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Briefing Report to the Ranking Minority Member, Committee on Appropriations, United States Senate

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UNIVERSITY FUNDING

Patterns of Distribution of Federal Research Funds to Universities

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Resources, Community, and
Economic Development Division

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February 5, 1987

The Honorable Mark O. Hatfield
Ranking Minority Member,
Committee on Appropriations
United States Senate

Dear Senator Hatfield:

As requested in your December 17, 1985, letter and subsequent discussions with your office, this report examines the patterns of distribution of federal research funds to universities and colleges. You expressed particular concern that these funds were excessively concentrated in certain institutions and regions of the country while other institutions and regions received very limited federal support for the scientific research undertaken on their campuses and that the system of using external peer reviewers might unfairly contribute to that concentration.

We subsequently agreed to (1) determine the distribution of federal research funds to universities and colleges by institution, state, agency, and field of science, (2) analyze the extent to which patterns of distribution are accounted for by historical trends, direct congressional action, field of science, demographic and socioeconomic factors, and the use and distribution of peer reviewers, (3) review previous studies of the relationship between the award process and distribution of federal research funds, and (4) describe award procedures at the National Institutes of Health (NIH) and the National Science Foundation (NSF). As we agreed, this report addresses points one and two; a subsequent report will examine points three and four.

To address points one and two, we examined data for total federal funding for research and development for the 50 states and the District of Columbia and for the 100 universities and colleges that received the most federal research and development funds. For the distribution of peer reviewers, we limited our analysis to NSF and NIH. These two agencies are the major sources of peer reviewed federal research awards and represented over 60 percent of all federal research funds to universities and colleges for fiscal year 1984.

Data for this report were obtained from NSF's Division of Science Resources Studies, NIH's Division of Research Grants, the Department of Education's National Center for Education Statistics, and the U.S. Bureau of the Census.

The following are the principal findings from our analyses.

-- Although the percentage of federal research and development funds received by the top funded 100 universities and colleges has remained relatively stable from 1967 to 1984, the composition of the top 100 has changed, with 19 institutions moving into the top 100. The top 100 institutions received 88 percent of the federal research funds in 1967 and 86 percent in 1984. Statutory earmarking of NIH research funds in appropriation acts and awards for institutional development did not appear to be related to change in institutional rank in funding from 1967 to 1984. (See section 2.)

-- Federal research funding to universities and colleges appears to be concentrated in relatively few states and institutions; however, when federal research funds are examined by field of science, states and institutions that rank below the top in total federal research funds may become among the top in a particular field of science. Forty institutions that rank below the top 20 in overall federal research funds rank within the top 20 for one or more fields of science. (See section 3.)

-- Federal research and development funding to universities and colleges by state positively correlates to varying degrees with the demographic and socioeconomic factors of population size, number of employed scientists and engineers, number of Ph.D.'s granted in science and engineering, and federal research and development funds to other than universities and colleges. (See section 4.)

-- NIH and NSF peer review participants and the number of NIH and NSF awards are less concentrated geographically than NIH and NSF research funds. (See section 5.)

We did not request agency comments because we did not evaluate the programs of any agencies and do not have any critical comments about any agencies or organizations.

We are sending copies of this report to the major federal agencies funding research at universities and to other interested parties upon request. If you have additional questions or if we can be of further assistance in this matter, please contact me at (202) 275-1000.

Major contributors are listed in Appendix I.

Sincerely yours,

Sarah P. Frazier

Sarah P. Frazier
Associate Director

C o n t e n t s

ABBREVIATIONS

DOD Department of Defense
GAO General Accounting Office
NIH National Institutes of Health
NSF National Science Foundation
R&D Research and development

SECTION 1

OBJECTIVES, SCOPE, AND METHODOLOGY

OBJECTIVES

The Chairman of the Senate Committee on Appropriations asked us to determine the distribution by institution of those scientific research funds where a peer review-based process[1] determined or helped to determine how the funds were distributed. In subsequent discussions with the Committee, we agreed to (1) determine the distribution of federal research funds to universities and colleges by institution, state, funding agency, and field of science and (2) analyze the extent to which the patterns of distribution are accounted for by historical trends; field of science; and demographic, socioeconomic, and peer review factors. The Chairman was also interested in whether statutory earmarking[2] of National Institutes of Health (NIH) research funds was related to change in institutional ranking based on total receipt of federal research funds.

SCOPE AND METHODOLOGY

To examine the distribution of federal research funds to universities and colleges, we obtained data from the National Science Foundation's (NSF) Division of Science Resources Studies, and from NIH's Division of Research Grants. NSF provided historical data for all federal agencies on federal research and development obligations to the top 100 institutions for the fiscal years 1967 (the first year for which we had complete data), 1970, 1975, 1980, and 1984 (the latest year for which we had complete data at the time of our review). We examined these years for trends in federal research funding. The top 100 institutions are defined as those universities and colleges receiving the largest amounts of federal research and development funding for the particular fiscal year. In addition, NSF provided data for all federal agencies on the funding to the top 100 institutions by field of science and by federal agency for fiscal year 1984.

To examine socioeconomic factors for the 50 states and the District of Columbia, we obtained NSF data for fiscal year 1984 on the number of scientists and engineers employed within a state and the number of Ph.D.'s granted in science and engineering. We used U.S. Bureau of the Census data for the estimated state population for 1984 for per capita computations. The Department of Education's National Center for Education Statistics provided data on state funding for higher education. NIH and NSF provided

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[1] Peer review is the process by which experts from academia, industry, and outside government agencies are used as advisors by NIH and NSF to select meritorious research projects for funding.

[2] Earmarking is the designation by the Congress of particular recipients of appropriated funds.

data by institution and by state for fiscal year 1984 on the number of peer reviewers, the number of proposals awarded, and the number of proposals reviewed. They also provided data on the value of the research awards.

We used these data to:

-- Examine the trends in federal research funding from fiscal years 1967 to 1984.

-- Examine the relationship between institutional ranking in the top 100 and institutional ranking by field of science for fiscal year 1984, the latest year for which complete data were available. The fields of science used in our analysis are engineering, physical sciences, math and computer sciences, environmental sciences, life sciences, psychology, social sciences, and other sciences not elsewhere classified. We used NSF definitions for these fields.

-- Compare the institutional and state ranking in federal research funds with the number and value of NIH and NSF grants and number of peer reviewers, awards, and proposals for each institution and state for fiscal year 1984.

