2

25 Years of the AAAS Report: Historical Perspectives of R&D in the Federal Budget

Kei Koizumi, AAAS

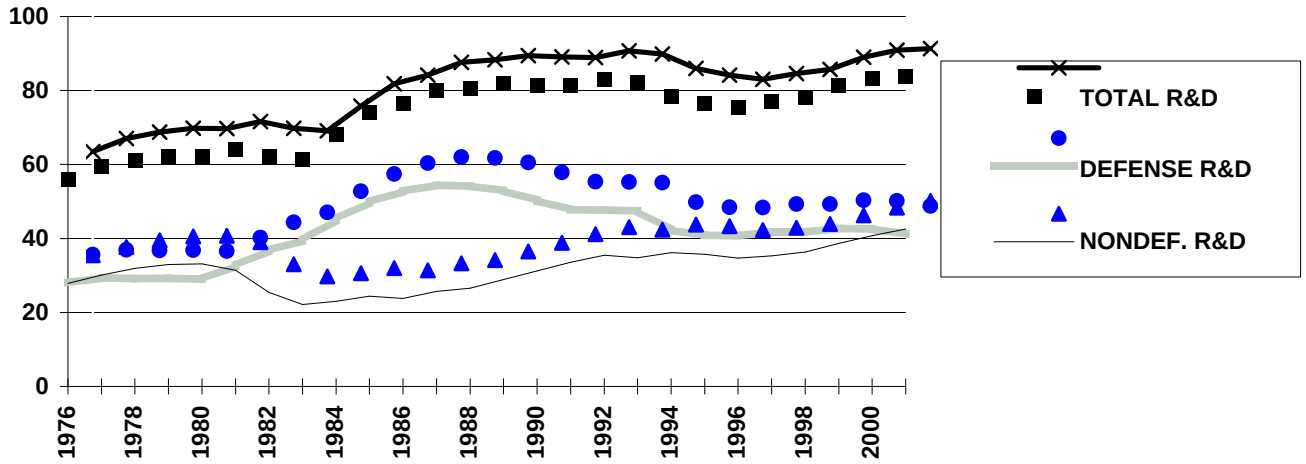
In 1976, AAAS published its first report on research and development in the federal budget, focusing on the President's proposals for R&D in FY 1977. This year's edition of the report marks the 25th in the series, and in commemoration this chapter examines selected historical trends in R&D funding over the past 25 years to illuminate briefly some significant historical trends in the U.S. R&D system, with the aim of providing useful historical context for the analyses of the FY 2001 budget that make up the remainder of this report.

TRENDS IN FEDERAL R&D, FY 1976-2001

Total federal R&D would be at an all-time high in inflation-adjusted terms in FY 2001 if the President's proposal is approved. As Figure 1 shows, the trend over the 25 years of the AAAS report has been of increasing federal support of R&D, from less than $60 billion in today's dollars in FY 1976 to $85 billion in the President's proposal. The path between these two points, however, has been far from smooth, and significant upheavals in federal R&D funding have taken place during this time period. (See Table I-16 for a condensed look at historical data on federal R&D, compiled from 25 years of AAAS reports; the full version is on line at the AAAS R&D web site.)

Defense and nondefense R&D have followed divergent paths during the past 25 years, and have tended to move in mirror images of the other. In FY 1976, defense and nondefense R&D were roughly equal shares of the federal R&D portfolio and, after diverging in FY 1982, only in FY

Figure 1. Trends in Federal R&D, FY 1976-2001
in billions of constant FY 2000 dollars



