General Issues in Science Policy Today

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Every year our multiple science communities scrutinize so intently the individual budget trees of their respective fields that I am always concerned that they miss the forest of broader policy issues that affect them all. My intention over the years has been to draw attention to long-term issues and use whatever power my office has to address them apart from the frenzy of the annual budget cycle. I'd like to take this opportunity to remind you of some of those issues and to add one more that deserves your attention. Along the way I'll also share a few observations about the current budget.

First, it is true that government-driven solutions to long-term problems require short-term authorizations, appropriations, and allocations in the budget process. It is also true that the budget process responds to many forces that pull it in different directions. It is all too easy for each of us to believe that the pressures we feel in our own work, research or its sustenance, can be solved by the passage of a bill in Congress—usually one that adds funds that maintain our particular laboratories and research groups. The advocacy that we perform individually or through our institutions or professional societies shapes the actions of government, whose impacts spread throughout society.

Ultimately the science posture of a nation expresses itself in the myriad activities of its scientists and engineers, students and technicians. Such activities may or may not sum to a coherent or effective whole. No law of nature or of politics guarantees that this real-life science *posture* will reflect a sensible science *policy*. The only hope of

coherence in our national science posture is for all the diverse actors to agree on a general direction and give it priority year after year.

Such a consensus has been achieved on some important science policy issues during the past six years. Following the terrorist attacks of September 11, 2001, the science community came together in a remarkable show of unity to support what would obviously be a difficult and protracted struggle against terrorism. My AAAS Policy Forum speeches from 2002 to 2004 featured science and technology dimensions of anti-terrorism, including the creation of a Science and Technology unit within the Department of Homeland Security, and a long list of initiatives to recruit science to the cause of homeland security. I also raised and reinforced concerns about the negative impacts of security measures on the conduct of science, and reported on actions OSTP and relevant departments and agencies were taking to mitigate these impacts. This is a continuing area of concern that deserves constant attention from the science community. While the student visa situation is much improved, we still have serious policy challenges ahead, including concerns about a cumbersome and graceless visa process for visiting scientists, implementation of the export control regime, potential over–regulation of dual-use bioscience, and security arrangements that stifle user programs at key national laboratories.

The good news is that there *is* a consensus among nearly all actors that these are problems that need to be addressed. The danger is that with time, the salience of these issues will diminish and momentum toward solutions will be lost. Within government, a number of interagency committees have sprung up to address problems at the intersection of science and security, and many other organizations, including the AAAS, have created committees and ongoing activities that will keep up the momentum. For example, the National Science Advisory Board for Biosecurity (NSABB), established by this Administration in 2004, has been meeting quarterly since the summer of 2005. For an impression of the care with which this group is considering the problem of "dual use" bioscience, see the draft of the report it considered at its meeting last month, *Proposed Strategies for Minimizing the Potential Misuse of Life Sciences Research,* available on the NSABB website.

Another good example of agency responsiveness is the action of the Department of Commerce in reconsidering a proposed rule affecting the implementation of certain export control regulations. The National Academies' Government–University–Industry Roundtable on this issue, chaired by Marye Anne Fox, has played a useful role in bringing parties together on this set of problems. I mention these issues now because

I think they are not getting as much visibility as they deserve in the science and technology media.

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Wide consensus also exists on the importance of federally funded science to our nation's long-term economic competitiveness. The National Academies' 2005 report, *Rising Above the Gathering Storm,* was an important expression of this view and echoed findings of many other reports. Notable among its recommendations was increased funding for basic research in the physical sciences, mathematics, and engineering—areas that had stagnated while the budget for biomedical research soared. The report even recommended that investment in these areas should increase "ideally, through reallocation of existing funds, but if necessary, via new funds." That statement is a rare recognition of the fact that federal funds for science are limited and that some programs may have to be held constant or reduced to fund priorities.