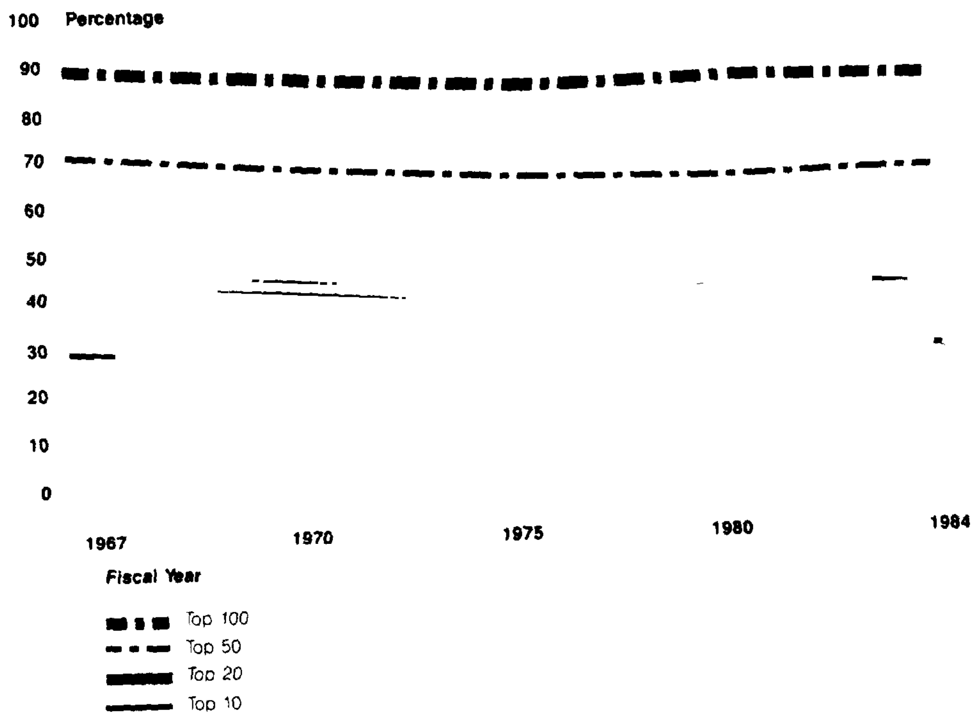
-- Correlate state rankings in federal research and development funds to universities and colleges with the following demographic and socioeconomic factors: population, number of employed scientists and engineers, number of Ph.D.'s granted in science and engineering, state funding of higher education, and total federal research and development funds.

SECTION 2

GENERAL DISTRIBUTION OF FEDERAL RESEARCH FUNDS TO UNIVERSITIES AND COLLEGES FROM FISCAL YEARS 1967 TO 1984

- The percentage of federal research funds awarded to the top 100 universities and colleges has remained stable over the past 17 years.
- There have been changes in the universities and colleges that constitute the top 100.
- Earmarking of NIH research funds and institutional development award programs did not seem to be related to change in rank for the top 100 institutions from 1967 to 1984.

Figure 2.1
Trends in Distribution of All Federal R&D Funds to Universities and Colleges for Fiscal Years 1967 to 1984



Trends in distribution of federal R&D funds to universities and colleges from 1967 to 1984

In 1984, over 80 percent of the federal obligations for research and development at universities and colleges were received by the top 100 institutions. This proportion has remained stable over the past 17 years. Figure 2.1 shows:

-- The percentage of funds going to the top 100 institutions decreased slightly from 88 percent in 1967 to 86 percent in 1984.

-- The percentage of funds going to the top 50 institutions decreased from 70 percent in 1967 to 67 percent in 1984.

-- The percentage of funds going to the top 20 institutions decreased from 45 percent to 42 percent.

Table 2.1

Changes in the Top 20 Institutions From 1967 to 1984

Fiscal year 1967 Top 20		Fiscal year 1984 Top 20	
1	Mass Inst of Technology	1	Johns Hopkins University
2	University of Michigan	2	Mass Inst of Technology
3	Columbia Univ Main Div	3	Stanford University
4	Harvard University	4	University of Washington
5	Univ of Illinois	5	Columbia Univ Main Div
6	Univ of Cal Berkeley	6	Univ of Cal Los Angeles
7	Stanford University	7	Cornell University
8	Univ of Cal Los Angeles	8	Univ of Cal San Diego
9	University of Chicago	9	Univ of Wis-Madison
10	Univ of Wis-Madison	10	Harvard University
11	Cornell University	11	Yale University
12	University of Minnesota	12	University of Michigan
13	University of Washington	13	Univ of Pennsylvania
14	Univ of Pennsylvania	14	Univ of Cal Berkeley
15	Johns Hopkins University	15	Univ of Cal San Francisco
16	New York University	16	Univ of Southern Cal
17	Yale University	17	University of Minnesota
18	University of Maryland	18	Univ of Illinois Urbana
19	Duke University	19	University of Chicago
20	Princeton University	20	Pennsylvania State Univ

Changes in the top 100 institutions from 1967 to 1984

Although there has been little change over the past 17 years in the degree to which federal research funds have been concentrated in the top 100 institutions, some of the particular institutions have changed.

Table 2.1 shows that 16 of the top 20 institutions have remained the same for 1967 and 1984. The institutions that had dropped out of the top 20 were:

-- New York University
-- University of Maryland
-- Duke University
-- Princeton University

The institutions that were in the top 20 in 1984 but not in 1967 were:

-- University of California-San Diego
-- University of California-San Francisco
-- University of Southern California
-- Pennsylvania State University

Table 2.2

Top 100 Institutions in 1984 Not in the Top 100 in 1967

Institution	1984 rank
Georgetown University	97
Georgia Institute of Technology	43
SUNY at Stony Brook	54
University of California at Irvine	61
University of California at Santa Barbara	79
University of Connecticut	57
University of Idaho	91
University of Medicine and Dentistry of New Jersey	98
University of Texas Health Science Center, Dallas	51
University of Texas Health Science Center, Houston	89
University of Texas Health Science Center, San Antonio	80
University of Texas System Cancer Center	84
University of Vermont and State Agricultural College	81
University of Wyoming	92
Utah State University	85
Virginia Polytechnic Institute and State University	75
Virginia Commonwealth University	74
Wake Forest University	96
Woods Hole Oceanographic Institute	40

Seven institutions were not in the top 50 in 1967 but were in the top 50 in 1984. They were:

- University of Arizona
- Woods Hole Oceanographic Institute
- Boston University
- Georgia Institute of Technology
- University of California-Davis
- Oregon State University
- University of New Mexico

Nineteen institutions that were not in the top 100 in 1967 were in the top 100 in 1984. (See table 2.2.)

