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Federal R&D in the FY 2006 Budget: An Introduction

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AN OVERVIEW OF R&D IN THE FY 2006 BUDGET

On February 7, 2005, President Bush released his proposed budget for fiscal year (FY) 2006. Against a backdrop of record-breaking federal budget deficits, a continuing and costly war in Iraq, an expansion of Medicare to pay for prescription drugs, and expensive proposals to introduce private accounts for Social Security in the future, the federal investment in research and development (R&D) would barely grow in FY 2006, with cuts to R&D programs outnumbering increases. In order to restrain the budget deficit, the President proposes to hold nondefense discretionary spending flat for the third year in a row; after factoring in increases for international aid and homeland security, domestic non-security spending overall would actually fall by 1 percent. Defense spending would increase modestly compared to previous years, but the true picture is uncertain because the budget excludes funding for the Iraq war. Federal R&D investment mirrors these overall trends, with flat funding for defense R&D and increases for homeland security and space exploration R&D, offset by cuts for most other R&D programs.

- **The proposed federal R&D portfolio in FY 2006 is $132.3 billion, just barely an increase of 0.1 percent or $84 million above this year**, and far short of the 2.0 percent increase needed to keep pace with expected inflation (see Table II-1). In real terms, the total federal R&D portfolio would decline for the first time since 1996. Increases for space exploration R&D in the National Aeronautics and Space Administration (NASA; up $508 million) would far exceed the $84 million increase, leaving all other R&D programs (including defense) with less money next year.

- **The nondefense R&D investment would barely increase 0.2 percent to $56.9 billion** (see Table II-1). While NASA would receive additional resources for the International Space Station and moon-and-Mars missions, nearly all other R&D agencies would see their funding decline.

- The National Science Foundation (NSF), after a cut in its budget in 2005, would see a modest increase of 2.8 percent to $4.2 billion for its R&D portfolio, but most of the increase would go to R&D facilities (see Table II-1 and Figure 1). As a result, the average NSF research grant would shrink for the second year in a row. The National Institutes of Health (NIH) budget, after doubling in the five years between 1998 and 2003, would see an increase of just 0.5 percent in FY 2006 to $28.7 billion. NIH projects a decline in the number of research project grants for the second year in a row and a decline in the research project grants (RPG) success rate for the fifth year in a row down to 21 percent.

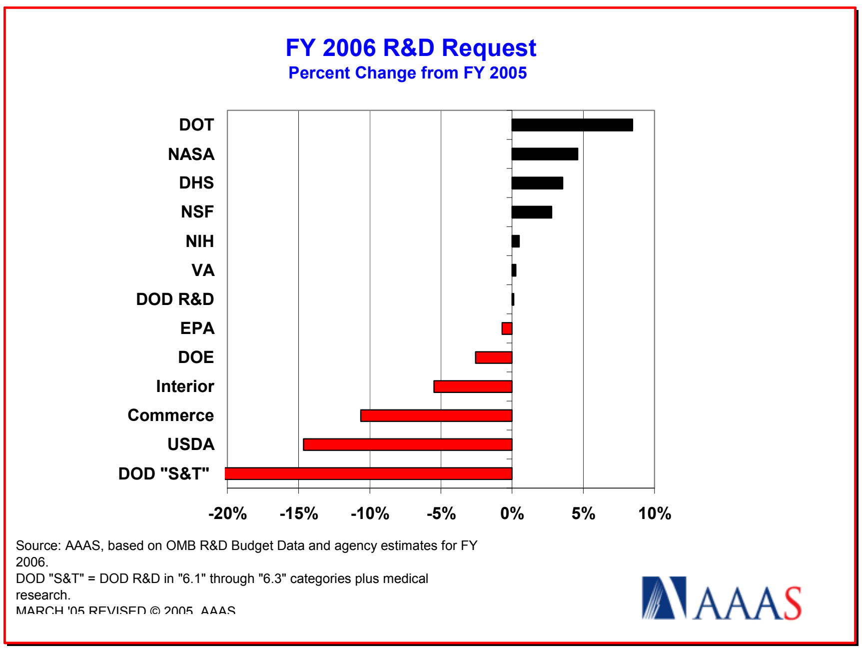

Figure 1.

