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ABSTRACT

Responding to a request by the United States Senate, this report examines the patterns of distribution of federal research funds to universities and colleges. These distribution patterns were determined by institution, state, agency, and field of science. In addition, the document provides an analysis of 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. The principal findings include: (1) that although the percentage of federal research and development funds received by the top funded 100 universities and colleges has remained stable from 1967 to 1984, the composition of the top 100 has changed, with 19 institutions moving into the top 100; (2) the total federal research funding to universities and colleges appears to be concentrated in relatively few states and institutions (although this does not hold when examining individual fields of science); and (3) that federal research and development funding to universities and colleges by state positively correlates to certain demographic and socioeconomic factors. (TW)

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United States General Accounting Office

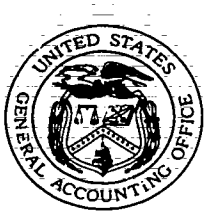
GAO

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

February 1987

UNIVERSITY FUNDING

Patterns of Distribution of Federal Research Funds to Universities



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United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-221714

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

Contents

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.

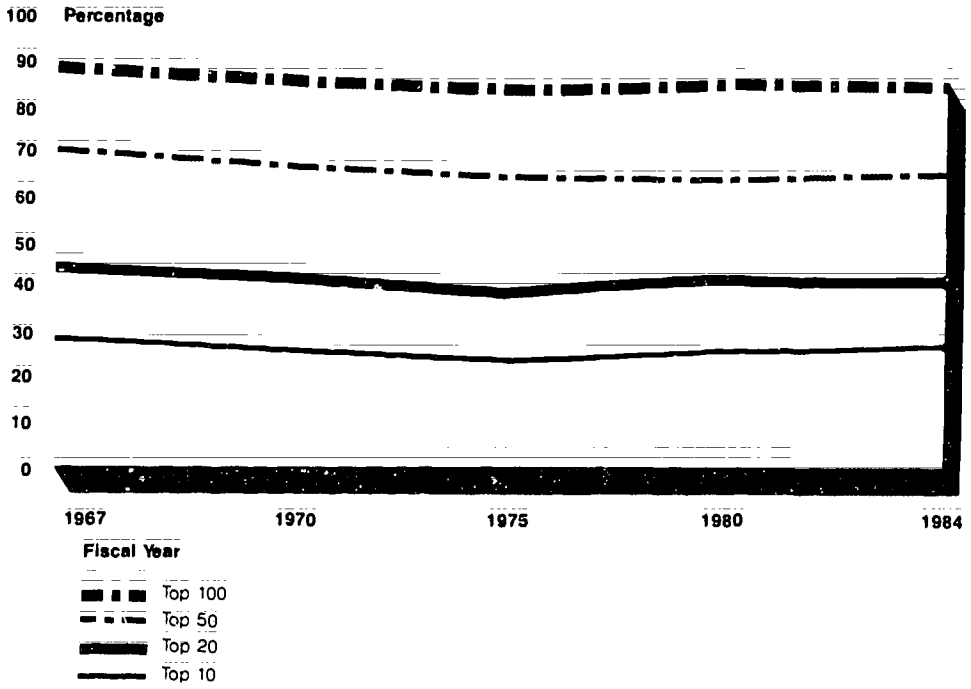
-- Correlate state rankings in federal research and development funds to universities and colleges with the following demographic and socioeconomic factors: population, number of employed scientists and engineers, number of Ph.D.'s granted in science and engineering, state funding of higher education,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



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

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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.