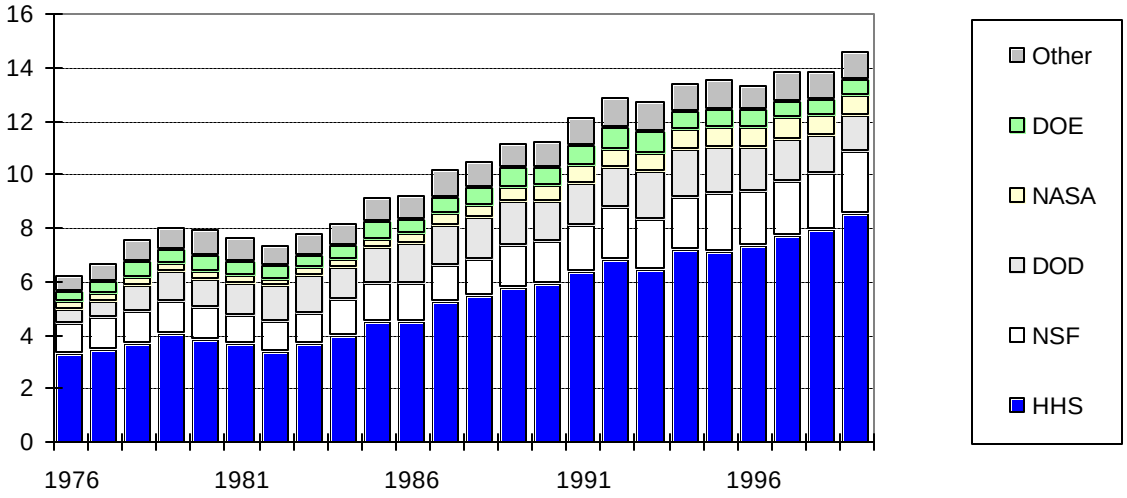
Source: AAAS analyses of R&D in AAAS Reports VIII- XXV. FY 2001 figures are President's request; FY 2000 figures are latest estimates.
MARCH '00 REVISED

2001 would their funding levels converge to once again make up roughly equal shares.

For defense R&D, the most significant trend of the past three decades, as seen in Figure 1, has been the dramatic Reagan-era buildup of defense R&D followed by equally dramatic post-Cold War cutbacks. From FY 1980 to its peak in FY 1987, defense R&D nearly doubled in real terms as the U.S. embarked upon a substantial increase in all forms of defense spending, motivated by high Cold War tensions with the Soviet Union and emerging technological opportunities such as the Strategic Defense Initiative. By FY 1987, defense R&D was two-thirds of total R&D, but funding fell dramatically from that peak funding level even before the end of the Cold War. The slide accelerated in the 1990s as the Department of Defense (DOD) and the defense activities of the Department of Energy (DOE) made a rough transition to the post-Cold War era. This decline was matched by declining defense spending overall as the military struggled to redefine its missions for a one-superpower world. Defense R&D is currently one-third below the peak funding levels of the late 1980s, and although there have been selected increases in defense over the past few years, concentrated in the areas of DOE stockpile stewardship R&D, the Ballistic Missile Defense Organization (successor to the Strategic Defense Initiative), and basic research, even the most ambitious defense hawks do not foresee a defense budget returning to peak Cold War levels in the future.

For nondefense R&D, the past 25 years have been a series of fluctuations, as shown in Figure 1. In the Carter Administration, nondefense R&D (especially DOE's energy R&D) was a priority and increased, but the Reagan Administration pushed through steep cuts in its first three years of office that reduced nondefense R&D excluding the National Institutes of Health (NIH) by a quarter. Once nondefense R&D hit bottom in FY 1983, however, Reagan and Congress worked together to gradually increase investments. Following the 1986 Challenger space shuttle disaster, NASA R&D increased dramatically as development of a replacement shuttle became a high priority, and in the Bush Administration growing nondefense discretionary spending helped to fuel more rapid increases in a broad range of nondefense R&D programs. During this time, increasing attention to and congressional support of biomedical research ensured steady growth of NIH R&D.

Figure 2. Federal R&D Funding to Colleges and Universities FY 1976-99
Obligations by agency in billions of constant FY 2000 $



Source: AAAS, based on NSF, Survey of Federal Support to Universities, Colleges, and Nonprofit Insitutions, FY 1997, 1999. FY 1998 and 1999 data are preliminary estimates based on Federal Funds survey of agencies. R&D includes research, development, and R&D facilities support.