- Other agencies in the federal R&D portfolio would see cuts in 2006, consistent with Administration plans to cut nondefense, non-homeland security spending (see Figure 1 and Table II-1). The Department of Energy's (DOE) Office of Science would see its R&D funding fall 4.5 percent to $3.2 billion. Environmental R&D would decline across the board, including cuts to R&D in the U.S. Geological

Survey (USGS; down 4.8 percent to $515 million), the National Oceanic and Atmospheric Administration (NOAA; down 11.2 percent to $565 million), and the Environmental Protection Agency (EPA; down 0.7 percent to $568 million). The U.S. Department of Agriculture (USDA), enjoying a record R&D portfolio in 2005, would see its R&D funding decline 14.6 percent to $2.1 billion.

- **There would be tough budgetary choices even in agencies with increasing budgets**. At NASA, a 4.6 percent boost in R&D funding to $11.5 billion would still require steep cuts in aeronautics and earth sciences research and the cancellation of a Hubble servicing mission to pay for NASA's ambitious space exploration plans and resumed construction of the Space Station. Although DOE's energy R&D portfolio would climb 3.2 percent to $1.2 billion because of increased investments in hydrogen, nuclear energy, fuel cells, and coal, DOE would eliminate R&D on gas and oil technologies and sharply reduce funding for other areas.

- For the first time in a decade, defense R&D would be subject to fiscal restraints. **Defense R&D would fall slightly by $16 million to $75.4 billion**, after multi-billion dollar increases for each of the past five years (see Table II-1).

- **Federal homeland security-related R&D would total $4.4 billion in FY 2006**, a gain of $208 million or 4.9 percent that represents a leveling off of the federal investment after dramatic recent increases (see Table I-6).

- The **total federal investment in research (basic and applied research) would fall 1.4 percent to $55.2 billion because of cuts in both defense and nondefense research** (see Table II-1). Although NASA (up 11.6 percent to $5.4 billion) plans a large increase in its research portfolio, other agencies would face steep cuts. DOD support of basic and applied research would fall 18.1 percent down to $5.6 billion because of the proposed elimination of earmarks and cuts in core research. USDA, DOE, Interior, and Commerce support of research would all fall. NIH would support the majority of the federal research effort for the first time in FY 2006, but its research portfolio of $27.8 billion would increase only 1.2 percent, far below increases in previous years. NSF research funding would increase 1.2 percent to $3.7 billion next year, but would remain below FY 2004 funding levels.

- Funding for all three multi-agency R&D initiatives would decline in FY 2006 (see Table I-9). After a nearly $100 million increase this year, **National Nanotechnology Initiative** (NNI) funding would fall 2.5 percent to $1.1 billion, well short of amounts authorized in the Nanotechnology R&D Act signed into law in December 2003. Funding for the **Networking and Information Technology R&D** (NITRD) initiative would decline 4.5 percent to $2.2 billion. The **Climate Change Science Program (CCSP)** would see its funding fall 1.4 percent to $1.9 billion, primarily because of steep cuts in NASA's contributions in space-based observations of the environment. (For more on the NNI, see Chapter 24; for more on NITRD, see Chapter 23; for more on CCSP, see Chapter 16.)

(Details of R&D in the largest R&D funding agencies can be found in Chapters 6 through 13.)

THE ROLE OF R&D IN THE U.S. INNOVATION SYSTEM

Science and technology are recognized as key drivers of economic growth, as well as improved health and quality of life in the United States and throughout the world. Economists estimate that up to half of U.S. economic growth over the past five decades is due to advances in technology. A study of recent U.S. patents released several years ago found that nearly two-thirds of the papers cited in these patents were published by researchers at organizations supported by federal funds—and these linkages have been growing at an accelerating pace.

Recent advances in genetics and biotechnology, as well as computers and information technology, have raised public awareness of the vital economic role of research-based technology. High-tech industry is sought after by economic development organizations in virtually every state and locality. Policymakers regard universities as catalysts for high-tech economic development both through entrepreneurial activity that spins off from their research and through the concentrations of highly trained human resources they attract and generate. The federal government plays a central role in research in the nation's universities.

R&D is a substantial and growing enterprise in the United States. All in all, the U.S. invested an estimated $284 billion in R&D in 2003. This represented 2.6 percent of the nation's Gross Domestic Product (GDP). The largest share of this money (63 percent) came from industrial firms.

Most of the balance (30 percent) came from the federal government. Colleges and universities, private foundations, other nonprofit institutions, and state and local governments provided the remainder. Industry's share of national R&D funding has been growing steadily for several decades (see Chapter 4 for more information on industry support of R&D). From the end of World War II to 1980, the federal government supported the largest share of the nation's R&D.