Table 2.4

Major Institutional Development Award Programs
From 1957 to 1974

Program:	NSF Science Development Grants
Primary Objective:	To increase the number of institutions of recognized excellence in research and research education in the sciences.
Time in Effect:	1964 to 1972.
Scope of Effort:	$233 million for 102 universities.
Program:	NIH Health Sciences Advancement Award Program
Primary Objective:	To expand the national capability for research in health sciences by increasing the number of distinguished biomedical research centers of excellence.
Time in Effect:	1966 to 1974.
Scope of Effort:	$26.3 million.
Program:	NIH Health Research Facilities
Primary Objective:	Support for construction, remodeling, alteration, and equipping new and existing buildings to be used for research in health-related sciences.
Time in Effect:	1957 to 1972.
Scope of Effort:	$535 million.
Program:	NASA Sustaining Universities Program
Primary Objective:	To utilize universities in its mission-oriented programs, while at the same time strengthening rather than weakening the universities' traditional teaching function.
Time in Effect:	1962 to 1971.
Scope of Effort:	$224.8 million.
Program:	DOD Project Themis
Primary Objective:	Support of defense-related multidisciplinary research programs at universities not heavily engaged in research for the federal government.
Time in Effect:	1967 to 1971.
Scope of Effort:	$95.5 million: Themis provided start-up funding for 118 interdisciplinary research programs at 76 universities.

Because statutory earmarking of NIH research funds was minimal, we decided to examine programs that provided institutional development awards to determine whether they had any influence on changes in institutional ranking. These award programs provided federal funding to selected universities to perform research in some general area or to strengthen their research capabilities and can be distinguished from individual project grants that are awarded for specific research projects. We reviewed the five major institutional development award programs that were in effect from 1957 to 1974 to determine whether institutions that received these awards had any net change in rank over the 17-year period we examined. (See table 2.4.)

Comparing the top 100 institutions in 1967 with the top 100 in 1984, we found 67 institutions that were in the top 100 in federal research funds for both years and had not changed by merging with other universities or by splitting campuses. Of these 67 institutions:

-- 22 moved up 6 or more ranks from 1967 to 1984.
-- 25 stayed within 5 ranks of their 1967 rank.
-- 20 moved down 6 or more ranks from 1967 to 1984.

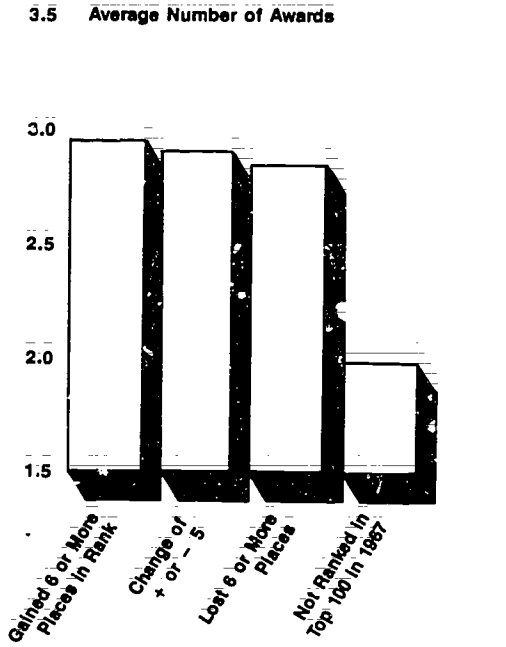
The average award size for institutions with the greatest change in rank, either up or down, was similar. In addition, these awards were, on the average about the same as awards made to institutions with the least change in ranking. (See figure 2.2.)

For the 19 institutions that entered the top 100 by fiscal year 1984 (listed earlier in table 2.1), 9 received institutional development grants. The average number of awards and award size was smaller than for the 67 institutions that were in the top 100 of 1967 and 1984.

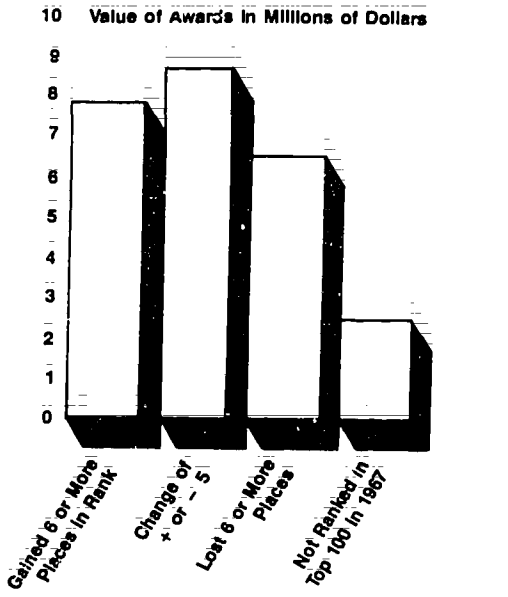
Our data do not demonstrate that receipt of institutional development awards guarantees an increase in an institution's ranking for federal research dollars or is essential to entry into the top 100 institutions.