Table 2.3

Statutory Earmarks of NIH Research Funds

Year	Amount	Institution	Purpose
1976	$ 100,000	Haskell Indian Junior College	Part of the Minority Biomedical Support Program
1983	500,000	New Mexico State University	Chimpanzee colony
1985	4,500,000	University of West Virginia	To develop an academically based center for cancer prevention, detection, and accessibility to specialized care for the Appalachian region

Effect of earmarking and institutional development award programs

Statutory earmarking and institutional development award programs are two examples of how institutions can receive federal research funds outside of the traditional research award system.

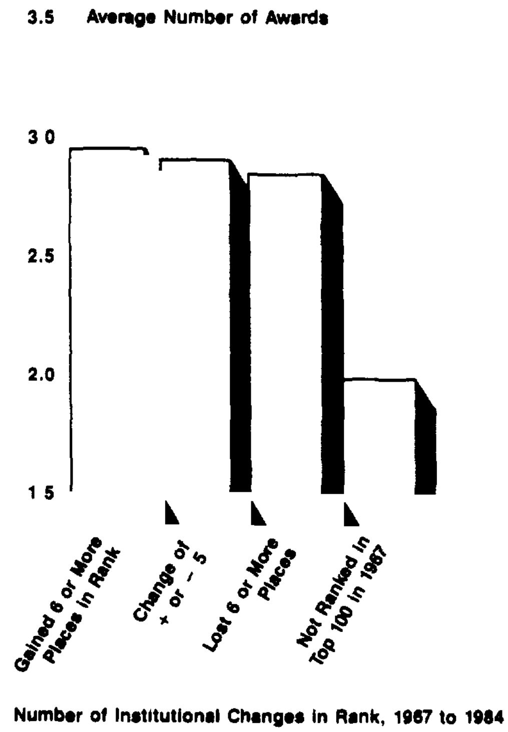
Among the concerns expressed by the scientific community about statutory earmarking of research funds is that recipients may have an unfair advantage in receiving future peer-reviewed awards and that earmarked funds are not awarded on the basis of merit of the research. We examined NIH research funds with statutory earmarking because NIH is the largest source of peer-reviewed funds.

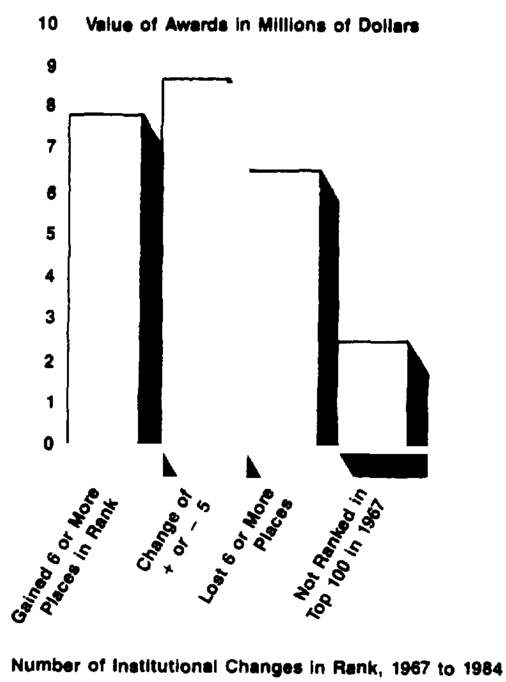
Statutory earmarking of NIH research funds for the 11 years we examined was minimal. We reviewed NIH appropriation acts for 1966, 1967, 1970, 1971, 1972, 1975, 1976, 1982, 1983, 1984, and 1985, and found three instances of congressionally earmarked funds. (See table 2.3.)

Of these three earmarkings, one is for a junior college which is not ranked as a university and the other two are too recent to have an effect on subsequent peer reviewed funding.

Figure 2.2

Influence of Institutional Development Award Programs on Change in Institutional Rank





SECTION 3

INFLUENCE OF FIELD OF SCIENCE ON GENERAL DISTRIBUTION OF FEDERAL RESEARCH FUNDS FOR 1984

- Federal funding when examined in total appears to be concentrated in relatively few institutions and states. However, when federal research funds are examined by field of science, the institutions and states that rank below the top in total federal funding may become among the top in a particular field of science.

Institutional rankings for fields of science

Because the life sciences receives the highest proportion of federal research funds, institutions that rank highly in the life sciences tend to rank highly in total receipt of federal research funds. None of the institutions that ranks in the top 20 for life sciences ranks below 27 in total federal research funds. Institutions that receive little or no life sciences funds and therefore may rank low in total federal research funds may nevertheless rank high within other fields of science. (See table 3.1.) For example:

-- In environmental science, Oregon State University ranks 6 while in total federal research funds it ranks 47. The University of Miami ranks 8 while in total federal research funds it ranks 59.

-- In engineering, the University of New Mexico and New Mexico State University rank 8 and 9, respectively, while overall they rank 50 and 63, respectively. The University of Dayton ranks 11 in engineering and 82 overall.

Of the 80 institutions ranking below the top 20 in overall federal research funds, 40 rank in the top 20 for one or more fields of science. (See table 3.2.)

Proportion of federal research funds to institutions by fields of science

When federal research funding to institutions is examined in total, it appears concentrated in a few institutions and states. However, when it is examined by field of science, it becomes more dispersed and institutions and states that rank below the top in total funding rise into the top for a particular field of science.

In addition, the proportion of federal research funds that a field of science receives affects the rank of institutions and states with respect to total funds. Institutions that receive a larger portion of funds in a highly funded field of science will rank higher in total receipt of federal research funds. Similarly, states that have a larger number of institutions receiving funds in highly funded fields of science generally will rank higher in total receipt of federal research funds.

Figure 3.1 shows that in 1984 life sciences receives the greatest proportion of federal research funds to institutions--over 50 percent. Engineering receives the next highest proportion of funds.