Despite its relatively modest share of total U.S. R&D funding, the federal government's role is critical to the nation's science and technology enterprise. Federal agencies support a majority of the nation's *basic* research and 58 percent of the R&D performed in U.S. colleges and universities. Basic research is the primary source of the new knowledge that ultimately drives the innovation process. At the same time, federally funded research at colleges and universities plays a key role in educating the next generation of scientists and engineers. Federal applied research and development programs also provide direct support for key government missions, such as improving the nation's health and medical care, exploring space, and national security.

R&D IN THE FEDERAL BUDGET

Although the President's budget presentation each year generally contains a section devoted to R&D and a number of tables summarizing proposed federal R&D expenditures, it is important to recognize that *there is no overall "R&D budget"* and no special treatment for R&D within the budget.

Expenditures for R&D programs are regular budget items. They are contained, along with other types of expenditures, within the budgets of more than 20 federal agencies and departments as shown in Table II-1. For some of those agencies, such as NSF, NASA, and NIH, R&D is a dominant activity. For others, such as the Department of Housing and Urban Development (HUD), it is a small part of a much larger set of programs. Some R&D programs are "line items" in the budget and are relatively easy to identify as R&D. Others are included within larger line items and are more difficult to ferret out.

Federal R&D expenditures represent 5.1 percent of the overall proposed $2.6 trillion federal budget for FY 2006. Nearly all federal R&D comes from the discretionary budget, the one-third of the budget that is subject to annual appropriations decided by the President and the Congress. (The remaining two-thirds of the federal budget goes to mandatory programs (entitlements) such as Social Security, Medicare, Medicaid, and interest on the national debt. Less than 0.2 percent of the federal R&D portfolio is mandatory spending.) Federal R&D is roughly one out of every seven discretionary dollars (see Table I-3). On the whole, trends in R&D funding have closely followed trends in federal discretionary spending, as shown in Figure 2. Despite the fact that R&D funding trends are the combination of hundreds of different budget decisions that are only aggregated after a budget is done, the trends match almost perfectly on the nondefense side for the past 30 years. On the defense side, R&D has grown as a share of the defense budget over the years as high-tech weapons systems have claimed increasing shares of defense spending.

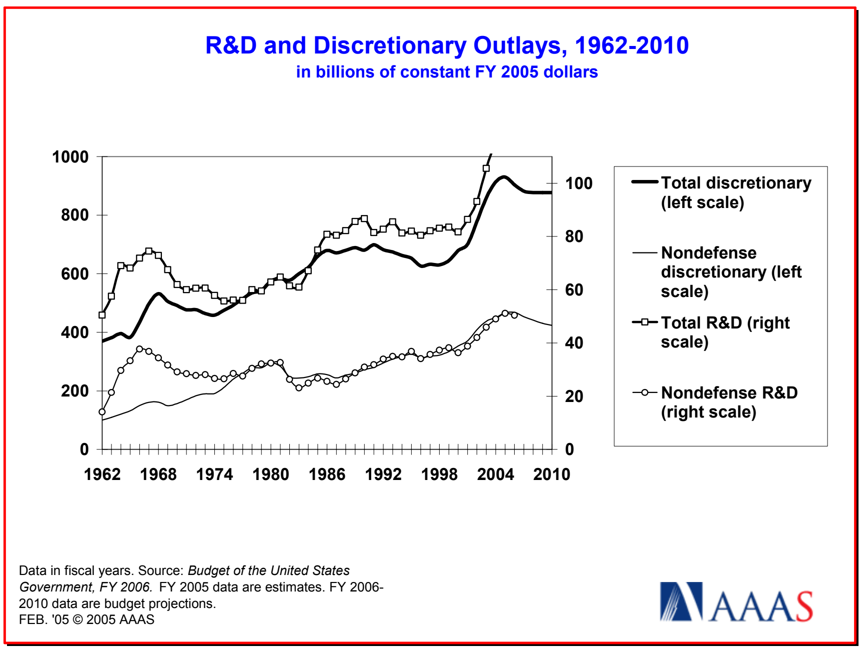

Figure 2.

Growth in overall discretionary spending over the past four decades has allowed federal investment to grow in many areas, including R&D. Efforts to balance the federal budget by cutting discretionary spending during the mid-1990s resulted in reductions in most of these areas, including R&D. Subsequent increases have erased these losses in several agencies and produced significant gains for a few, but the return of budget deficits this decade has resulted in flat to declining discretionary spending in 2005 and the 2006 proposal, mirrored by similar trends in R&D spending.