Figure 2.2

Influence of Institutional Development Award Programs on Change in Institutional Rank



Number of Institutional Changes in Rank, 1967 to 1984



Number of Institutional Changes in Rank, 1967 to 1984

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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.

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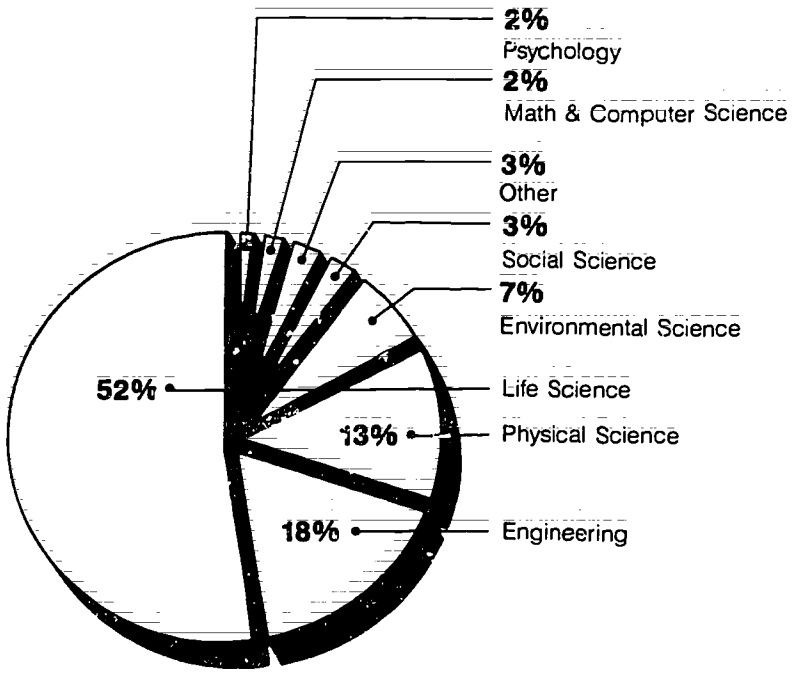
Figure 3.1

Proportion of Federal Research Funds to Institutions by Field of Science



Fiscal Year 1984

Source: National Science Foundation.

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.

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.)

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
1	JOHNS HOPKINS UNIVERSITY	1
2	UNIV OF CAL SAN FRANCISCO	15
3	UNIVERSITY OF WASHINGTON	4
4	YALE UNIVERSITY	11
5	UNIV OF CAL LOS ANGELES	6
6	HARVARD UNIVERSITY	10
7	STANFORD UNIVERSITY	3
8	COLUMBIA UNIV MAIN DIV	5
9	UNIV OF PENNSYLVANIA	13
10	UNIV OF WIS-MADISON	9
11	UNIVERSITY OF MICHIGAN	12
12	YESHIVA UNIVERSITY	27
13	UNIVERSITY OF MINNESOTA	17
14	WASHINGTON UNIVERSITY	24
15	CORNELL UNIVERSITY	7
16	DUKE UNIVERSITY	23
17	UNIV OF CAL SAN DIEGO	8
18	UNIV OF CAL BERKELEY	14
19	MASS INST OF TECHNOLOGY	2
20	UNIVERSITY OF CHICAGO	19