Table 3.1

Rankings of the Top 20 Universities and Colleges by Field of Science For 1984

Field of science rank	Social sciences	Total federal R&D rank	Field of science rank	Other sciences, not elsewhere classified	Total federal R&D rank
1	UNIVERSITY OF MICHIGAN	12	1	STANFORD UNIVERSITY	3
2	OHIO STATE UNIVERSITY	32	2	UNIVERSITY OF MINNESOTA	17
3	UNIV OF CAL LOS ANGELES	6	3	UNIV OF TEXAS AT AUSTIN	22
4	UNIV OF WIS-MADISON	9	4	RUTGERS THE ST UNIV OF NJ	68
5	STANFORD UNIVERSITY	3	5	UNIVERSITY OF MICHIGAN	12
6	HARVARD UNIVERSITY	10	6	UNIVERSITY OF WASHINGTON	4
7	JOHNS HOPKINS UNIVERSITY	1	7	HARVARD UNIVERSITY	10
8	UNIV OF ILL URBANA	18	8	UNIVERSITY OF COLORADO	21
9	UNIVERSITY OF PITTSBURGH	28	9	JOHNS HOPKINS UNIVERSITY	1
10	MICHIGAN STATE UNIVERSITY	38	10	OREGON STATE UNIVERSITY	47
11	UNIV OF NC AT CHAPEL HILL	30	11	TUFTS UNIVERSITY	58
12	UNIV OF PENNSYLVANIA	13	12	WAKE FOREST UNIVERSITY	96
13	COLUMBIA UNIV MAIN DIV	5	13	UNIV OF MD BALT PROF SCH	76
14	UNIV OF TEXAS AT AUSTIN	22	14	UNIV OF CAL SAN FRANCISCO	15
15	YALE UNIVERSITY	11	15	MASS INST OF TECHNOLOGY	2
16	UNIVERSITY OF MINNESOTA	17	16	YALE UNIVERSITY	11
17	UNIVERSITY OF WASHINGTON	4	17	UNIVERSITY OF IOWA	31
18	UNIV OF CAL BERKELEY	14	18	UNIVERSITY OF FLORIDA	39
19	UNIV OF CAL SAN FRANCISCO	15	19	COLUMBIA UNIV MAIN DIV	5
20	PENNSYLVANIA STATE UNIV	20	20	UNIV OF ILL CHICAGO	73

Field of science rank	Math and computer sciences	Total federal R&D rank	Field of science rank	Psychology	Total federal R&D rank
1	STANFORD UNIVERSITY	3	1	UNIVERSITY OF PITTSBURGH	28
2	UNIV OF WIS-MADISON	9	2	STANFORD UNIVERSITY	3
3	MASS INST OF TECHNOLOGY	2	3	UNIV OF CAL BERKELEY	14
4	NEW YORK UNIVERSITY	26	4	UNIV OF CAL LOS ANGELES	6
5	UNIV OF CAL BERKELEY	14	5	UNIVERSITY OF MICHIGAN	12
6	UNIV OF MD COLLEGE PARK	44	6	UNIVERSITY OF WASHINGTON	4
7	CORNELL UNIVERSITY	7	7	JOHNS HOPKINS UNIVERSITY	1
8	UNIV OF ILL URBANA	18	8	UNIV OF SOUTHERN CAL	16
9	UNIVERSITY OF WASHINGTON	4	9	UNIV OF ILL URBANA	18
10	UNIV OF TEXAS AT AUSTIN	22	10	UNIV OF CAL SAN FRANCISCO	15
11	UNIV OF CAL LOS ANGELES	6	11	RUTGERS THE ST UNIV OF NJ	68
12	UNIV OF PENNSYLVANIA	13	12	UNIVERSITY OF MINNESOTA	17
13	GEORGIA INSTITUTE OF TECH	43	13	UNIVERSITY OF COLORADO	21
14	PRINCETON UNIVERSITY	56	14	UNIV OF PENNSYLVANIA	13
15	BROWN UNIVERSITY	71	15	PENNSYLVANIA STATE UNIV	20
16	YALE UNIVERSITY	11	16	MASS INST OF TECHNOLOGY	2
17	UNIV OF NC AT CHAPEL HILL	30	17	HARVARD UNIVERSITY	10
18	PURDUE UNIVERSITY	37	18	UNIV OF CAL SAN DIEGO	8
19	HARVARD UNIVERSITY	10	19	DUKE UNIVERSITY	23
20	CARNEGIE-MELLON UNIV	60	20	BOSTON UNIVERSITY	42