FEDERAL R&D BY PERFORMER

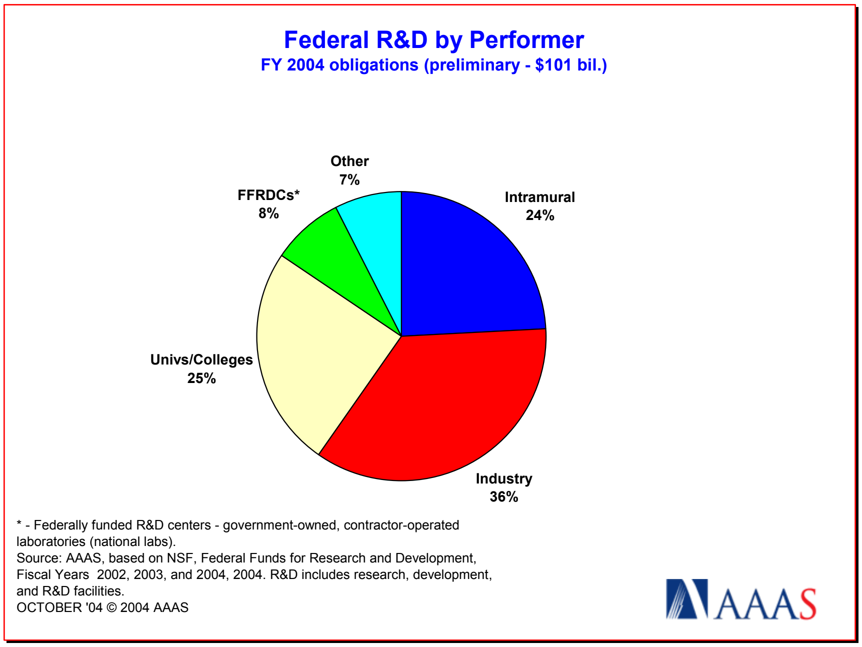

Figure 3.

Although the government maintains several hundred laboratories around the country, only a quarter of federally supported R&D is actually carried out in these labs. The largest share of federally funded R&D is performed by industrial firms under contracts (36 percent of the total; see Figure 3). A quarter is conducted under federal grants in colleges and universities. Other nonprofit institutions perform a small portion, and 8 percent of the portfolio is performed by FFRDCs (federally funded R&D centers) operated by contractors, such as the Department of Energy's (DOE) Oak Ridge National Laboratory in Tennessee, which is operated in partnership by the University of Tennessee and the Battelle Memorial Institute. Although these figures apply to the overall federal R&D portfolio, each federal funding agency has its own mix of performers depending on the agency's mission and historical relationships with performers. The majority of DOD's R&D portfolio is performed by industry, for example, while DOE sends the majority of its R&D portfolio to its network of FFRDCs; nearly all of the NSF portfolio, however, goes to universities.

Altogether, including the research that firms support with their own funds and that which is conducted under government contracts, industry is responsible for performing two-thirds (68 percent) of the nation's total R&D. U.S. academic institutions perform 14 percent, while federal laboratories, nonprofit institutions (research institutes, hospitals, etc.), and FFRDCs perform the remainder.

FEDERAL R&D BY NATIONAL MISSIONS

Most of the federal government's R&D is mission oriented; that is, it is intended to serve the goals and objectives of the agency that provides the funds (*e.g.*, agricultural research in the U.S. Department of Agriculture). Only NSF, whose mission is to support basic and applied research, research facilities, and education across a wide range of science and engineering disciplines, has a primary mission to support science and engineering. For the remaining 97 percent of the federal R&D portfolio, R&D investments are the means to achieve other government ends.

The federal government divides the budget into 20 "functional" groupings to illustrate these national missions, each with a function number.[1] The President's budget and the congressional budget resolution divide the total budget "pie" into functional "slices," which serve as non-binding guides for appropriators in allocating funds to agencies and programs. Viewing the R&D budget by function sheds light on the funding priorities assigned to different areas over time, and allows for international comparisons with other nations' spending on R&D by objective. Table I-4 shows R&D by function in the FY 2006 budget. (Chapter 2 discusses historical trends in federal R&D missions.)

Although there is much talk of homeland security becoming a major new federal mission, in the budget homeland security spending is a category that cuts across spending on traditional government missions such as national defense, transportation, and justice. R&D in the new Department

[1] AAAS separates the general science, space, and technology function (function 250) into its subfunctions of General Science (251) and Space (252). AAAS also counts Department of Veterans Affairs R&D programs in the health (550) function instead of veterans affairs (700).

of Homeland Security (DHS), for example, serves the three missions of defense, justice, and transportation. (See Chapter 12 for more information on DHS.)

