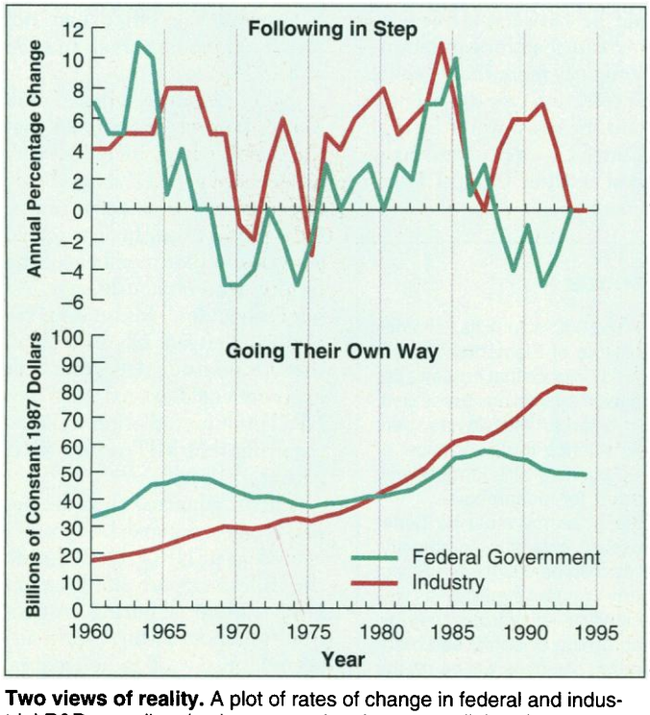
R&D Impact: A Numbers Game?

The partisan debate over how federal policies affect industrial R&D spending is heating up, but the rhetoric and the reality don't always match up

Last month, at a hastily scheduled press briefing in the Capitol during the latest budget battle, Senate Democrats and White House officials made a plea for continued federal support for industry-related research. Holding center stage was a graph—"the most compelling argument I've ever seen," declared Senator Joseph Lieberman (D–CT)—showing that industrial spending on R&D has dutifully followed the rise and fall of federal science spending in the past 35 years. The message was clear and compelling: Republican plans to cut federal R&D by as much as 30% over the next 7 years, according to the Democrats, would have a ripple effect throughout the economy, handicapping U.S. companies in their technological race against global competitors.

The graph, devised last summer by technology professor Christopher Hill of George Mason University in Fairfax, Virginia, and circulated widely throughout the Clinton Administration, is part of the statistical ammunition that Democrats are using to defend their R&D priorities. Their battle plan is based on the idea that companies need a little help from government, especially in areas—a rust-free bridge, for example, or a nonpolluting car—where the potential gains accrue more to society than to corporate bottom lines. Last month's meeting also featured Laura D'Andrea Tyson, the president's top economic adviser, arguing that past investments in research have yielded a 50% rate of return to the country. Her conclusion: Preserve current spending levels. And science adviser Jack Gibbons, citing a report from the Council of Economic Advisers, warned that Japan's government spending on civilian R&D will soon surpass the U.S. total unless Congress rejects the proposed R&D cuts.

The Republicans, for their part, have a different model of how government policy affects R&D spending. They argue that companies will step up their own spending if the government creates the proper regulatory, tax, and economic climate. House Science Committee Chair Robert Walker (R–PA), who has been leading the fight to eliminate about $1 billion worth of federally funded research that benefits industry, told *Science* in an interview earlier this year that "if we got the government off the backs of industry, they would be able to compete [globally]" (11 August, p. 749). There's even a small plot of neutral territory in this battle: Legislators from both parties support a 14-year-old tax credit that they say has helped entice companies to invest more in R&D.



Two views of reality. A plot of rates of change in federal and industrial R&D spending *(top)* suggests that the two are linked (1-year lag built into industry line); trends in actual spending show little correlation.

Despite the strong feelings, experts from government, academia, and industry who follow the debate say that the rhetoric and statistics from both sides should be taken with a grain of salt. "Economists have played with these numbers for a long time, but there are so many variables that it's incredibly difficult to tease out the real impact of one on the other," says David Roessner, a professor of public policy at the Georgia Institute of Technology, about the links between government and corporate R&D spending. Adds John Alic, a former senior associate for industry programs at the now-defunct Office of Technology Assessment (OTA), "There are some pretty good people working on these issues, but the results are not very illuminating." Even the R&D tax credit is on shaky ground as a policy tool, say experts, pointing to studies showing that it has little impact on industry's research spending patterns.