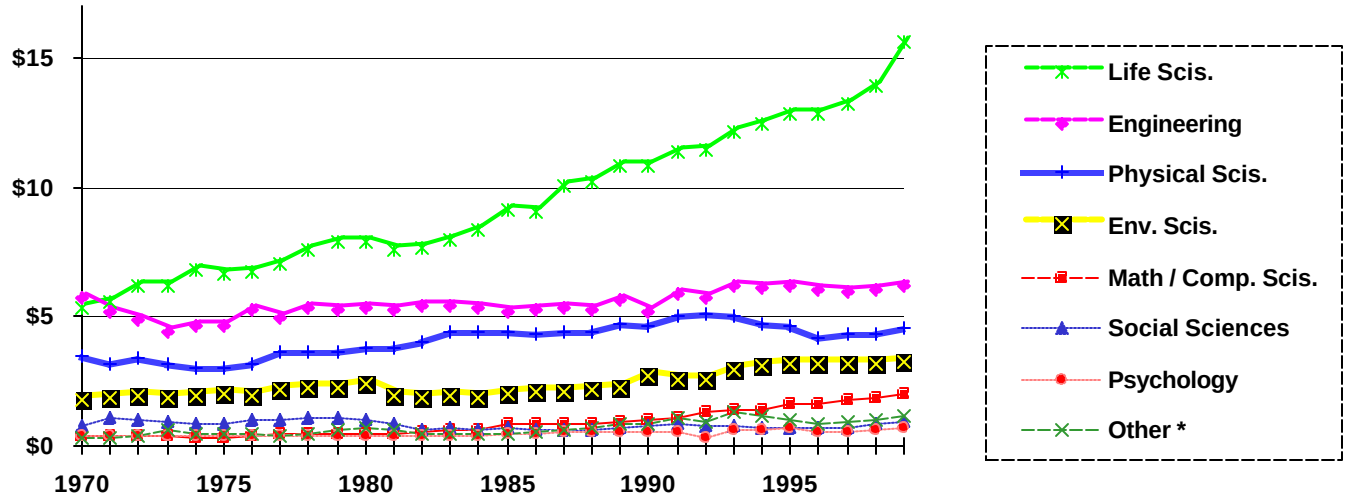
Lurking underneath these increases and decreases, however, were budget deficits, which ballooned under the Reagan Administration's defense buildup and tax cuts. The rapid increase in budget deficits and consequent explosion of the national debt left a tough challenge for the Bush and Clinton Administrations and the Congresses of those times. In the 1990s, reducing and then eliminating the federal budget deficit came to dominate budget politics, and it became clear that in addition to tax hikes, defense spending cuts, and entitlement program changes, some cuts in nondefense discretionary programs would be necessary to achieve the goal. Growth in nondefense discretionary spending slowed in the early 1990s. Nondefense R&D peaked in FY 1994 and then declined as tight discretionary spending limits, designed to help rein in deficits, took their toll on R&D programs. In FY 1998, however, mostly because of unexpected economic growth and surging tax revenues, the federal government recorded its first budget surplus in thirty years; the restrictive spending limits were loosened. Consequently, nondefense R&D has increased for the past few years and would reach parity with defense R&D again in FY 2001.

R&D IN COLLEGES AND UNIVERSITIES

In contrast to the ups and downs of federal funding for defense R&D and nondefense R&D, federal R&D funding to colleges and universities has increased steadily over the past 25 years with only minor interruptions. As Figure 2 shows, in real terms federal support of academic R&D has more than doubled in the past 25 years, with a fairly steady progression upward. The only exceptions are slightly declining funding in the early 1980s as a result of the aforementioned steep cuts in nondefense R&D in the early days of the Reagan Administration and stagnant funding in the mid-1990s because of deficit reduction pressures.

The relatively smooth upward trend is due to two important factors. The first is that the majority of federally funded basic research is performed in the nation's colleges and universities, and basic research has steadily increased as a share of the federal R&D portfolio. In FY 1980, basic research was 14 percent of the federal R&D portfolio, rising to 17 percent by FY 1990 and 24 percent by FY 2001 (see Table I-5). This steady increase in basic research's importance has smoothed out fluctuations in overall funding of R&D.