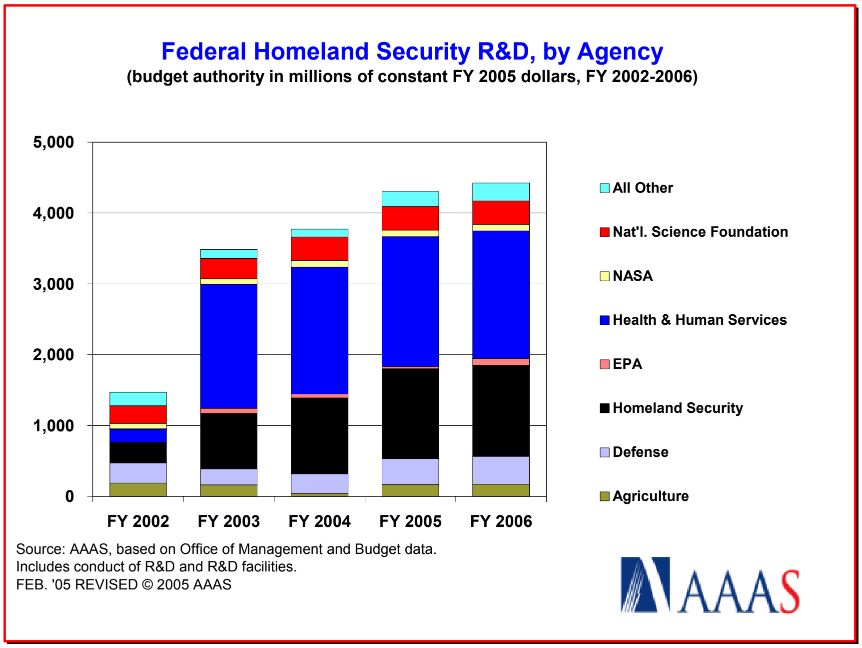

Figure 4.

Federal homeland security-related R&D would total $4.4 billion in FY 2006, a gain of $208 million or 4.9 percent that represents a leveling off of the federal investment after dramatic recent increases (see Table I-6 and Figure 4). The majority of the multi-agency portfolio would remain outside the Department of Homeland Security (DHS), with the largest part of funding coming from NIH for its biodefense research portfolio. NIH's portfolio, mostly in the National Institute of Allergy and Infectious Diseases (NIAID), would total $1.8 billion in FY 2006, up 0.4 percent but with room for an 8 percent increase for biodefense research because of a drop in laboratory construction funding. After annual increases greater than 20 percent in the first few years of its existence, growth in the DHS R&D portfolio would level off with an FY 2006 request of $1.3 billion, up $44 million or 3.6 percent.

Defense (050) R&D, which includes R&D activities in the Department of Defense (DOD), the defense-related atomic energy activities of the

Department of Energy (DOE), and defense-related programs in the Department of Homeland Security (DHS), has accounted for the majority of R&D for the past two decades. Nondefense and defense R&D almost reached parity in FY 2001, but in the aftermath of the September 11 terrorist attacks defense R&D has climbed sharply.

For the first time in a decade, defense (050) R&D would be subject to fiscal restraints. **Defense R&D would fall slightly by $16 million to $75.4 billion**, after multi-billion dollar increases for each of the past five years (see Table I-4). Department of Defense (DOD) weapons development would see a modest increase overall, but there would be a $1.0 billion cut to missile defense. There would be steep cuts to DOD's S&T (DOD "6.1" through "6.3" plus medical research) programs. DOD S&T would plummet 21 percent down to $10.7 billion, falling far short of the goal of 3 percent of the overall DOD budget at just 2.54 percent. DOE's weapons-related R&D would fall 2.6 percent, including cuts to inertial confinement fusion and advanced computing research. (See Chapter 6 for more on DOD; see Chapter 9 for DOE's defense R&D).

Health (550) R&D would continue to be the dominant mission on the nondefense side as a result of the now-completed campaign to double the NIH budget between FY 1998 and FY 2003. Health-related R&D would total $29.9 billion in FY 2006, barely an increase of 0.2 percent coming after nearly 15 percent increases annually from 1999 to 2003. Health R&D would make up a majority of the nondefense R&D portfolio and 22.6 percent of the total R&D portfolio.

Space (252) R&D would continue to be a beneficiary of the Bush Administration's January 2004 announcement of a space exploration vision to return humans to the Moon within the next decades and then possibly on to Mars. In FY 2006, NASA's space R&D would increase 5.6 percent to $10.6 billion, with increases for the moon-and-Mars efforts and resumed construction of the Space Station.