Table 3.1

Rankings of the Top 20 Universities and Colleges by Field of Science For 1984

Field of science rank	Life sciences	Total federal R&D rank	Field of science rank	Engineering	Total federal R&D rank
1	JOHNS HOPKINS UNIVERSITY	1	1	JOHNS HOPKINS UNIVERSITY	1
2	UNIV OF CAL SAN FRANCISCO	15	2	MASS INST OF TECHNOLOGY	2
3	UNIVERSITY OF WASHINGTON	4	3	GEORGIA INSTITUTE OF TECH	43
4	YALE UNIVERSITY	11	4	UNIV OF SOUTHERN CAL	16
5	UNIV OF CAL LOS ANGELES	6	5	UNIV OF TEXAS AT AUSTIN	22
6	HARVARD UNIVERSITY	10	6	PENNSYLVANIA STATE UNIV	20
7	STANFORD UNIVERSITY	3	7	STANFORD UNIVERSITY	3
8	COLUMBIA UNIV MAIN DIV	5	8	UNIVERSITY OF NEW MEXICO	50
9	UNIV OF PENNSYLVANIA	13	9	NEW MEXICO STATE UNIV	63
10	UNIV OF WIS-MADISON	9	10	UNIVERSITY OF WASHINGTON	4
11	UNIVERSITY OF MICHIGAN	12	11	UNIVERSITY OF DAYTON	82
12	YESHIVA UNIVERSITY	27	12	CARNEGIE-MELLON UNIV	60
13	UNIVERSITY OF MINNESOTA	17	13	UNIV OF ILL URBANA	18
14	WASHINGTON UNIVERSITY	24	14	UNIV OF CAL SAN DIEGO	8
15	CORNELL UNIVERSITY	7	15	CORNELL UNIVERSITY	7
16	DUKE UNIVERSITY	23	16	UNIV OF CAL BERKELEY	14
17	UNIV OF CAL SAN DIEGO	8	17	UNIVERSITY OF IDAHO	91
18	UNIV OF CAL BERKELEY	14	18	UNIVERSITY OF MICHIGAN	12
19	MASS INST OF TECHNOLOGY	2	19	PURDUE UNIVERSITY	37
20	UNIVERSITY OF CHICAGO	19	20	CASE WESTERN RESERVE UNIV	34
	Physical sciences			**Environmental sciences**	
1	MASS INST OF TECHNOLOGY	2	1	WOODS HOLE OCNGRPHIC INST	40
2	STANFORD UNIVERSITY	3	2	UNIV OF CAL SAN DIEGO	8
3	CORNELL UNIVERSITY	7	3	UNIVERSITY OF WASHINGTON	4
4	CALIFORNIA INST OF TECH	29	4	MASS INST OF TECHNOLOGY	2
5	UNIV OF WIS-MADISON	9	5	COLUMBIA UNIV MAIN DIV	5
6	UNIV OF ILL URBANA	18	6	OREGON STATE UNIVERSITY	47
7	UNIV OF CAL BERKELEY	14	7	UTAH STATE UNIVERSITY	85
8	UNIV OF PENNSYLVANIA	13	8	UNIVERSITY OF MIAMI	59
9	UNIVERSITY OF ROCHESTER	25	9	CORNELL UNIVERSITY	7
10	UNIVERSITY OF CHICAGO	19	10	COLORADO STATE UNIVERSITY	65
11	UNIV OF CAL LOS ANGELES	6	11	UNIVERSITY OF MICHIGAN	12
12	UNIV OF TEXAS AT AUSTIN	22	12	UNIV OF HAWAII-MANOA	66
13	UNIV OF MD COLLEGE PARK	44	13	CALIFORNIA INST OF TECH	29
14	HARVARD UNIVERSITY	10	14	UNIV OF CAL LOS ANGELES	6
15	MICHIGAN STATE UNIVERSITY	38	15	UNIV OF MD COLLEGE PARK	44
16	UNIV OF CAL SAN DIEGO	8	16	UNIV OF SOUTHERN CAL	16
17	COLUMBIA UNIV MAIN DIV	5	17	UNIVERSITY OF COLORADO	21
18	INDIANA UNIVERSITY	49	18	STANFORD UNIVERSITY	3
19	YALE UNIVERSITY	11	19	UNIVERSITY OF ARIZONA	35
20	JOHNS HOPKINS UNIVERSITY	1	20	TEXAS A&M UNIVERSITY	52

State rankings for fields of science

The top 10 states accounted for about 65 percent of the total federal research funds to institutions in 1984. These states in order of receipt of federal research funds are:

1. California
2. New York
3. Maryland
4. Massachusetts
5. Pennsylvania
6. Texas
7. Illinois
8. Michigan
9. North Carolina
10. Washington

States that rank below the top 10 in total federal research funding to institutions can nevertheless rank in the top 10 for a particular field of science. (See table 3.3.) Utah, for example, ranks 8 in environmental science and 24 in total federal research funds. New Jersey ranks 9 in math and computer science and 22 in total federal research funds.

Table 3.2
Institutions Ranking in the Top 20 in One or More Fields of Science But Not in the Top 20 Overall

Institution	Federal R&D rank FY 1984	State	Geographic region[a]
Brown University	71	Rhode Island	New England
Tufts University	58	Massachusetts	New England
Woods Hole Oceanographic Inst	40	Massachusetts	New England
Boston University	42	Massachusetts	New England
University of Rochester	25	New York	Middle Atlantic
Carnegie-Mellon University	60	Pennsylvania	Middle Atlantic
Princeton University	56	New Jersey	Middle Atlantic
Yeshiva University	27	New York	Middle Atlantic
Rutgers the State Univ of NJ	68	New Jersey	Middle Atlantic
New York University	26	New York	Middle Atlantic
University of Pittsburgh	28	Pennsylvania	Middle Atlantic
University of Miami	59	Florida	South Atlantic
Duke University	23	N. Carolina	South Atlantic
Univ of MD Balt Prof Sch	76	Maryland	South Atlantic
University of Florida	39	Florida	South Atlantic
Georgia Institute of Tech	43	Georgia	South Atlantic
Wake Forest University	96	N. Carolina	South Atlantic
Univ of NC at Chapel Hill	30	N. Carolina	South Atlantic
Univ of MD College Park	44	Maryland	South Atlantic
Univ of Illinois Chicago	73	Illinois	E. North Central
Michigan State University	38	Michigan	E. North Central
University of Dayton	82	Ohio	E. North Central
Indiana University	49	Indiana	E. North Central
Purdue University	37	Indiana	E. North Central
Case Western Reserve Univ	34	Ohio	E. North Central
Ohio State University	32	Ohio	E. North Central
University of Iowa	31	Iowa	W. North Central
Washington University	24	Missouri	W. North Central
Univ of Texas at Austin	22	Texas	W. South Central
Texas A&M University	52	Texas	W. South Central
Colorado State University	65	Colorado	Mountain
New Mexico State Univ	63	New Mexico	Mountain
University of Idaho	91	Idaho	Mountain
University of Arizona	35	Arizona	Mountain
University of New Mexico	50	New Mexico	Mountain
Utah State University	85	Utah	Mountain
University of Colorado	21	Colorado	Mountain
Univ of Hawaii-Manoa	66	Hawaii	Pacific
Oregon State University	47	Oregon	Pacific
California Inst of Tech	29	California	Pacific
Number of institutions	40		

[a]As defined by the National Science Foundation.

Table 3.3
State Rankings by Fields of Science
For 1984

Field of science rank	Math & computer sciences	Federal R&D rank	Field of science rank	Psychology	Federal R&D rank
1	California	1	1	California	1
2	New York	2	2	Pennsylvania	5
3	Massachusetts	4	3	New York	2
4	Pennsylvania	5	4	Massachusetts	4
5	Illinois	7	5	Illinois	7
6	Texas	6	6	Maryland	3
7	Wisconsin	13	7	Texas	6
8	Maryland	3	8	Michigan	8
9	New Jersey	22	9	N. Carolina	9
10	N. Carolina	9	10	New Jersey	22