Figure 3. Trends in Federal Research by Discipline, FY 1970-1999
obligations in billions of constant FY 2000 dollars



Source: National Science Foundation, Federal Funds for Research and Development FY 1998, 1999, and 2000, 1999. FY 1999 data are preliminary. Constant-dollar conversions based on OMB's GDP deflators.

* - Other includes research not classified
(includes basic research and applied research; excludes development and R&D facilities)

The second reason is that the majority of federal academic R&D is sponsored by the National Institutes of Health (NIH), and NIH has won steady increases in its budget for the past three decades even as other agencies' R&D budgets have fluctuated. Figure 2 shows steady growth in Department of Health and Human Services (HHS) support of academic R&D, nearly all of which comes from NIH. Because more than 60 percent of all federal support for academic R&D now comes from NIH, growth in the NIH budget has resulted directly in growth in academic R&D.

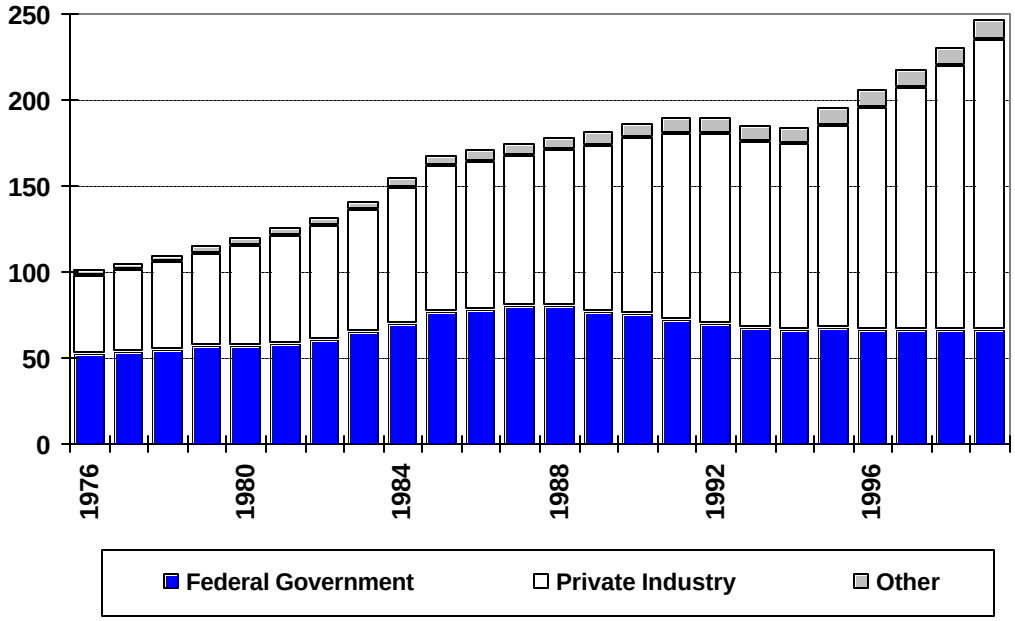
The growth in federal support for academic R&D has been matched by growth in academic R&D funded by other sources. The share of total academic R&D funded by the federal government has actually declined in the past 25 years from 67 percent to the current ratio of 59 percent, meaning that universities have managed to tap even faster-growing sources of R&D support. Although one of these sources is universities' own funds, which have grown from 12 percent to 19 percent of total academic R&D over the past 25 years, industry support of academic R&D has grown from 3 percent to 7 percent of the total, representing a nearly 7-fold increase in inflation-adjusted dollar terms.

In sum, for colleges and universities growth in federal funding and growth in funding from other sources have smoothed out the rough transitions experienced by other R&D performers. Their total performance of R&D has nearly tripled in real terms during this time period, and the future looks equally bright as the federal portfolio continues to shift toward basic research and increased NIH support, and as industry support of academic R&D continues to grow.

