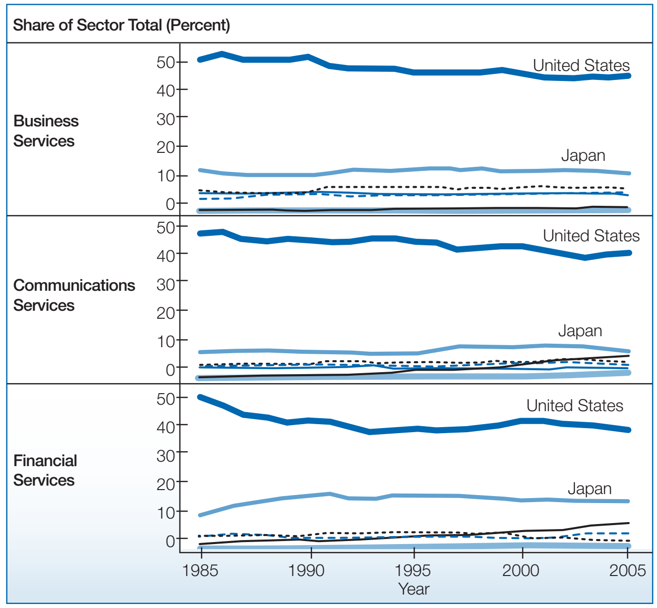


Figure 20.2. Value-added revenue in the three market-oriented knowledge-intensive sectors, selected countries: 1985 – 2005



SOURCE: Appendix Tables 6-4 and 6-5, *Science and Engineering Indicators 2008*, National Science Foundation.

Why is this indicator important?

- The U.S. economy and the economies of other developed countries are increasingly dominated by service industries. U.S. market share in these industries is an indicator of its competitiveness.

Key Observations

- The U.S. share of world market-oriented knowledge-intensive service value-added revenue remained constant at around 40% between 1995 and 2005.
  - While the U.S. share of business and financial service revenue remained constant or increased between 1996 and 2005, the U.S. share of communications services revenue declined from 42 to 39% between 1996 and 2005.
- China's financial services sector has historically been that country's highest grossing market-oriented, knowledge-intensive sector, accounting for 8% of the world financial services value-added and ranking third behind Japan's financial services sector in 2005.
  - China's communications service industry grew at an average annual rate of nearly 20% between 1995 and 2005, reaching 7% of the world communications service value-added in 2005.

Related Discussion

- The service sector is driving economic activity around the world, accounting for nearly 70% of global economic activity in 2003 (*SEI 2008* Figure 6-5).
- Market-oriented , knowledge-intensive services are driving the growth in the service sector, accounting for 30% of gross service revenue in 2005, with an average annual growth rate of 4.8% between 1986 and 2005 (*SEI 2008* Table 6-4).

Glossary

Budget function: One of 20 broad categories that classify activities covered by the federal budget, including R&D. An agency's activities are not necessarily included in only one function. Instead, the programs of one agency typically are distributed across functions, and each function often includes programs from multiple agencies.

Commerce: United States Department of Commerce

DoD: United States Department of Defense

DOE: United States Department of Energy

EPA: United States Environmental Protection Agency

FFRDC: Federally Funded Research and Development Center

G7: Group of Seven, the world's largest industrial market economies: the United States, Japan, Germany, France, Britain, Italy and Canada

GDP: Gross Domestic Product. The market value of all final goods and services produced within a country within a given period of time

HHS: United States Department of Health and Human Services

High-technology manufacturing industries: Five manufacturing industries, identified by OECD, that have particularly strong linkages to science and technology, consisting of aerospace, communications equipment, office machinery and computers, pharmaceuticals, and scientific instruments.

Homeland Security: United States Department of Homeland Security

ipIQ: Private company specializing in patent analysis, http://www.ipiq.com

Knowledge-intensive services: Five service industries, identified by OECD that have particularly strong linkages to science and technology, consisting of business, financial, communications, education, and health services. **Market-oriented knowledge-intensive services:** Those knowledge-intensive service industries that are commercially oriented, consisting of business, financial, and communications services

NASA: United States National Aeronautics and Space Administration

NCES: National Center for Education Statistics, United States Department of Education

NIH: United States National Institutes of Health

NSB: National Science Board (Board)

NSF: National Science Foundation

OECD: Organization for Economic Co-operation and Development. Member countries include Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States

Productivity: The efficiency with which resources are employed within an economy or industry, measured as labor productivity. Labor productivity is measured by change in GDP or output per unit of labor.

PPP: Purchasing Power Parities. The exchange rate required to purchase an equivalent market basket of goods.

R&D: Research and Development

S&E: Science and Engineering

S&T: Science and Technology

SEI: Science and Engineering Indicators

SRS: Division of Science Resource Statistics, National Science Foundation

Transportation: United States Department of Transportation

Triadic patents: Triadic patent families refer to inventions that have sought patent protection in the world's three largest markets: the United States, the EU, and Japan.

UIS: UNESCO Institute for Statistics

UNESCO: United Nations Educational, Scientific and Cultural Organization

USPTO: United States Patent and Trademark Office

USDA: United States Department of Agriculture

Value-added revenue: Gross revenue minus the cost of purchased domestic and foreign inputs and materials.

Appendix: Detailed Catalog of S&E Indicators: 2008 Topics

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Chapter 4. Research and Development: National Trends and International Linkages
Chapter 5. Academic Research and Development
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Chapter 7. Science and Technology: Public Attitudes and Understanding

Cover Credits

The cover for *Digest of Key Science and Engineering Indicators 2008* celebrates the 2007–09 International Polar Year with a montage including photographic images from the polar regions. At the center is an ice cave at Loudwater Cove, on Anvers Island. Arcing above it and to the left are smaller images showing (counterclockwise): a team of seal researchers in Antarctica by the light of research vessel Laurence M. Gould; the elevated station and flags of the original 12 Antarctic Treaty signatory nations, reflected on the ceremonial pole at Amundsen-Scott South Pole Station, and a sundog caused by diffraction of ice crystals; an Emperor penguin dives through a hole into the water below the McMurdo Sound sea ice; Aequorea aequorea jellyfish, illuminated by bioluminescence; a cable protruding from the ice wall at Explorer's Cover, New Harbor, McMurdo Sound, used for Remotely Operable Micro-Environmental Observatory (ROMEO), an underwater camera; Diplulmaris Antarctica jellyfish, floating with the current just offshore of McMurdo Station, Ross Island *(Credit, ice cave: Zenobia Evans, National Science Foundation (NSF); Credits for images counter clockwise: Steve Trumble, NSF; Scott Smith, NSF; Emily Stone, NSF; Dr. Osamu Shimomura, Marine Biological Laboratory, Woods Hole, MA; Steve Clabuesch, NSF; Steve Clabuesch, NSF).*

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