Council on Governmental Relations
Washington, D.C.
October 26, 2006
Emerging Issues in Science and Technology Policy

John Marburger
Director, Office of Science and Technology Policy
Executive Office of the President

COGR and its members represent an important constituency for federal science agencies. As a former university president and now a government official, I know how much COGR does – not only for its institutions, but also for the government – and I welcome the opportunity to speak with you this afternoon. One of my responsibilities is to keep track of strategic issues that affect the nation's research enterprise, and today I will talk about aspects of that 'big picture' that are particularly relevant to COGR's mission. I know many COGR members are medical centers and hospitals that have a research focus, but to make shorter sentences I will say 'research universities' or just 'universities' in my remarks. The issues I want to talk about apply to all the institutions that COGR serves, namely those that receive significant federal funding for research.

I also know by experience that the set of research universities is very diverse. Among them are publics and privates, and those who provide health care and those who don't. I have served at all levels of administration, from faculty principal investigator to trustee, and in both public and private sectors. Based on my personal experience I think the financial conditions for all types of universities have been in a volatile state for decades, and I believe this condition will continue into the indefinite future. The volatility comes partly from the changing interests and fortunes of the institutional sponsors, whether public or private. Possibly more important, and less appreciated, is the fact that the activities that define these types of institutions amount to an unregulated market subject to economic phenomena similar to those that cause business cycles in the larger economy. It is this latter aspect I want to focus on today. The research enterprise, as you well know, is undergoing changes that are part of a broader transformation of work in society driven by revolutionary innovations in information technology and associated instrumentation. This is a true socio-economic revolution, one of a sequence that began with the industrial revolution, and it has not yet played itself out. While we all read and make speeches about this phenomenon, it is not clear to me that we are taking it adequately into account in our institutional planning.

The federal role in dealing with volatility and change in this particular part of the economy is limited. Because of the peculiar distributed responsibility for education and research in America, the U.S. government has considerably less power to manage or regulate these activities than federal governments in most other developed countries. That is a mixed blessing. It eliminates the vulnerabilities of central planning, increases flexibility to respond to changing conditions, and creates the pluralistic mixture of institutional types and strategies of which our community is rightly proud. But this decentralized system has side effects that can be negative and even destructive if the various actors do not understand and respond to each other's respective roles and capabilities in a larger economic context. There is no center of coordination for accomplishing this, which is why organizations like COGR are important. In today's dynamic environment I am not sure that is enough, because while COGR may represent its members, it has little influence on how they behave, and the least coordinated among the actors are the individual research institutions themselves. I know because I played as an executive in this game for more than two decades.

Let me start with a simple (hypothetical) example to explain my concern. Suppose that many COGR members have the commendable desire to be in the "Top 20%" of research universities. Considerably more than twenty percent can reasonably aspire to this status, so many will be disappointed. Since status is elusive in any case, perhaps the benefits of a campaign to achieve Top 20% standing will outweigh the cost of inevitable failure for the other 80% of competing institutions. While losers are guaranteed, the penalty is not severe. There are other ways to play this game, however, where failure has sterner consequences.

Consider, as a more realistic example, an institution that persuades its sponsors – let's say a state government – to finance a building to replace outmoded research space and thus increase its competitiveness for research grants in a target area – or if not research grants directly, then outstanding faculty who can attract new grants or other funding. Based on its historical success rate for proposals to federal agencies, its record of fund-raising from private donors, and perhaps the political strength of its congressional delegation, the institution assumes a revenue stream from endowments and reimbursement for direct and indirect costs of sponsored research to fund long-term staff expansions and amortization of construction and initial equipment costs. This is the basis for a financial plan that can be presented to a board of overseers for approval. Despite the more definite financial exposure here than in the previous example, the opportunity for success appears to be greater. There is no automatic limitation on the number of institutions that can successfully follow this development path. Or is there? We each tend to view such development strategies institution by institution, ignoring the other 150 players that have made the same case to their sponsors, and developed similar plans, all at the same time. What would the trustees or the regents think of the proposal if they knew how large the competition is? In business terms they would want to know how many providers the market can sustain.