R&D funding for most of the other national missions would decline (see Table I-4). There would be steep cuts to commerce R&D (370; down 9.9 percent to $448 million) because of the perennial proposal to eliminate the Advanced Technology Program (ATP) in the Department of Commerce. There would also be steep cuts to environment (450) R&D (down 4.9 percent to $2.1 billion) and agriculture (350) R&D (down 17 percent to $1.7 billion). Environmental R&D would decline because of cuts to a broad portfolio of R&D funding agencies including the Environmental Protection Agency (EPA), the U.S. Geological Survey (USGS), and the National Oceanic and Atmospheric Administration (NOAA). Agriculture R&D would decline because the Administration would not renew congressionally designated research projects.

The 30 percent increase in justice R&D to $1.1 billion would be more apparent than real, because in FY 2006 several transportation-related R&D programs in DHS would shift to the justice-oriented S&T directorate, and therefore shift budget function. Conversely, the drop in transportation R&D would be mostly due to the classification shift.

R&D BY CHARACTER OF WORK

The total federal R&D portfolio is made up of five different kinds of investments, known as the "character of work" of R&D. Within the R&D portfolio, distinctions are made among basic research, applied research, development, R&D facilities construction, and capital equipment for R&D (See Appendix 2 for definitions. AAAS tables combine R&D facilities construction and capital equipment for R&D, often described together as "R&D facilities" or "R&D plant.") Basic and applied research together make up "research", while the two research categories plus development make up "conduct of R&D." Adding in R&D facilities construction and capital equipment results in "total R&D" or "R&D."

The figures shown in Tables I-5 and II-1 represent agencies' best attempts to classify basic and applied research, development, and R&D facilities within their R&D portfolios. The data reported here are imprecise and reflect the agencies' judgments as to how their R&D fits into the definitions for character of work.

The **total federal investment in research (basic and applied research) would fall 1.4 percent to $55.2 billion because of cuts in both defense and nondefense research** (see Table II-1). Although NASA (up 11.6 percent to $5.4 billion) plans a large increase in its research portfolio, other agencies would face steep cuts. DOD support of basic and applied research would fall 18.1 percent down to $5.6 billion because of the proposed elimination of earmarks and cuts in core research. NIH would support the majority of the federal research effort for the first time in FY 2006, but its research portfolio of $27.8 billion would increase only 1.2 percent, far below increases in previous years.

Development would increase 1.6 percent to a record $72.5 billion in FY 2006 because of continuing increases for DOD's development of weapons systems, including national missile defenses, new fighter planes, and an array of other expensive future weapons systems (see Chapter 6 for more on DOD development).

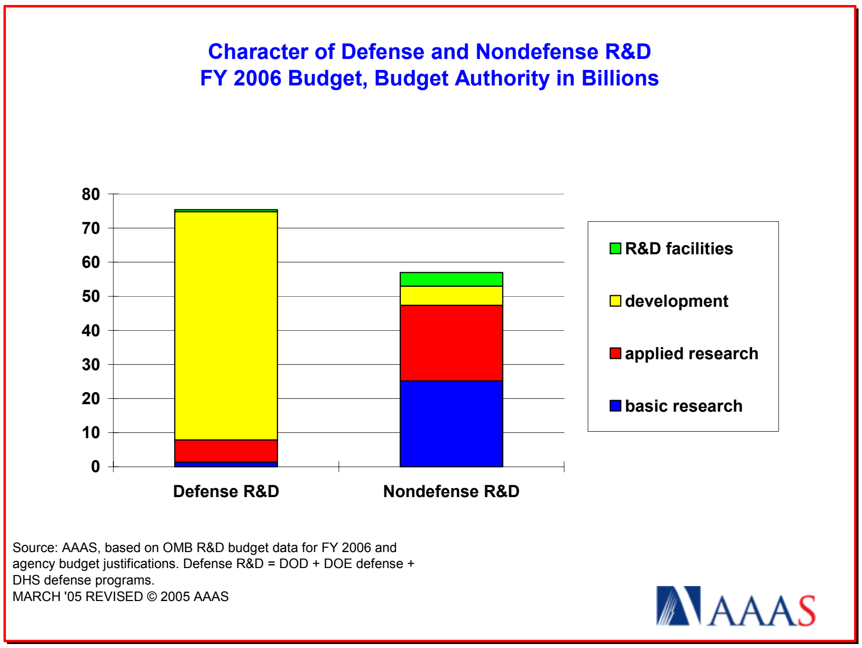

Figure 5.

