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RESEARCH COMPETITIVENESS AND NATIONAL SCIENCE POLICY

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Competitiveness is built into the nature of American higher education. Unlike the systems of many other countries, the American higher education system is not governed or funded by any single central authority or policymaking body. Although the shape of higher education is influenced by the policies and budgetary decisions of the federal government, particularly those decisions that relate to research, the federal government does not in any sense control the system. In essence, this means that individual institutions (or, in some cases, statewide systems comprised of numbers of institutions) are free to define own particular niches and to compete with one another for students, for research funding and other resources, and, more generally, for prestige and positions in the academic "pecking order." To a significant extent, this "pecking order" is determined by the amount of federal research funding a university is able to attract. Research funding is also increasingly viewed by universities, the communities they serve, and the political leaders who represent them as a key element in technology-based economic development at the local and regional, as well as the national,

levels. Thus competition for research funding, especially federal research funding, is a central fact of academic life in the United States.[1]

Competition is facilitated by the size and diversity of the U.S. system of higher education. In 1996, there were reported to be 3,660 (1,580 public and 2,080 private) institutions in the U.S. offering education beyond the secondary school level. These institutions, which range from two-year vocationally-oriented community colleges, to four-year colleges, to research universities with a full array of graduate and professional schools, enrolled 14.5 million students in that year and awarded 2.2 million degrees, one-quarter of which were in science and engineering.[2] These higher education institutions, especially the subset broadly termed "research universities" perform a major share of the nation's basic research while, at the same time, educating the next generation of scientists and engineers.

The federal government is the principal source of funds for academic research in the United States. In 1998, it provided nearly 60 percent of the support for research[3] performed in universities and colleges. About 19 percent of research support came from institutions' own funds (including appropriated state and local government funds at public institutions as well as endowment income and tuition) and the remainder came from industry (about seven percent) and other sources (mainly foundations and voluntary health organizations). Colleges and universities play a vital role in the U.S. research system, performing nearly 50 percent of the nation's basic research.

The framework for government-university relations in research was established during and immediately following World War II. Prior to that time, government funding for academic research was relatively limited and concentrated in a few specific areas, especially agriculture. During and after the war, support for scientific research came to be viewed as a legitimate and important role of government. Universities were

regarded as a natural home for this research, since their faculties and research laboratories were well-established and they had a steady supply of advanced students who could receive their training while assisting in the research. Further, the U.S. had not developed the same type of government institutes and centers for research that had emerged in other countries, and that might have provided a ready alternative for conducting federally-sponsored basic research. Finally, the prevailing ideology and preferences of the leading scientists who influenced policy formation favored adding as little as possible to government bureaucracy while providing academic scientists with funds to continue and expand research in their own university laboratories.

The greatest emphasis on research is, of course, at the universities that offer graduate degrees, particularly those that confer doctorates. Of the 3,660 institutions mentioned above, some 235 award doctoral degrees, and 126 have been classified by the Carnegie Foundation for the Advancement of Teaching as "Research Universities I and II." These institutions offer a full range of undergraduate programs, are committed to graduate education, and give high priority to research. Research Universities I award 50 or more doctorates a year and receive at least $40 million a year in federal research support. Research Universities II also award at least 50 doctorates but receive less federal research support—between $15.5 and $40 million a year.[4]

By far the largest share of federal funding for research in universities is distributed in the form of project grants. The National Institutes of Health (NIH—the largest funder of academic research), for example, spends about three-fourths of its extramural R&D funds on such grants. Larger grants that support centers or institutes are another popular funding mechanism. In general, both project and center grants are awarded through a peer or merit review process[5] (although there has been a growing tendency in recent years for institutions to bypass such review through the intervention of Mem-

bers of Congress[6]). The Department of Agriculture, the oldest federal agency supporting academic research, awards some of its funds in the form of "block grants" according to a formula, but these grants are concentrated in the field of agriculture and represent only a small fraction of federal support for academic research.