FEDERAL RESEARCH BY SCIENCE AND ENGINEERING DISCIPLINE

Steady growth in the NIH budget over the past 25 years has had a striking impact on the federal research portfolio by science and engineering (S&E) discipline. As shown in Figure 3, federal support for research in the life sciences, of which nearly three-quarters comes from NIH, has expanded dramatically over the past three decades and now makes up a near-majority of the federal research portfolio compared to less than a third in the early 1970s. (This figure looks at research only; development and R&D facilities are not classified by S&E discipline.)

Figure 4. U.S. R&D Funding by Source, 1976-1999
Expenditures in Billions of Constant 1999 Dollars



Source: National Science Foundation, *National Patterns of R&D Resources: 1999 Data Update* (Data for 1998 and 1999 are preliminary.)

By contrast, federal support for most other S&E disciplines has remained relatively flat over the past few decades. Support for the engineering sciences, which used to make up the largest part of the research portfolio in the 1960s, has remained steady for the past three decades. Support for the physical sciences increased until the early 1990s because of their strong contribution to Cold War defense needs in DOD and DOE, but in the post-Cold War era support has declined dramatically. Other disciplines have grown over the last 25 years, but from smaller bases, making their impacts on the total portfolio hard to notice: environmental sciences research declined in the early 1980s because of Reagan Administration cutbacks, but has increased since then. Mathematics research and computer sciences research, though still small parts of the portfolio, have expanded dramatically, especially as the computer sciences have become more visible and more important in the civilian economy.

This dramatic growth for the life sciences combined with flat or declining funding in most other disciplines has resulted in increasing concern within the science and engineering communities that the federal portfolio has become unbalanced. In response to this concern, the FY 2001 budget proposal calls for further increases for NIH, but larger increases to R&D programs in other agencies whose support is key to non-life sciences disciplines, including NSF, DOE, and NASA, in an attempt to narrow the growing gap between life sciences and all other disciplines.

FEDERAL AND INDUSTRY R&D: TOTAL U.S. R&D

There has been a remarkable shift in the composition of total U.S. R&D over the past 25 years, as shown in Figure 4. Back in 1976, the federal government was still the dominant supporter of R&D in the United States as it had been for the entire post-World War II era, while U.S. industrial firms were steadily but slowly increasing their investments in privately funded R&D. In 1980, however, industry support of R&D exceeded federal support of R&D for the first time because of stagnating federal support combined with accelerated growth in industry support. Since then, industry support of R&D has grown dramatically, but federal support of R&D has actually stagnated or declined in real terms after peaking in the mid-1980s as a result of post-Cold War cutbacks, mostly in defense R&D.

Now, industrial firms funds two-thirds of total U.S. R&D (68.5 percent in 1999; see Table I-13), nearly three times the federal investment (26.7 percent in 1999; see Table I-13). The federal share is shrinking fast as industry expands its R&D investments far faster than the growth rate of the economy as a whole, due to a favorable economic climate in the 1990s and also due to the increased emphasis on technology as an element in economic competition. These trends are expected to continue well into the new century. The federal government, by contrast, has been lucky to see its R&D investments stay even with inflation in recent years because of tight budgets within a general atmosphere of fiscal restraint.

Thus, times have changed from the first edition of the AAAS Report on R&D in 1976, when the opening lines could say "The federal government holds most of the high cards which determine the thrust and priorities of scientific research and development effort in the United States." In the R&D environment of the 25th edition of the report in 2000, it may be more accurate to replace "federal government" with "U.S. industry." The federal government still plays a strong role in funding academic R&D, basic research, and funding R&D for national missions, and thus plays an irreplaceable role in educating future scientists and engineers, exploring the frontiers of knowledge, finding solutions to national problems, and seeding knowledge for the industries of the future. But the near-term economic competitiveness of U.S. firms, progress on today's technological frontiers, and the overall health of the increasingly technology-based U.S. economy are today far more dependent on U.S. industrial firms' R&D efforts than could have been imagined 25 years ago, and the overall health of the U.S. R&D enterprise is far more dependent on private industry than when the first edition of this report was published.