The Administration's response to this consensus was the *American Competitiveness Initiative* (ACI), which, among other things, proposed doubling budgets for NSF, NIST and the Department of Energy's Office of Science over ten years. Appropriation committees in the 109th Congress produced bills that would have fully funded the ACI, but unfortunately, and to the great dismay of the very large number of ACI supporters, the Congress retired without passing the necessary bills.

The previous Congress did, however, pass appropriations bills for the Departments of Defense and Homeland Security. I will come back to the implications of these bills in a moment. The new Congress adopted a "Continuing Resolution" (CR) that froze all discretionary budgets at FY2006 levels with two very important provisions: First, the 110th Congress used flexibility within the CR to fund the President's proposed ACI science budget for FY2007 but only at half the requested level. Second, it adopted a rule suspending earmark requirements on the continuing funds that had been earmarked in FY06. This has had a profound impact on the budget discussion for FY2008. Let me explain with an example.

The AAAS analysis of the President's FY2008 budget request states that "once again there would be steep cuts in DOD's S&T . . . programs. DOD S&T would plummet 20.1 percent down to $10.9 billion, with cuts in all three categories of basic research, applied research, and technology development. "

As I explained in my remarks last year:

> The fact is that the . . . cost of the ACI is dwarfed by the $2.7 billion in current year earmarks in the research budget. Earmarking has increased rapidly during the past five years, and has reached the point where it now threatens the missions of the agencies whose funds have been directed toward purposes that do not support the agency work plans. From the point of view of transparency in government operations, earmarking at this level erodes the value of reported budget numbers for inferring agency resources. . . . This is a very serious problem. Media reporters attempting to identify "winners and losers" cannot even get the sign right on the budget changes inferred this way.

That's what I said last year. What readers of the AAAS report need to know is that the entire change in the FY08 Presidential budget request for DOD S&T comes from removing the FY07 earmarks to determine a meaningful base budget for this important research. The President is actually asking Congress to *increase* the S&T budget that DOD can devote to its core programs.

This failure by the AAAS to explain the treatment of earmarks in the Administration's budget proposals is not good. It is a serious and unacceptable flaw in a report that is widely used as an authoritative reference on the budget. I am particularly disappointed by this lapse because last year at this time I pleaded that:

> The White House Office of Management and Budget has criteria for identifying and accounting for earmarks, but those criteria are not employed by AAAS analysis, and the AAAS earmark methodology is not transparent. Unfortunately OMB does not publish earmark data, or include the effects of earmarks in its tables. Consequently the dramatic growth of earmarks has seriously undermined the usefulness of the historically valuable OMB and AAAS analyses. Published budget numbers from either source no longer consistently reflect the actual resources available to science agencies to carry out their programs. This is not a satisfactory situation, and I urge AAAS to work with OSTP and OMB to develop a mutually comprehensible approach to the problem of taking earmarks into account in analyzing the annual science budgets.

Well, AAAS has done nothing to correct its practice, but OMB has. Now you can look on the OMB website (http://earmarks.omb.gov) to browse the 13,497 earmarks that occurred in 2005 by agency or by state. In that year the earmarks totaled almost $19 billion, more than half of which was in DOD alone.

This year is an especially important one for understanding the status of earmarks because Congress, to its great credit, has passed on the prior year's earmarked funds to the agencies *without the requirement that they direct the funds to the earmarked purposes*. That is, they can—if they accept this generosity at face value and choose to ignore the original restrictive language—add the funds to programs that have been planned, prioritized, and properly evaluated to satisfy the mission needs of their departments and agencies. This is a very remarkable gesture that has effectively given agencies a huge windfall for the current FY07 budget year. This action could not be taken into account in the President's budget proposal, which had to be prepared before Congress made its decision to remove the earmarking restrictions from the Continuing Resolution. I emphasize that this action did not apply to the hugely earmarked DOD budget, which is not subject to the CR.