My main point today is 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. Let me pause here to reflect on the growth of research universities.

In 1900, when the Association of American Universities began, about a dozen institutions could be described as 'research universities,' most of them private. Today there are five times that many AAU members, and 152 "Carnegie Type I" research universities plus an additional 110 "Type II's", most of them public. Academic research capacity grew rapidly after World War II, stimulated primarily by federal grants. At first the policy objective was to sustain the academic research groups created for the war effort at a handful of universities. The Pentagon's *Joint Services Electronics Program*, started in 1946, provided the first major federal research support to these and later about a dozen other universities. But funding really took off after Sputnik in 1957. In constant dollars the non-defense federal research budget increased by a factor of ten in the decade following Sputnik. Both the Department of Defense and the National Science Foundation launched programs during this period that effectively increased the number of research universities. Most 'colleges' morphed into 'universities,' and many universities morphed into 'research universities.' NASA's budget grew exponentially. The National Defense Education Act boosted funding across the educational spectrum. The objective then was to avoid future "technological surprises" like Sputnik. Today academic research capacity is again expanding at a rate I have not seen since those remarkable years. This time it is linked to broader national and regional objectives, and the role of the federal government appears to be very different. In contrast to the top-down character of post-Sputnik policies, the impetus for expansion of research capacity today is coming from a broader set of actors, and it is building on a much larger base.

Last March NIH Director Elias Zerhouni and I spoke in a panel at a well-attended meeting of the Association of Academic Health Centers (AAHC) whose membership totals 98 regular and 11 associate or affiliate members. During a question and answer session, Dr. Zerhouni asked how many institutions represented were building, or had recently completed, a major new facility. It seemed to us that every hand went up. We did not probe further to see how many of these facilities actually had a research focus, but it was my impression they all had laboratories. Recently Dr. Zerhouni sent me figures that showed a tripling of investment in research facilities by 99 of 125 Association of American Medical Colleges (AAMC) member schools from a seven year period prior to the NIH budget doubling phase to the four year period following the doubling. It appears the rapid rise of NIH funding, coupled presumably with the expansion of the biotechnology and pharmaceutical industries, has stimulated an enormous increase in the research capacity of U.S. research institutions, at least in the biomedical research area.

This accelerating expansion over decades raises important questions about what might be called the collective business model for research institutions. I owe the phrase 'business model' in this context to Dr. Zerhouni, whose concern may exceed even mine regarding the economics of academic research. The market, in this case, is the set of sponsors of academic research, and these are dominated by the federal government. Of the roughly $40 billion spent on academic R&D in 2003, about $25 billion came from federal sources. The next largest source, according to the NSF figures, is the institutions themselves at about $8 billion, which presumably draw on a mix of discretionary revenues for seed money, matching funds and other non-reimbursed costs. Industry and the states contribute relatively small direct amounts to university-based R&D. Since most federal funds do not go to the construction of new facilities, the research business model appears to be similar to the one I described in my example: Institutions rely on financing from non-federal sponsors to build capabilities that make them more competitive for federal funding, then go after federal grants to sustain the new enterprise. Or perhaps to pick up the costs of a portion of the old enterprise that failing revenues from other sources cannot meet.

This is a model whose definition is clear enough that we can analyze its viability. If the federal funds do not expand at the same rate as the research capacity, then we have the situation of my first example: there are bound to be losers. If the institutions are relatively evenly balanced, competition-wise, *then all can be losers*. From a broader perspective, that conclusion applies not only to the institutions, but also to the graduates and post-docs they produce. That is, the demand on federal resources exceeds what you would need if the only product were research. Every year the expanded research activity produces a new cadre of research performers – arguably the most creative and potentially productive part of the research workforce – who expect to get jobs commensurate with their talents and aspirations. Institutions eager to climb the prestige ladder hire them to compete against their former supervisors. The result is a geometrically growing appetite for research support – that is, federal support, unless a new revenue source can be found to supplement the public funds.