The character of work is quite different in defense and nondefense R&D, a point illustrated in Table I-5 and Figure 5. Development would be by far the largest component of defense R&D, accounting for 89 percent of the FY 2006 total, while applied research would be 9 percent and basic research would be only 2 percent. In nondefense R&D, by contrast, basic research would be the largest category at 44 percent, with development at only 10 percent and applied research at 39 percent. A major reason for the difference between the character of defense and nondefense R&D is that development in DOD includes testing and evaluation of weapons systems. These activities are extremely expensive compared to other types of R&D. R&D facilities construction and capital equipment costs make up 8 percent of nondefense R&D and 1 percent of defense R&D.

PRIORITY-SETTING FOR FEDERAL R&D INVESTMENTS

Priorities for R&D programs generally depend on the priorities of the agencies in which they are located and the priority of the missions of those agencies. From the standpoint of serving the nation's interests, at least in the short term, this makes good sense, since these R&D programs are not ends in themselves but means to the ends (missions) that their sponsoring agencies serve. From the standpoint of the long-term health of the research enterprise, however, it can cause problems. The mission orientation of R&D programs may make it difficult for policymakers to assess the overall health of the research enterprise, to coordinate programs among different agencies, and to address issues of balance among various scientific and engineering fields and disciplines.

The Office of Management and Budget (OMB), which has overall responsibility for preparation of the President's budget, is able to provide some coordination, although it is hampered by the fact that the agencies that support R&D are treated individually by its different sections in the budget review process. Some coordination also takes place under the National Science and Technology Council (NSTC), an interagency body comprised of cabinet officers and the President. NSTC has organized a number of interagency initiatives in areas of R&D, including global change research, information technology, and nanotechnology. Budgets for three of these initiatives are shown in Table I-9, and are discussed in Chapters 16 (CCSP), 23 (NITRD), and 24 (NNI).

Even the modest level of coordination in R&D in the executive branch is not matched by Congress. Congressional treatment of R&D, like most other aspects of congressional budget and policymaking, is characterized by fragmentation and diffusion of power. R&D programs are considered at two main levels in Congress, that of authorizations and that of appropriations. Authorizing committees (such as the House Science Committee and the Senate Committee on Health, Education, Labor, and Pensions) develop special expertise in the programs they oversee and review the substance of these programs. However, the legislation they prepare does not directly result in spending but only provides guidance and sets appropriations ceilings.

For discretionary programs, including R&D, the power to write the legislation that provides actual spending authority resides in the Appropriations Committees of the House and Senate. These committees were, until this year, each divided into 13 subcommittees, each of which is responsible for a bill that controls one portion of the budget.

Congress will tackle the FY 2006 appropriations process in a newly reorganized committee structure (see Table I-8). In early 2005, both the House and the Senate approved separate restructurings of their Appropriations Committees; instead of 13 subcommittees in each chamber writing 13 appropriations bills, the House shuffled subcommittee jurisdictions to consolidate into 10 subcommittees. The Senate chose 12 subcommittees with jurisdictions similar to, but not identical to, the House. The result could be an appropriations process more protracted and confusing than normal. The federal R&D portfolio would be divided among all 10 House appropriations bills, and 10 of the 12 Senate bills (see Table I-8). As before, four appropriations bills would fund 95 percent of all federal R&D, and the major R&D funding agencies of DOD, NIH, NASA, and DOE would continue to be funded in separate bills. NASA and NSF would move together from the eliminated VA-HUD bill to a Commerce, Justice, and Science bill in the Senate (Science, Commerce, and Justice in the House) to join the Commerce R&D portfolio, while EPA would move from VA-HUD to the Interior bill to join the Department of the Interior.

Table I-8 shows the distribution of R&D funds among the newly reorganized appropriations subcommittees; each subcommittee produces its appropriations bill separately from the others, and each bill is usually signed into law separately, although in recent years several bills have had to be bundled into a single omnibus appropriations bill at the end of the congressional session. The FY 2005 omnibus appropriations bill, for example, contained final versions of 9 regular appropriations bills.

The division of the budget into 10 or 12 appropriations bills limits the extent to which it is possible to coordinate or trade off increases and decreases in agency R&D budgets in the congressional process. For example, three R&D agencies—NSF, NASA, and the Department of Commerce—will come under the jurisdiction of the Subcommittee on Science, Commerce, and Justice. NIH appropriations continue to reside in the Labor, Health and Human Services, and Education subcommittee. This means, for example, that money used for the increase in NASA's budget in FY 2005 did not come from the same pot of money as NIH, although NASA's budget increase was offset with a cut in NSF's budget.