What happens next will be extremely interesting. If Congress permits earmarks in its FY08 appropriations bills, it will in effect be taking away the agency flexibility it granted in the Continuing Resolution, returning budgets the agencies can evaluate and use effectively to the base the President uses in his requests. President Bush has asked Congress to cut the total amount of earmarks in half. If Congress does that for the science budgets—without removing the associated funds it granted in the CR—it would be wonderful for science.

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What Congress decides to do here will signal its priorities for research. The ACI prioritizes basic research in key agencies that have been relatively under–funded, given the importance of the fields they support for long-term economic competitiveness. Because two Congresses have now failed to fund the first year of ACI at the level the President has requested, it is now behind schedule. The Administration's FY08 request aims to catch up. The Administration continues to believe it is essential to rectify a long growing imbalance in the pattern of research funding affecting the prioritized agencies.

Despite much good–will toward the ACI, and recent actions on competitiveness bills by authorizing committees in both the House and the Senate, the fate of this important initiative remains in doubt. What these agencies need is appropriations for their under–funded basic research programs. They do not need new programs or new bureaucracy, new reporting requirements, or new constraints on how they use their funds, all of which are features of the authorization bills. My plea to Congress is that it

protect the basic research aims of the ACI from suffocation under the weight of all these other trimmings—20 new programs in the Senate bill alone.

Why, you may ask, can we not fund *all* the ideas everyone has proposed for maintaining U.S. economic vitality in the face of rapidly increasing competition from other countries? Why can we not take advantage of *all* the research opportunities now available to us by virtue of new instrumentation, new computing power, and the mounting base of new information about everything from dark matter to social behavior? I believe we can do all the R&D we *need* to do, and very much of what we *want* to do, but I do not believe we can accomplish this the way we would *like* to do it, namely, by simply appropriating more federal funds.

Neither this Administration nor any future one can escape the urgent demands of 21st century realities. The struggle against terrorism is real and persistent. Climate change demands attention. Globalization is bringing the problems of countries around the world to our doorstep. And we have yet to address the looming crunch of entitlement programs in our own country—funded through the relentlessly expanding mandatory portion of the federal budget.

All these demands impact the Domestic Discretionary Budget, which for decades has not grown as fast as the Gross Domestic Product. It is an empirical fact that the science share of the discretionary budget has remained practically constant over time, so of course its share of GDP has fallen. Many science advocates, including probably most people in this audience, have used the resulting decline in ratio of federal research to GDP to argue for bigger federal science budgets. Because of the constraints on the discretionary budget, this argument will not be effective in the long run.

Two years ago in this forum, to repeat myself again, I argued that the ratio of federal science funding to GDP is not necessarily a meaningful indicator of a nation's science strength. I called for better benchmarks and a new "science of science policy" that would give us a surer foundation for setting priorities and better arguments for taking action. I am impressed and pleased with the response to that plea, not only by our own National Science Foundation, which has launched a program in the "social science of science policy," but also by the international community. The OECD—Organization for Economic Cooperation and Development—has acknowledged the need to have better data, better models, and better indicators that take into account the dynamic and global nature of research and development. Meanwhile, in the absence of a deeper understanding of cause and effect in the new era of globalized technical work, we need to be wary of reading too much into ratios and rates. Today, however, I want to make a different point.

Last October I gave a speech to the annual meeting of the Council on Governmental Relations (COGR) in which I expressed my concern about the mismatch between research capacity and the federal resources to sustain it. I claimed that "the universe of research universities has expanded to an economically significant size, by which I mean that the sum of financial decisions by its individual members has an impact on the resources available to any one of them. It is not quite a zero–sum game, but we have moved into a new operating regime where the limits of the 'market' for research university services are being tested." The doubling of the NIH budget that occurred with everyone's blessing over a five year period ending in 2003, was an experiment in the rapid expansion of a broad but still well-defined scientific field. The most obvious lesson from this rapid growth is that it could not be sustained. There is a deeper lesson.