Federal support for research at colleges and universities, which totaled $15.1 billion in 1998, comes from 18 government departments and agencies, but the largest share (about 71 percent) comes from just two—the above-mentioned National Institutes of Health (NIH) and the National Science Foundation (NSF). The top six agencies (which include the Department of Defense (DOD), the Department of Energy (DOE), the Department of Agriculture (U.S.DA), and the National Aeronautics and Space Administration (NASA)) together account for over 95 percent of the total. The federal government provides very little direct support for teaching, except in a few select institutions (e.g., historically black colleges and universities), but it does contribute to the general support of colleges and universities through subsidies to undergraduate student aid and graduate fellowships and traineeships.

Universities differ substantially in the level of priority they accord to research, the expectations of faculty research productivity they maintain, and the conditions they provide for the conduct of research. In general, the more elite research universities have higher standards of research productivity for their faculty than do other institutions. To make this productivity possible, they allow their faculties to do less teaching and they provide other support in terms of laboratory facilities, libraries, information services, funds for graduate assistants, and the like. The faculty, in turn, are expected to seek outside (i.e., federal or foundation) funding for their research and to cover a portion of their salaries and the stipends for their graduate assistants out of the grants they receive.

In less research-intensive institutions, teaching loads are higher (in some state institutions, they may be set by state

law) and expectations of research productivity are lower. Faculty receive fewer grants, on average, and the share of internal, institutional money devoted to research is also lower. These differences are readily perceived by the faculty involved. One professor from a second-tier institution in a rural area, interviewed by the author a few years ago, used a common sports metaphor to describe the differences: "You're looking at the majors and the minors."[7]

Indeed, the differences between the "major leagues" and the "minor leagues" are clearly evident in terms of the distribution of research funding among institutions. In 1997, R&D expenditures of the to ten universities represented over 18 percent of all academic R&D spending, the top 100 universities laid claim to nearly 80 percent. The share of federal funding for academic institutions received by these institutions is even higher (22 percent and 82 percent, respectively).

The institutions that receive the lion's share of federal funding are the same ones that rank most highly on virtually all measures of academic quality and prestige. Because of the decentralized nature of the higher education system, there is no "official" national quality assurance or peer review system. However, various groups and publications periodically publish unofficial rankings of university departments. By far the most comprehensive and important of these is that prepared by the National Research Council (the operating arm of the National Academies of Science and Engineering and the Institute of Medicine) which looks at research-doctorate programs. Its most recent such study, published in 1995, provides information on 4,000 doctoral programs in 41 subdisciplines at 274 doctorate-granting institutions, including ratings of faculty quality, ratios of publications to faculty, ratios of citations to faculty, etc. The data in its massive report are used widely by other organizations to judge the relative standing of graduate departments.[8]

Again as a result of decentralization, there is no systematic relationship between these ratings and either research

or education funding for various academic departments. However, universities themselves and state systems take them into account in allocating resources internally, and the rankings likely also become part of the mental calculus of grant peer reviewers and program managers at federal agencies and foundations who must judge the merits of research proposals. This is not to say that an outstanding proposal from a researcher in a lower-ranked department cannot obtain funding, but only that, given two proposals of equal quality, the one from the stronger department will, in most circumstances, have at least a slight edge.

This situation has important practical and political consequences for both higher education and research in the United States. Institutions, and the people who lead them, quite naturally compare themselves with others and aspire to improve their status. Many universities outside of the top 100 in research funding are eager to enter that charmed circle in the expectation that more research funding will create a positive feedback loop. They believe it will allow them to attract better faculty and better students, improve their prestige, and further increase their funding. Universities within e top 100 want to move up the list for the same reasons. Research II universities want to become Research I universities. And so on. Members of Congress as well as local officials and political leaders support these ambitions in the expectation that they will benefit their economies, giving rise to high-tech industry and high-wage jobs.