But this system does mean that R&D programs compete with non-R&D programs in the same appropriations bill for limited funds.

THE "FEDERAL SCIENCE AND TECHNOLOGY (FS&T)" BUDGET

Four years ago, the Office of Management and Budget (OMB) introduced a "Federal Science and Technology" (FS&T) budget in the FY 2002 budget, and continues to advance this concept in the FY 2006 budget (see Table I-7). The **FS&T budget** is successor to the Clinton Administration's "21st Century Research Fund" (see previous editions of this report) and contains most of the same programs. FS&T is a collection of selected R&D and non-R&D programs that emphasize basic and applied research and the creation of new knowledge or technologies. It also includes some S&T education and training activities but excludes most development, and is designed to be an alternative measure for the federal investment in science and technology and an alternative way to track federal S&T investments in the budget process. (This FS&T budget has a similar emphasis but different definitions from the FS&T concept proposed in 1995 by the National Academies as a subset of federal R&D; thus, the data in Table I-7 differ from NAS discussions of its version of FS&T in previous editions of this report.)

Because of the tight situation for domestic discretionary programs in the FY 2006 budget, FS&T would fall 1.4 percent to $60.8 billion.

U.S. INVESTMENTS IN AN INTERNATIONAL CONTEXT

In absolute terms, the $284 billion spent on R&D from all sources in the U.S. in 2003, the latest year for which full international data are available, was larger than the total R&D expenditures of Japan, and larger than even the entire European Union combined. The U.S. spent 38 percent of world R&D, a share that has declined only slightly over the past decade even as emerging R&D powers such as South Korea and China have dramatically increased spending (see Figure 6). From tiny amounts in the last decade, China has emerged as a major R&D investor this decade. Adjusting for the much lower costs for R&D talent and equipment there, China is now the third largest R&D performer in the world, behind only the U.S. and Japan.

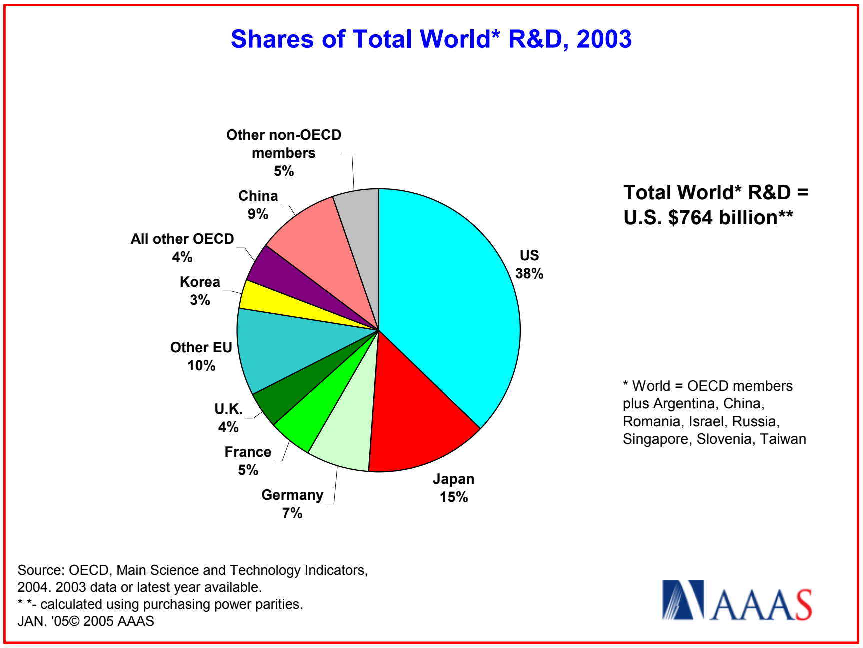

Figure 6.

When one looks at the national R&D expenditures of various countries in relation to the size of their economies, however, the picture is somewhat different. R&D represented 2.6 percent of gross domestic product (GDP) in the United States in 2003. This places the U.S. below Japan (3.1 percent) but above most other major industrialized countries—including the United Kingdom, France, and Germany. Although the EU recently set a goal of attaining an EU-wide R&D investment ratio of 3 percent of the EU economy by 2010, currently the combined EU nations have a R&D/GDP ratio of just 1.9 percent, down significantly from previous figures because of the induction of 10 less research-intensive nations last year. On the other hand, a significant share of the U.S. R&D investment is on the military side, where it has relatively little impact on the civilian economy and U.S. industrial competitiveness. This is very different from the situation in Germany and Japan, which devote only a small portion of their R&D resources to defense. (For more on international R&D, see Chapter 4.)