Federal budgets are notoriously awkward to predict, agency by agency and year by year. But in the aggregate over a period of years, the funds available for academic R&D are remarkably stable. During nearly all the period since Sputnik, federal research budgets have been a practically constant fraction of the Domestic Discretionary Budget. Non-defense research as a fraction of the non-defense discretionary budget has always been close to 11%. I do not know why this should be so, and you could argue that it does not need to be so, but it is not particularly surprising because the multi-sector tug-of-war that divides the Discretionary Budget each year always includes the same players: housing, veterans' affairs, law enforcement, domestic security, public health, water projects, transportation, and so on. The politics of this tug-of-war looks rather arbitrary and opportunistic every year, but at a sufficient level of aggregation the outcome is remarkably stable. I take it as a given that science will get its historical share and perhaps a little more. For planning purposes it makes sense to extend the historical average of this share into the future. Then the rate at which federal research funds will grow is linked to the rate of growth of the Discretionary budget.

COGR needs to pay attention to these macro-trends on behalf of its members. The Domestic Discretionary Budget does not grow geometrically with time. In constant dollars, using the consumer price index as the deflator, it tends to grow linearly – that is, by a constant amount, not a constant percentage each year. Therefore the share for federal research cannot grow geometrically, in constant dollars. If it grows faster than the Discretionary budget in any period, then it needs to grow slower than the Discretionary budget in a subsequent period to avoid crunching the other sectors. The time scale of these fluctuations is comparable to the lifetime of a single administration. The same rules apply to any subset of the science budget. We are currently in a period where the discretionary budget is declining in constant dollars, by policy, to bring the deficit under control. To increase the pot for research, or even hold it constant, means diminishing the share of other sectors, which goes against the political grain.

You will recognize some of the effects of this set of conditions in our current experience. The NIH budget grew geometrically and faster than any other sector within the more or less constant share for science, creating political forces that are now correcting the balance over several years. Meanwhile the growth spurt in the biomedical sector fostered expansion of programs that have led to large numbers of graduate students and post-docs who cannot find independent research support or academic jobs, and to increased competition that is causing stress among the researchers who do have academic jobs. After I showed graphs, more than a year ago at Princeton, of increasing federal funding for science, a faculty investigator raised her hand and exclaimed "If everything is so good, why do I feel so bad?" The answer, in economic terms, is that production (research capacity) outstripped demand (sponsor funds) and created serious competition whose consequences are now quite visible.

You could argue that the importance of academic research to the future economy requires a fundamental change in the balance of shares, or even in the size of the overall budget through increased taxes or reallocations from the huge and growing non-discretionary programs. I take the urgent tone of the recent National Academies Report *"Rising Above the Gathering Storm … "* to signal the need for such a change. But the recommendations of that report with respect to research funding are less dramatic than those for education, workforce development, and tax incentives. The Administration's *"American Competitiveness Initiative"* (ACI) launched in January by President Bush, addresses the research recommendations with relatively little change in the overall level of federal research support. The NIH budget, in particular, remains flat in the 2007 budget proposal, and is likely to continue to grow at a slow rate until imbalances with respect to other fields, particularly physical science, are smoothed out.