Field of science rank	Engineering	Total federal R&D rank
1	JOHNS HOPKINS UNIVERSITY	1
2	MASS INST OF TECHNOLOGY	2
3	GEORGIA INSTITUTE OF TECH	43
4	UNIV OF SOUTHERN CAL	16
5	UNIV OF TEXAS AT AUSTIN	22
6	PENNSYLVANIA STATE UNIV	20
7	STANFORD UNIVERSITY	3
8	UNIVERSITY OF NEW MEXICO	50
9	NEW MEXICO STATE UNIV	63
10	UNIVERSITY OF WASHINGTON	4
11	UNIVERSITY OF DAYTON	82
12	CARNEGIE-MELLON UNIV	60
13	UNIV OF ILL URBANA	18
14	UNIV OF CAL SAN DIEGO	8
15	CORNELL UNIVERSITY	7
16	UNIV OF CAL BERKELEY	14
17	UNIVERSITY OF IDAHO	91
18	UNIVERSITY OF MICHIGAN	12
19	PURDUE UNIVERSITY	37
20	CASE WESTERN RESERVE UNIV	34

	Physical sciences	
1	MASS INST OF TECHNOLOGY	2
2	STANFORD UNIVERSITY	3
3	CORNELL UNIVERSITY	7
4	CALIFORNIA INST OF TECH	29
5	UNIV OF WIS-MADISON	9
6	UNIV OF ILL URBANA	18
7	UNIV OF CAL BERKELEY	14
8	UNIV OF PENNSYLVANIA	13
9	UNIVERSITY OF ROCHESTER	25
10	UNIVERSITY OF CHICAGO	19
11	UNIV OF CAL LOS ANGELES	6
12	UNIV OF TEXAS AT AUSTIN	22
13	UNIV OF MD COLLEGE PARK	44
14	HARVARD UNIVERSITY	10
15	MICHIGAN STATE UNIVERSITY	38
16	UNIV OF CAL SAN DIEGO	8
17	COLUMBIA UNIV MAIN DIV	5
18	INDIANA UNIVERSITY	49
19	YALE UNIVERSITY	11
20	JOHNS HOPKINS UNIVERSITY	1

	Environmental sciences	
1	WOODS HOLE OCNGRPHIC INST	40
2	UNIV OF CAL SAN DIEGO	8
3	UNIVERSITY OF WASHINGTON	4
4	MASS INST OF TECHNOLOGY	2
5	COLUMBIA UNIV MAIN DIV	5
6	OREGON STATE UNIVERSITY	47
7	UTAH STATE UNIVERSITY	85
8	UNIVERSITY OF MIAMI	59
9	CORNELL UNIVERSITY	7
10	COLORADO STATE UNIVERSITY	65
11	UNIVERSITY OF MICHIGAN	12
12	UNIV OF HAWAII-MANOA	66
13	CALIFORNIA INST OF TECH	29
14	UNIV OF CAL LOS ANGELES	6
15	UNIV OF MD COLLEGE PARK	44
16	UNIV OF SOUTHERN CAL	16
17	UNIVERSITY OF COLORADO	21
18	STANFORD UNIVERSITY	3
19	UNIVERSITY OF ARIZONA	35
20	TEXAS A&M UNIVERSITY	52

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
1	UNIVERSITY OF MICHIGAN	12
2	OHIO STATE UNIVERSITY	32
3	UNIV OF CAL LOS ANGELES	6
4	UNIV OF WIS-MADISON	9
5	STANFORD UNIVERSITY	3
6	HARVARD UNIVERSITY	10
7	JOHNS HOPKINS UNIVERSITY	1
8	UNIV OF ILL URBANA	18
9	UNIVERSITY OF PITTSBURGH	28
10	MICHIGAN STATE UNIVERSITY	38
11	UNIV OF NC AT CHAPEL HILL	30
12	UNIV OF PENNSYLVANIA	13
13	COLUMBIA UNIV MAIN DIV	5
14	UNIV OF TEXAS AT AUSTIN	22
15	YALE UNIVERSITY	11
16	UNIVERSITY OF MINNESOTA	17
17	UNIVERSITY OF WASHINGTON	4
18	UNIV OF CAL BERKELEY	14
19	UNIV OF CAL SAN FRANCISCO	15
20	PENNSYLVANIA STATE UNIV	20