Table 3.3
State Rankings by Fields of Science
For 1984

Field of science rank	Life sciences	Federal R&D rank	Field of science rank	Engineering	Federal R&D rank
1	California	1	1	Maryland	3
2	New York	2	2	California	1
3	Massachusetts	4	3	Pennsylvania	5
4	Texas	6	4	Massachusetts	4
5	Pennsylvania	5	5	New York	2
6	Illinois	7	6	New Mexico	25
7	Maryland	3	7	Ohio	11
8	N. Carolina	9	8	Texas	6
9	Connecticut	12	9	Georgia	14
10	Michigan	8	10	Illinois	7
	Physical sciences			Environmental sciences	
1	California	1	1	Massachusetts	4
2	Massachusetts	4	2	California	1
3	New York	2	3	New York	2
4	Illinois	7	4	Washington	10
5	Pennsylvania	5	5	Colorado	15
6	Texas	6	6	Florida	17
7	Indiana	18	7	Oregon	21
8	Michigan	8	8	Utah	24
9	Maryland	3	9	Texas	6
10	Wisconsin	13	10	Maryland	3
	Social sciences			Other sciences	
1	California	1	1	California	1
2	New York	2	2	Massachusetts	4
3	Michigan	8	3	Texas	6
4	Pennsylvania	5	4	Oregon	21
5	Massachusetts	4	5	New York	2
6	Illinois	7	6	Michigan	8
7	Ohio	11	7	Minnesota	20
8	N. Carolina	9	8	N. Carolina	9
9	Wisconsin	13	9	New Jersey	22
10	Texas	6	10	Maryland	3

Table 4.1

Rank Order Correlations for Demographic and Socioeconomic Factors[a]
1984

Population rank	0.85
Employed scientists/engineers	0.92
No. of Ph.D.'s granted in science/engineering	0.94
State per capita funds to higher education	0.01
State per capita federal R&D to institutions	0.52
Federal extramural R&D to states excluding universities and colleges	0.77

[a]A high number indicates a high correlation.

SECTION 4

COMPARISON OF FEDERAL RESEARCH FUNDING TO RELATED SOCIOECONOMIC AND DEMOGRAPHIC FACTORS

- State rankings in receipt of federal research funds to institutions highly correlate with such factors as population, number of employed scientists and engineers, number of Ph.D.'s granted. Correlations between federal research funds to institutions and such factors as state per capita federal research funds to institutions and federal extramural research and development funds to other than institutions are moderate. State per capita funding of higher education does not correlate with federal research funding.

- Total federal research funds are highly correlated to NIH research grant funds and, in turn, NIH research grants are highly correlated to NIH research grants to medical schools.

Socioeconomic factors

We wanted to examine the factors that pertain more directly to research capacity of states. (See table 4.3.) Two socioeconomic factors that indicate the availability of researchers within a state are the number of employed scientists and engineers and the number of Ph.D.'s granted in science and engineering by institutions in the state. We compared these two factors with federal research funding to institutions and found that states that rank high in number of employed scientists and engineers and in number of Ph.D.'s granted in science and engineering rank high in federal research funds to institutions.

Federal extramural research and development funding to states is an indicator of the total federal research funding a state receives in addition to research funds for universities and colleges. Federal extramural research and development funds include all federal research and development funds obligated to a state, including research funds for federally funded research and development centers, industrial firms, universities and colleges, nonprofit institutions, and state and local governments. We subtracted out federal research funds to universities and colleges so as not to count it twice. We wanted to determine whether extramural research funds and research funds to institutions were related. We found that federal extramural research and development funds relate moderately to federal research funds to institutions. The top 10 states receiving federal extramural research and development funds include 5 states that are not in the top 10 states for total federal research funds to institutions. They are Virginia, New Mexico, Ohio, Florida, and New Jersey.

Comparison of federal research funds to related factors

We wanted to determine whether state demographic and socioeconomic factors influenced the patterns of distribution of federal research funds to institutions in those states. Demographic and socioeconomic factors are important as indicators of the resources a state has available that enable it to compete for federal research funds.

Using a rank order correlation,[3] we compared federal research funding with state demographic and socioeconomic factors. (See table 4.1.) The results of the rank order correlation show the degree to which state rankings for various factors relate to state rankings in federal research funds to institutions.

Demographic factors

Population is a primary factor to be considered in relation to federal research funds. (See table 4.2.) Consideration of whether there is "undue concentration" of federal research funds involves the question of whether differences between the states simply reflect differences in population size; that is, does the distribution of federal research funds simply mirror each state's population. We found that generally states that rank high in population rank high in federal research funds to institutions. For example, California and New York rank first and second, respectively, in federal research funds and in population. Nevada, Montana, and South Dakota rank 49, 50, and 51, in federal research funds and 43, 44, and 45 in population, respectively.

Although the more populous states generally received more federal research funding than the less populous states, we found that there were substantial differences between states with respect to the per capita share of funds received. Table 4.2 shows that some states with smaller populations receive a higher per capita amount of federal research funds. For example, Vermont ranks 49 in population but 9 in per capita federal research funds and New Mexico ranks 37 in population but 4 in per capita federal research funds.

We also wanted to see whether success in receiving federal research funds reflected the state's own commitment to higher education by using the state's per capita funding to higher

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[3] Rank order correlation measures the extent to which two variables are related or tend to vary together. Correlations vary between values of -1.00 and +1.00; both extremes represent perfect relationships. A correlation of zero indicates the absence of relationship between variables.

Relationship of NIH research grants to state rankings

Because NIH research grants represent 44 percent of the federal research grants, we wanted to determine how these grants influence a state's ranking in total federal research funds. We also wanted to determine whether NIH research grants to medical schools and the size of the medical school, as measured by the number of faculty, are related to a state's ranking in federal research funds. NIH research grants to medical schools are about 56 percent of total NIH research grants.

We found a high correlation between a state's ranking in federal research funds and a state's ranking in NIH research funds (.95). We also found a high correlation between the number of medical school faculty and a state's ranking in federal research funds (.87). In addition state rankings for total NIH research grants highly correlated to state rankings for NIH research grants to medical schools (.97). This indicates that the extent of research activity at medical schools is associated with the state's rank in overall federal research funding.