Speaking of the ACI, the most expensive part by far of that initiative is the tax credit for industrial research and experimentation – a cost of $86 billion over ten years compared with $50 billion over the same period in new funds for NSF, DOE/Office of Science, and NIST Core budgets. This tilt toward private sector research has a firm policy justification because studies by OECD have shown a much stronger link between economic productivity and research spending by the private sector as compared with government funded research. Even with the existing unpredictable research investment tax credit, U.S. private sector research is large on an absolute scale and very competitive with other countries as a percentage of GDP. I am drawing attention to these points because they bear on the probability that federal research funding will grow dramatically faster than the historical average. Over the long term I see no reason to believe that the federal science budget will grow at a rate faster than the Domestic Discretionary Budget. The science share of that budget has grown, in constant dollars, in increments averaging about $500 million per year over the long run. That is not insignificant, but it equals only about 1.6% of the current NIH budget. That is, to grow 1.6% over the CPI next year, NIH must consume all new money available to science, according to average historical trends that have been valid for four decades.

All science policy issues need to be examined against this budget background. On a sufficiently long time scale, federal science funding is nearly, but not completely, a zero sum game. Competition will continue to be an important fact of life, and the slowly expanding science resources will be spread ever more thinly among an increasing number of capable institutions. From the government perspective, the policy issue in the short run is how to allocate the science funds in an optimal way. In the long run, the health of the research university community is also important, and as I said at the outset, the federal government has few tools to manage this issue. In most other countries, this highest level of education is subject to regulation by the central government. The recent actions by Germany to create an "Ivy League" are a good example of how a government might deal with a condition where research resources are spread too thinly over a large number of institutions. The German program was announced in 2004 and just completed its first round of awards. It is somewhat similar to the NSF Centers of Excellence grants to universities in the post-Sputnik era, but then the idea was to increase the number of research centers. In Germany the idea is to focus or re-focus resources to strengthen a smaller number of centers. I am not suggesting anything like this is about to happen in the U.S. which has three-quarters of the top 50 universities in the world, and nearly half the top 100 (according to the recent survey by Shanghai Jiao Tong University). But the dilution of research capability is a real phenomenon and we must keep an eye on it.

More likely in the foreseeable future is an increasing intensity of competition for a large and expanding but finite federal research fund by a growing number of research-capable universities. The competition has already led to a huge increase of expenditures by COGR members for Washington D.C. offices and lobbyists (I have only anecdotal information about this), and an accompanying increase in earmarking by Congressional appropriations committees. (The current non-military R&D budget contains about $2.7 billion of Congressional earmarks, by OMB reckoning.) I think this is an unhealthy practice that in the long run will weaken the quality of all our institutions. In the short run, OSTP has called on OMB and AAAS, which tracks federal science budgets, to devise a better way of accounting for the impact of earmarks on federal agency science programs.

We can take actions to make the available funds go farther through streamlining grant management practices and making them more uniform among agencies, and other measures being considered by the National Science and Technology Council's Research Business Models subcommittee (which has its own website at http://rbm.nih.gov/). These are important initiatives, but they are not going to solve the basic problem of unregulated growth of research capacity. Nor are actions to improve the management of indirect costs, which are important but will not affect the total sum of funds available to support research.

More promising is the prospect of increasing the share of research funding contributed by the states and by the private sector, particularly by industries that benefit from technologies that build on the scientific products of the universities. Unlike the Domestic Discretionary budget, the assets of the private sector do grow with GDP, and industrial investment in R&D has consequently increased much more rapidly than the federal contribution. Much of the facilities investment I cited earlier has come from the states, which have become increasingly aware of the importance of research universities for regional economic development. There is a natural division of effort here among federal, state, and industrial investment in R&D. The federal government acknowledges its responsibility to fund long term, high risk basic research, and industry funds short term low risk R&D. The states tend to make investments in incubator facilities and other technology transfer activities in the fuzzy boundary between these domains of risk. I have visited many exciting regional centers of such development, and am impressed by the many different models for bringing diverse partners together in a way that satisfies regional needs for health care, education, training, research, and industrial development.

I hope that new institutional models like these regional centers will lead to sustainable new business models for sustaining the vitality of our research universities.

In view of their importance to the future health of the university community and the quality and quantity of the services they perform, these topics deserve your attention. Thanks for giving me an opportunity to speak about them today.