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

	Math and computer sciences	
1	STANFORD UNIVERSITY	3
2	UNIV OF WIS-MADISON	9
3	MASS INST OF TECHNOLOGY	2
4	NEW YORK UNIVERSITY	26
5	UNIV OF CAL BERKELEY	14
6	UNIV OF MD COLLEGE PARK	44
7	CORNELL UNIVERSITY	7
8	UNIV OF ILL URBANA	18
9	UNIVERSITY OF WASHINGTON	4
10	UNIV OF TEXAS AT AUSTIN	22
11	UNIV OF CAL LOS ANGELES	6
12	UNIV OF PENNSYLVANIA	13
13	GEORGIA INSTITUTE OF TECH	43
14	PRINCETON UNIVERSITY	56
15	BROWN UNIVERSITY	71
16	YALE UNIVERSITY	11
17	UNIV OF NC AT CHAPEL HILL	30
18	PURDUE UNIVERSITY	37
19	HARVARD UNIVERSITY	10
20	CARNEGIE-MELLON UNIV	60

	Psychology	
1	UNIVERSITY OF PITTSBURGH	28
2	STANFORD UNIVERSITY	3
3	UNIV OF CAL BERKELEY	14
4	UNIV OF CAL LOS ANGELES	6
5	UNIVERSITY OF MICHIGAN	12
6	UNIVERSITY OF WASHINGTON	4
7	JOHNS HOPKINS UNIVERSITY	1
8	UNIV OF SOUTHERN CAL	16
9	UNIV OF ILL URBANA	18
10	UNIV OF CAL SAN FRANCISCO	15
11	RUTGERS THE ST UNIV OF NJ	68
12	UNIVERSITY OF MINNESOTA	17
13	UNIVERSITY OF COLORADO	21
14	UNIV OF PENNSYLVANIA	13
15	PENNSYLVANIA STATE UNIV	20
16	MASS INST OF TECHNOLOGY	2
17	HARVARD UNIVERSITY	10
18	UNIV OF CAL SAN DIEGO	8
19	DUKE UNIVERSITY	23
20	BOSTON UNIVERSITY	42

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.

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 3.3
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 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

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.

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.

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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.

education as an indicator of its commitment. We found that state per capita funding of higher education has a low rank order correlation with federal research funds to institutions within a state. For example, Alaska, which ranks 46 in federal research funds to institutions, ranks first in state per capita funding to higher education. Wyoming, which ranks 42 in federal research funds, ranks second in state per capita funding to higher education.