Federal funding for science will not grow fast enough in the foreseeable future to keep up with the geometrically expanding research capacity . . . state and private sector resources should be considered more systematically in formulating federal science policy.

It is clear that the doubling has had a profound impact on the nation's biomedical research enterprise. It helps to think of this enterprise, and R&D activities generally, as a miniature economy with its own labor pool, markets, productive capacity, and business cycles. The response to the NIH doubling has been an abrupt increase in research capacity, financed not only by the direct federal investment, but also by state governments and private sector sponsors eager to leverage this investment, not the least to enhance competitiveness for additional federal funds.

We now have an enlarged biomedical R&D labor pool—a new generation of researchers—who are populating new expanded research facilities and writing federal grant proposals in competition with the previous, still productive generation of their faculty advisors. And they are training yet another generation of new researchers who hope to follow the same pattern. I cannot see how such an expansion can be sustained by the same business model that led to its creation. The new researchers will either find new ways to fund their work, or they will leave the field and seek jobs in other sectors of the economy. This sub-economy is unregulated, and we can expect it to experience booms and busts typical of unregulated markets.

Under the stimulus of federal funding, research capacity as measured in terms of labor pool and facilities can easily expand much more rapidly than even the most optimistic projections of the growth rate of the federal research budget. New capacity

can only be sustained by new revenue sources. In this connection it is noteworthy that the federal research budget is dwarfed by private sector research expenditures. Under the pressure of increased competition for federal funds, research universities are in fact forging new relationships with private sponsors, and I expect this trend to continue.

The President's Council of Advisors on Science and Technology (PCAST) devoted a session in its recent meeting to reports by university, industry and foundation leaders on modes of private sector support for university–based research. Many universities are experimenting with new modes of interacting with industry and philanthropic organizations. Universities prefer sponsors who do not encumber their largesse with conditions, and the process of mutual accommodation with industrial sponsors may take time, but I believe accommodations are inevitable. The economics of university–based research are beginning to change to a new model with diversified sources of revenue.

Federal science policy should encourage this change. Not only will it enable an expanded research enterprise, it will also promote development of capacity in areas likely to produce economically relevant outcomes. Moreover, economists have documented a positive correlation between industrial research investment and national economic productivity, and to the extent this correlation indicates a causal relationship, increased industrial research will be good for the economy.

The message here is that federal funding for science will not grow fast enough in the foreseeable future to keep up with the geometrically expanding research capacity, and that state and private sector resources should be considered more systematically in formulating federal science policy. A possible precedent for federal action in this area may be found in the Bayh–Dole and Stevenson–Wydler legislation of more than 25 years ago. These acts gave ownership of intellectual property to the institutions in which it was developed with federal funds. Not only did it motivate federally funded research institutions to transfer technology to the private sector, it also created a dynamic that attracted private sector resources to the institutions. The level of industrially supported basic and applied research at universities remains low, however, relative to its potential.

Many precedents exist for private support of research, from the numerous societies formed to raise money for medical research on specific diseases to the remnants of the once robust system of industrial research laboratories. A remarkable example of private sector involvement in institutions that also receive significant federal support is the string of more than a dozen research institutes endowed by the Kavli Foundation. One is located on the campus of SLAC—the Stanford Linear Accelerator Center—and

forms a crucial part of the long-term strategic plan for that federal laboratory. Most other Kavli centers are on university campuses, and they represent a wide range of research topics, but always with a strong basic research orientation.

The links between federal, state and private funding deserve more study. They are multiplying and growing stronger with relatively little federal encouragement. They appear to be building on foundations formed by federal funding, and there is no question that they could grow if encouraged by federal policies.

You will have your own ideas about how to fill the inevitable gap between the exponentially increasing research capacity and the much more slowly growing federal ability to satisfy it. This issue will be with us for a long time and will have a significant impact on how and what research is performed in our institutions. Research universities are responding with the creativity and entrepreneurial spirit characteristic of the U.S. economy as a whole, which is a step in the right direction.