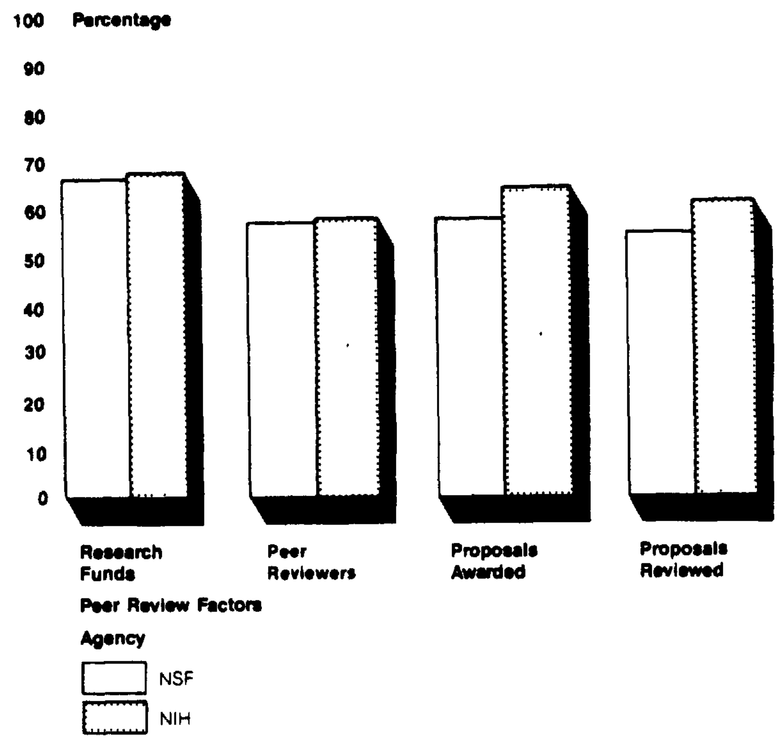
SECTION 5

PEER REVIEW AND DISTRIBUTION OF NIH AND NSF RESEARCH FUNDS

- NIH and NSF peer review participants and the number of NIH and NSF awards are less concentrated than NIH and NSF research funds.
- Success rates for receiving NIH and NSF research funds can vary widely depending on the institution and are not necessarily related to rank within the top 100.
- The research funds awarded by NIH and NSF, which use peer reviewers from outside their agencies, were less concentrated in the top 10 states than the funds awarded by the Department of Defense (DOD), which uses internal agency review.

Figure 5.1

Percent of NSF and NIH Research Funds to Top 10 States by Peer Review Factors



Peer review and NIH and NSF research funds

Peer reviewers from academia, industry, or other government agencies are used by NIH and NSF to select meritorious research projects for funding. According to NIH and NSF officials, peer reviewers are chosen for their expertise and serve as advisors only. NIH and NSF prohibit peer reviewers from reviewing proposals from their home institutions.

Peer review has been criticized by many in the scientific community as an "old boy's network" that is biased in favor of established researchers and institutions. Measuring the validity of this criticism is a difficult task because peer review is subjective, involving judgment of many people on the merits of the proposed research. However, it is possible to examine the relationship between selected aspects of the awards process and the results of the process. We examined two kinds of relationships: (1) the relationship between the geographic and institutional distribution of awards with the distribution of peer reviewers and (2) the relationship between the amount of funding and the success rate[4] of states and institutions.

Distribution of peer reviewers and awards

To examine the concentration of peer reviewers and awards, we compared the states and institutions of the peer reviewers that NIH and NSF used as advisors in 1984 with (1) total NIH and NSF research funds to states and institutions and (2) total proposals reviewed by and awarded to NIH and NSF from the states and institutions.

By state, the data showed that:

-- For NSF, the top 10 states accounted for 67 percent of NSF research funds to institutions. These states supplied 57.2 percent of the peer reviewers, provided 54.3 percent of the proposals reviewed, and received 58.2 percent of the proposals awarded.

-- For NIH, the top 10 states accounted for 68 percent of the research funds to institutions. These states supplied 58.6 percent of the peer reviewers, provided 61.2 percent of the proposals reviewed, and received 64.6 percent of the proposals awarded. (See figure 5.1.)

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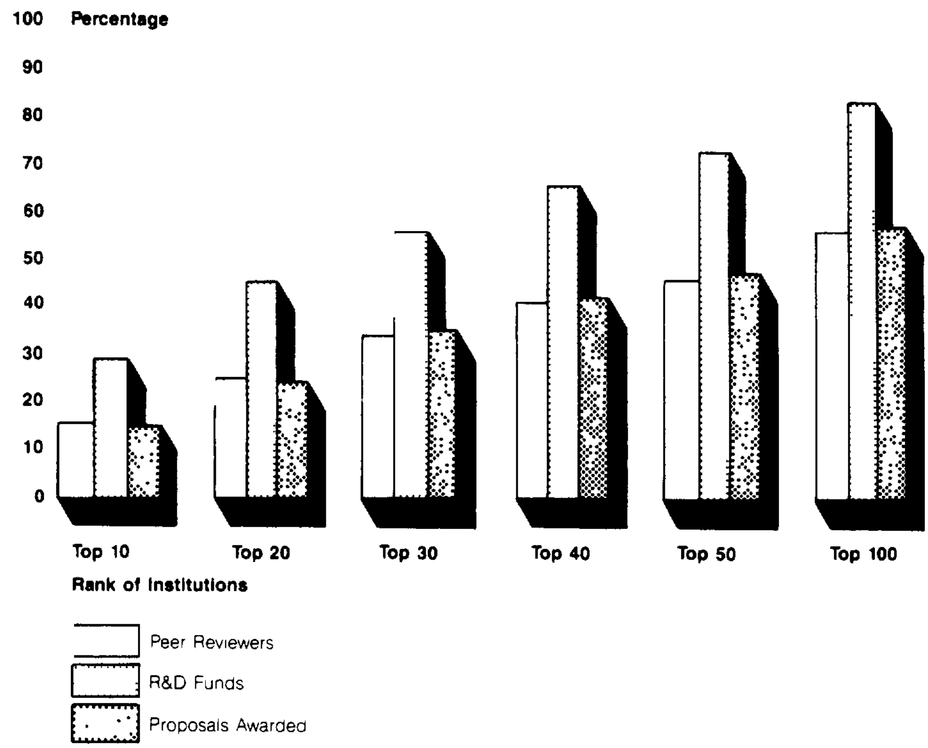
[4] Success rate is the percentage of proposals which receive awards relative to the total number of proposals reviewed.