Highly-ranked research universities are not distributed evenly around the country. They are, in fact, concentrated in a relatively small number of high population, industrialized states including California, Massachusetts, New York, Pennsylvania, and a few others. This results in a rather strong geographical concentration of federal funding of academic research. As Feller notes in Chapter 2 of this volume, the top five states account for more than 40 percent of all federally-funded academic R&D, while top ten account for nearly 60 percent. In

contrast, the aggregate share of the 20 states at the bottom of the list is only six percent. These include states with small populations and those that are largely rural in character, like Wyoming, the Dakotas, and Idaho, as well as more populous but poorer states like Mississippi. This situation has its analogue within more R&D-intensive states where less-renowned colleges and universities (often in economically disadvantaged areas) share many of the problems of institutions in the lower-ranked states.

As Lambright and Cozzens discuss in Chapters 3 and 7, respectively, the EPSCoR program (Experimental Program to Stimulate Competitive Research) was created over 20 years ago to fulfill the longstanding federal mandate to make scientific and technological opportunities available on an equitable basis to all regions and groups in the United States. Rather than simply distributing research funds to disadvantaged states or institutions on a formula basis as if they were entitlements, however, EPSCoR seeks to cultivate research competitiveness in those states and institutions—i.e., to help them develop the ability to compete successfully in the "major leagues."

What does it mean for a university or a state to cultivate its competitiveness in research? At one level, the answer is simple: more grants, larger grants, and more money for research. But while administrators and policymakers may set these as goals, for faculty and researchers they are means—means by which to produce more research results, more publications, more highly-cited publications, ultimately more recognition for the researchers and their institutions. Beyond this, increased research competitiveness should help to stimulate local economic development through technology transfer and licensing, spin-off companies, and, of course, employment.

The experiences that various states and universities have had in seeking to enhance their research competitiveness, the strategies they have available to them, and the implications for researchers and research administrators are discussed in the chapters that follow. But what of the national

issues involved and their implications for policymakers, institutions, and the researchers themselves?

One thing is clear: cultivating research competitiveness in lower-ranked universities will not result in a uniform distribution of funding. There will always be the "Lake Woebegon problem."[9] Every class must have a lower half. Only one hundred institutions can be among the top one hundred. Nevertheless, it is possible to narrow the gap between the haves and the have-nots. If a wider range of universities is capable of competing in the major leagues, funds are likely to be spread more evenly.

Will this disadvantage the stronger institutions? Not necessarily. Federal funding for research is not a zero sum game. More federal research money for the University of Idaho need not mean less for Stamford or MIT. Major League Baseball has expanded from 16 to 30 teams over the past four decades and, while there has certainly been a negative side to the changes that have accompanied this growth, the talent pool and the aggregate revenues, as well as the revenues of the top teams have all grown enormously.

From the standpoint of national science policy, the key issue is how to assist the have-not institutions in a manner that not only strengthens them but strengthens the research system as a whole. This means placing the notion of research competitiveness in proper perspective, understanding its importance to the university, incorporating it into the university's overall planning, and following rules that benefit the research system as a whole, not just the institution.

Important as it is, research is not the only mission of the university. Competitiveness in research should be developed in a manner that supports, rather than undermines the other missions of the university, especially undergraduate education. This means not only attracting more federal money, but investing in libraries and information systems, advanced computer networks, and areas, all of which can help to improve undergraduate education as it builds research capacity.

It is significant that the Carnegie Foundation, which created the classification scheme for academic institutions some 30 years ago, has recently expressed concern about the effect of that scheme on the policy directions of those institutions: "We are concerned about—particularly among doctoral institutions—the tournament mentality that has grown up around the classifications. This has led to an imbalance in the attention given to various components of an institution's mission." In response, Carnegie has announced a revised classification scheme intended to encourage a more balanced view of academic excellence.[10]

A balanced view of the university's missions is essential for the long-term institutional health of EPSCoR universities as well as EPSCoR-like institutions in other states. Not only will it help the institution in allocating its resources in an optimal fashion, but it will strengthen the institution's political support base. Maintaining this base—which involves alumni, community and business leaders, and parents, as well as state legislators for public institutions—is vital to the university.