As a result, policy-makers are flying blind, with neither side really knowing the impact of rising or falling federal R&D spending on the nation's overall science and technology effort. One thing is clear, though: Some technology-based projects will have a hard time finding new sponsors if Congress pulls the plug on industrial research programs that have grown rapidly in recent years (see box).

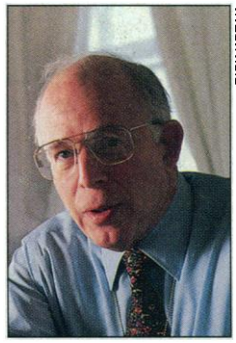
Correlation quandary

While Republicans rest most of their argument on first principles, the White House and congressional Democrats seem determined to make their case with numbers. Exhibit A is Lieberman's favorite chart, which plots year-to-year rates of change in spending by government and industry. It seems to show industry adjusting its R&D spending levels each year to stay in step with federal spending in the previous year. Hill suggests that companies may be positioning themselves to respond to federal initiatives, or that corporate decisions are shaped by public debate on R&D issues. Yet a very different story emerges from a plot of actual spending by the public and private sector, rather than rates of change. It shows that industry has steadily increased its R&D outlays since 1960, including a doubling in the past 2 decades (using constant 1987 dollars). Federal R&D over the same period has been cyclical and has fallen 15% in constant dollars since reaching a peak in the second Reagan Administration.

"Market forces and competition have far more impact on industrial R&D than does federal R&D spending," says Charles Larson, executive director of the Industrial Research Institute (IRI), whose 257 members include the leading U.S. corporate R&D spenders. R&D decisions are part of a company's overall strategy, say analysts, and are made at the highest corporate level without a lot of input from research chiefs. "R&D is at the periphery of a company's spending and planning

projections," says Roessner.

Two other factors also explain corporate R&D's separate trajectory, say analysts. The first is that the federal government's annual budget cycle is too short and the outcome too unpredictable to be used as a basis for corporate policy. The second is that the government's reach into corporate R&D is small: Direct government R&D contracts with industry amount to only about 20% of the total that corporations themselves spend, a share that has declined steadily for 30 years.



RICK KOZAK

Number one. Gibbons wants the U.S. to remain global R&D leader.

Larson and others also point out that industrial R&D isn't monolithic: The aerospace and biotechnology industries, for example, are likely to respond very differently to fluctuations in federal R&D spending. Indeed, many economists believe that any link between federal and corporate expenditures is confined to defense R&D. Not only does federal procurement of specific technologies directly stimulate related corporate R&D, explains William Cox, a senior analyst with the Congressional Research Service, but the hope of obtaining a government contract to build the next weapons system is also likely to spur companies to beef up R&D.

"I'm not surprised that Chris has found a link because of the large role of the military," says economist Linda Cohen of the University of California, Irvine. "That part makes sense. But I would guess that opportunities [for industry to invest] from federally funded basic research in other areas would take many years to show up, if at all."

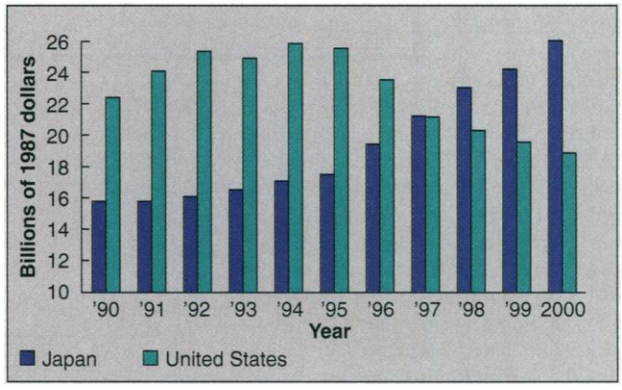
Even if a causal relationship between federal and industrial R&D does exist, some analysts wonder whether it's desirable. "The point of federal subsidies is to go where industry doesn't want to go—to address public goods that the private sector won't support," says Paul Doremus, project director for an OTA background paper issued in September on the research and experimentation tax credit. "I would think that you don't want the two curves to line up, as least not in the same areas."