Figure 5.2

Comparison of NSF Research Funds to Institutions with Peer Reviewers and Proposals Awarded



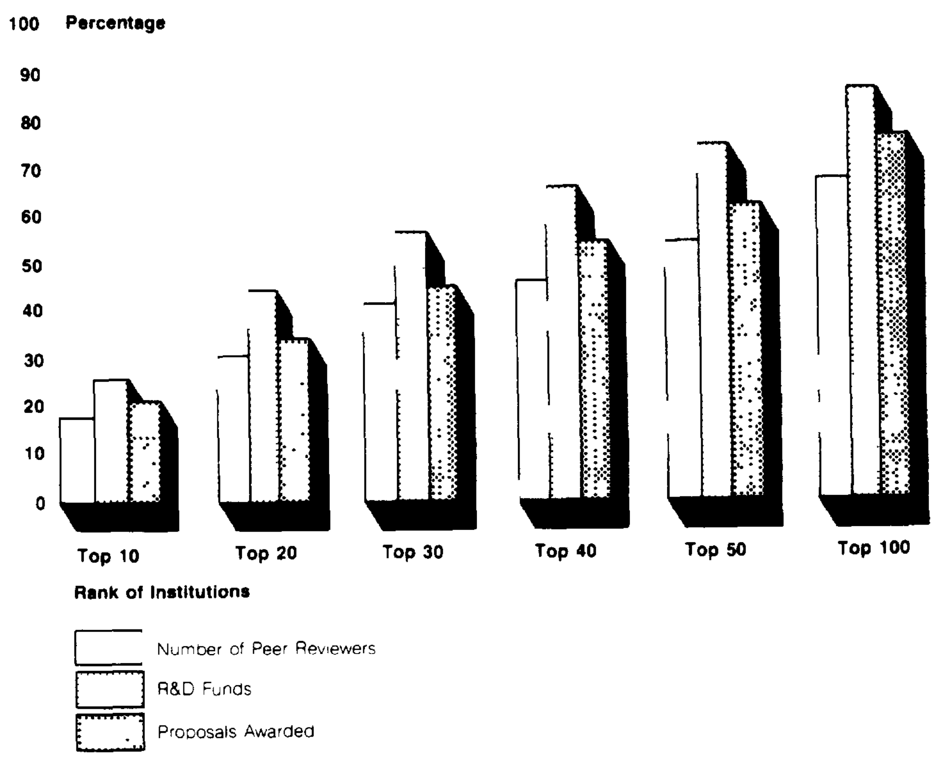
By institution, distribution of peer reviewers showed similar relationships. (See figures 5.2 and 5.3.) The data showed that:

-- For NSF, the top 20 institutions supplied approximately 25 percent of the peer reviewers. They received about 24 percent of the proposals awarded and about 46 percent of NSF research funds to institutions.

-- For NIH, the top 20 institutions supplied about 30 percent of the peer reviewers. They received about 33 percent of the proposals awarded and about 44 percent of the NIH research funds to institutions.

Figure 5.3

Comparison of NIH Research Funds to Institutions with Peer Reviewers and Proposals Awarded



Success rate

We examined success rate to assess the possibility that lower ranked schools may actually have a better success rate as a proportion of proposals reviewed. On an institutional basis, we found that the average institutional success rate was 37 percent for NIH and 40 percent for NSF. NIH and NSF success rates for the top 20 institutions are in the 36 to 76 percent range, with an average success rate of 43 percent for NIH and 50 percent for NSF. Institutions ranking below the top 20 have success rates in the 12 to 70 percent range, with an average success rate of 38 percent for NIH and 35 percent for NSF.

Table 5.1

Rank Comparison of Top 10 States Receiving Research Funds From NSF, NIH, and DOD

Total federal R&D to institutions	External peer review NSF	External peer review NIH	Agency internal review DOD
California	California	California	Maryland
New York	New York	New York	California
Maryland	Massachusetts	Massachusetts	Massachusetts
Massachusetts	Illinois	Pennsylvania	Pennsylvania
Pennsylvania	Pennsylvania	Texas	Texas
Texas	Michigan	Illinois	New Mexico
Illinois	Texas	Maryland	New York
Michigan	Indiana	N.Carolina	Georgia
N. Carolina	Washington	Connecticut	Ohio
Washington	Wisconsin	Washington	Washington

Table 5.2

Percent of Research and Development to Top 10 States by Total Federal and by Selected Agencies

	Percent
Federal research funds to top 10 states	64.6
NSF research funds to top 10 states	67.1
NIH research funds to top 10 states	68.0
DOD research funds to top 10 states	82.0

Effect of external peer review on distribution of research funds

Because external peer review[5] has been criticized as being biased, we compared state rankings for externally peer reviewed funds as represented by NIH and NSF to state rankings for DOD research funds, which are generally not externally peer reviewed. We wanted to determine whether external peer review or internal agency review would make a difference in the state rankings and whether funding awarded through external peer review was more concentrated.

For 1984, the data showed that:

-- A core of states rank within the top 10 for total federal research funds from NIH, NSF, and DOD. These states are California, New York, Massachusetts, Pennsylvania, Texas, and Washington.

-- DOD research funds, which are generally not externally peer reviewed, are more concentrated in the top 10 states than are NIH and NSF research funds. (See tables 5.1 and 5.2.)

This comparison does not indicate that the peer review process by itself yields a more concentrated distribution of funds.

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5 External peer review is peer review by experts located outside the agency awarding grants.

SECTION 6

SUMMARY

SUMMARY

Although distribution of total federal research funds to institutions appears to be concentrated in a few states and institutions, this overall picture can be misleading. When related factors that influence the patterns of distribution of federal research funds are examined, a clearer picture is presented.

Patterns of distribution of total federal research funds to institutions from 1967 to 1984 indicate that the system is stable and that once an institution becomes well established in a particular area, it is able to continually attract federal research funds. However, the system is not closed because institutions can enter the top 100, as 19 have done since 1967. In this period, the data do not necessarily show a relationship between change in an institution's rank and statutory earmarking and past institutional development award programs.

Because fields of science receive different proportions of federal research funds, an institution's overall rank will be affected by the field or fields of science in which it ranks highly, if any. Institutions that rank highly in life science research tend to rank higher in federal research funds because life science contributes over 50 percent of all federal research funds.

Demographic and socioeconomic factors, including population, employed scientists and engineers, number of Ph.D.'s granted in science and engineering, state per capita funds to higher education, and federal extramural research and development, are associated with a state's ranking in federal research funds so that states that rank high in these factors generally rank higher in total federal research funds to institutions. Medical school research also influences a state's ranking because medical schools receive the majority of life sciences research funds.

While peer reviewed NIH and NSF research funds appear to be concentrated in a few institutions and states, peer reviewers are more widely disbursed and therefore are not necessarily where the funds are. In addition, externally peer reviewed funds, as represented by NIH and NSF, are less concentrated in the top 10 states than DOD research funds, which are generally not externally peer reviewed. This comparison indicates that peer review does not by itself account for the concentration of federal research funds to institutions.

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