Balance is needed, too, in the choice of which research areas to cultivate, for this can also influence political support for the institution. Research strengths need to be developed in a manner that is appropriate for the region and the community. This is hardly news to most institutions, but it is worth reemphasizing nonetheless. It does not at all mean that institutions in rural areas need concentrate only on agricultural research, but it does suggest that institutions should keep their local situations and economic needs and opportunities in mind in choosing among potential research directions. While this may seen obvious, it is too often ignored.

All of these factors—balance among the missions of the university, political support, and taking the university's local environments into account in establishing research priorities—can best be accomplished in the context of a well-managed strategic planning effort. Hauger addresses this issue in depth in Chapter 4 and several other authors in this volume

touch upon it in their chapters. Planning, as he observes, needs to be open and participatory, attributes that can be facilitated by the use of the World Wide Web. It needs to involve all those who have a stake in it and it requires the visible commitment of top administrators.

Finally, a word about the rules of the game. There is a temptation in building research competitiveness for universities to use their political resources to obtain research funds directly from Congress through appropriations earmarks that bypass the merit review process. Such earmarks, which have been employed by the "haves" among universities to at least as great an extent as the "have-nots," totaled more than a billion dollars in FY 2000. It is easy for universities to rationalize going this route: everyone is doing it, the end (valuable research) justifies the means, this is a better use of the money than (fill in the blank with your least-favorite federal program) and (for the have-nots, at least) this is the only way to level the playing field. And it is hard to deny the short-term benefits of funds that may be obtained in this way.

Nevertheless, there are costs that must be stacked up against these benefits. Earmarks can be habit forming: one success builds up an appetite for more. And continued reliance on earmarking can undermine the development of the capabilities needed to compete for funds under merit review. Even more importantly from the standpoint of national science policy, funding academic research through earmarks weakens the case for federal support of science on the basis of its excellence and undercuts the role of the research community in allocating that support.

ENDNOTES

1. Portions of this paper have been adapted from "Observations on the Interface Between Teaching and Research in the United States," prepared by the author for the U.K. Higher Education Funding Council, January 2000.

2. Data from Higher Education Publications, The HEP 1996 Higher Education Directory (Falls Church, VA: HEP, 1997), cited in *National Science Board, Science & Engineering Indicators—1998* (Arlington, VA: National Science Foundation, 2000), p. 4–6.

3. The term "research" is used for convenience. These statistics actually refer to "R&D" or "research and development," but the amount of development work at universities is small in comparison to the amount of research.

4. In November 1999, the Carnegie Foundation announced major changes in its system of classifying institutions of higher education. These changes are discussed at the end of this paper.

5. The terms "peer review" and "merit review" are used here as synonyms.

6. See James D. Savage, *Funding Science in America: Congress, Universities, and the Politics of the Academic Pork Barrel* (New York: Cambridge University Press, 1999).

7. Albert H. Teich and Kathleen M. Gramp, "Competitiveness in Research: Perceptions of Practitioners," in Teich, ed., *Competitiveness in Academic Research* (Washington, DC: American Association for the Advancement of Science, 1996), p. 87.

8. Marvin L. Goldberger, Brendan A. Maher, and Pamela Ebert Flattau, eds., *Research-Doctorate Programs in the United States: Continuity and Change* (Washington, DC: National Research Council, 1995).

9. Lake Woebegon is the mythical Minnesota town created by public radio humorist Garrison Keillor in which "all the children are above average."

10. Kit Lively, "Changes Planned for Carnegie Classifications," *The Chronicle of Higher Education* (November 5, 1999), p. A46.