Hill accepts some of the criticism of his analysis, which has not been submitted for publication, noting that he did not intend it to be a substitute for detailed analyses of different types of spending and across all sectors. But he believes that the graph expresses an underlying truth about the ties between federal and industrial R&D. "The statistical relationship doesn't hold for the past 7 years," he acknowledges, adding that it is also weak during the early 1960s. "But the rates of change move in lock step from the late 1960s to the early 1980s. The strongest claim I'd make is that industry doesn't step in when federal spending goes down."

Gibbons's chart of a surging Japanese R&D budget presents a crisper message: The U.S. government will soon be outspent by its major high-tech competitor if the Republican cutbacks take effect. But even this message becomes murky when held up to the light. One problem is that Gibbons's chart assumes the Japanese are committed to doubling government spending in 5 years, by 2000. In fact, in 1992 the Japanese Cabinet endorsed the idea without setting a target date (*Science*, 8 December, p. 1563). And White House economists concede that the Japanese numbers are not adjusted for what they would buy in the United States. Analysts at the National Science Foundation (NSF), which gathers such data for the government, emphasize the need to use a parity purchasing power index when doing such international comparisons. Applying that formula to existing NSF data on Japan's spending levels would lower the total by roughly one third. Although the adjustment doesn't change the projected trends—up for Japan, down for the United States—it keeps the U.S. government's research budget ahead for several years.

Taking credit?

Democrats and Republicans may be far apart on the need for direct government investment in industrial R&D, but they are in agreement on one issue: The federal government can shape industrial R&D through tax incentives. Here there are some data, but it's equivocal. First passed in 1981 and extended six times, the research and experimentation tax credit is intended to reward companies for spending more on research, excluding capital improvements. Companies have taken advantage of it—$1.6 billion worth of credits were claimed in 1992, the most recent year—although the total has never amounted to more than a few percentage points of overall federal R&D spending.



SOURCE: COUNCIL OF ECONOMIC ADVISERS

What if? Japan's projected lead is based on a promise the government hasn't made and a plan the U.S. Congress may not follow.

After 14 years, the credit has lost none of its popularity: The current long-range budget plan approved by Congress would extend it through 1996, and the Administration would like to make it permanent. But its durability masks what William Morin, vice president of the National Association of Manufacturers, calls "our dirty little secret"—that the tax credit has little or no effect on corporate R&D decisions and is too generic to bolster any one segment of the economy, much less a particular technology. For example, 55% of IRI members surveyed this summer said that the tax credit was "not at all influential" in setting company R&D spending levels.

The recent OTA paper explains why. "The tax credit encourages industry to do more of what it already does," it notes. The law does not reward basic research, it adds, and it discourages shifting funds from one type of research to another. As one staffer for the White House Council of Economic Advisers observes, "The credit is an extraordinarily blunt instrument. It applies equally to donutmakers and microchip manufacturers."

Underlying this debate is the assumption that R&D spending is ultimately good for the economy. But, again, detailed analyses are hard to come by. The House Science Committee's subcommittee on technology is hoping to fill the gap. In September, the panel asked the General Accounting Office to undertake a study of public and private R&D spending that would include a measure of significant outputs—patents, licensing agreements, and so on—that relate directly to R&D investment. "We believe that we need more facts rather than myths about the spending patterns of the industrial and government sectors," says staff director Doug Comer. "We want to know what's happening in specific sectors, past as well as present. There hasn't been a good look at this side of the equation—not the dollars spent, but the value of what comes out."

The absence of hard data is not likely to deter Democrats. At the same time, numbers alone are probably not enough to carry the day. Taking the microphone at the Capitol press briefing, Senator Jay Rockefeller (D–WV) couldn't resist a rhetorical reach of his own. "If we adopt the GOP budget, the next generation of scientists and engineers will be Japanese and Germans, not Americans." Such flourishes make it clear that, despite the numbers being bandied about, decisions about federal R&D programs ultimately will be made on the basis of politics, not statistics.

–Jeffrey Mervis