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Table 4.2

State Rankings for Demographic Factors, 1984

State	Federal R&D funds to institutions FY 1984	Rank	State population July 1984	Rank	Per capita federal R&D to institutions	Rank	Per capita state funds to higher education	Rank
	(000 omitted)							
California	$ 792,770	1	25,622	1	$ 30.94	11	$144.44	8
New York	581,251	2	17,735	2	32.77	10	133.58	13
Maryland	532,841	3	4,349	19	122.52	1	117.68	22
Massachusetts	453,875	4	5,798	12	78.28	2	66.57	49
Pennsylvania	289,296	5	11,901	4	24.31	17	67.96	48
Texas	280,464	6	15,989	3	17.54	27	154.15	6
Illinois	226,377	7	11,511	5	19.67	23	98.79	33
Michigan	157,889	8	9,075	8	17.40	28	108.71	28
N. Carolina	155,208	9	6,165	10	25.18	16	137.17	12
Washington	154,323	10	4,349	20	35.48	8	129.98	15
Ohio	148,999	11	10,752	7	13.86	37	85.53	41
Connecticut	128,786	12	3,154	27	40.83	5	75.58	46
Wisconsin	126,771	13	4,766	16	26.60	15	155.50	5
Georgia	98,665	14	5,837	11	16.90	29	100.39	32
Colorado	97,761	15	3,178	26	30.76	12	109.89	26
Missouri	94,072	16	5,008	15	18.78	24	78.36	44
Florida	91,555	17	10,976	6	$8.34	42	91.64	38
Indiana	87,369	18	5,498	14	15.89	31	98.50	34
Virginia	83,170	19	5,636	13	14.76	35	97.54	35
Minnesota	73,721	20	4,162	21	17.71	26	111.71	25
Oregon	72,618	21	2,674	30	27.16	14	133.24	14
New Jersey	71,131	22	7,515	9	$9.47	39	87.32	39
Tennessee	65,865	23	4,717	17	13.96	36	79.83	43
Utah	65,774	24	1,652	35	39.81	6	125.66	18
New Mexico	65,427	25	1,424	37	45.95	4	129.74	16
Iowa	61,933	26	2,910	29	21.28	20	138.82	11
Alabama	60,489	27	3,990	22	15.16	33	109.42	27
Arizona	54,295	28	3,053	28	17.78	25	140.05	10
D.C.	46,096	29	623	47	73.99	3	101.09	31
Louisiana	40,098	30	4,462	18	8.99	40	116.52	23
Rhode Island	35,219	31	962	42	36.61	7	96.71	37
Kansas	25,845	32	2,438	32	10.60	38	151.51	7
Hawaii	24,691	33	1,039	39	23.76	18	163.08	3
S. Carolina	24,424	34	3,300	24	7.40	44	113.18	24
Oklahoma	24,010	35	3,298	25	7.28	45	107.90	29
Nebraska	23,816	36	1,606	36	14.83	34	144.22	9
New Hampshire	22,409	37	977	41	22.94	19	43.63	51
Kentucky	21,281	38	3,723	23	5.72	49	118.81	20
Vermont	18,412	39	530	49	34.74	9	61.85	50
Mississippi	18,103	40	2,598	31	6.97	46	125.82	17
Idaho	15,765	41	1,001	40	15.75	32	105.48	30
Wyoming	15,349	42	511	50	30.04	13	225.03	2
N. Dakota	13,534	43	686	46	19.73	22	158.88	4
Arkansas	11,935	44	2,349	33	5.08	51	86.54	40
West Virginia	11,075	45	1,952	34	5.67	50	97.08	36
Alaska	10,611	46	500	51	21.22	21	326.71	1
Delaware	10,123	47	613	48	16.51	30	121.31	19
Maine	7,999	48	1,156	38	6.92	47	68.80	47
Nevada	7,299	49	911	43	8.01	43	78.13	45
Montana	7,014	50	824	44	8.51	41	117.93	21
S. Dakota	4,701	51	706	45	6.66	48	80.81	42
Total	$5,612,504		236,161					
				Average	$ 23.77		$113.90	

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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.

Table 4.3

State Rankings for Socioeconomic Factors
1984

State	Federal R&D funds to universities and colleges	Employed scientists/ engineers	No. of Ph.D.'s granted	Federal extramural R&D to states (a)
California	1	1	1	1
New York	2	2	2	3
Maryland	3	10	15	6
Massachusetts	4	9	4	2
Pennsylvania	5	4	6	12
Texas	6	3	5	7
Illinois	7	6	3	18
Michigan	8	8	8	22
North Carolina	9	19	9	26
Washington	10	12	14	11
Ohio	11	5	7	8
Connecticut	12	16	19	15
Wisconsin	13	21	11	39
Georgia	14	22	20	27
Colorado	15	15	17	21
Missouri	16	17	18	14
Florida	17	13	12	9
Indiana	18	20	10	28
Virginia	19	14	16	4
Minnesota	20	18	21	13
Oregon	21	25	27	36
New Jersey	22	7	13	10
Tennessee	23	23	24	16
Utah	24	30	26	25
New Mexico	25	34	37	5
Iowa	26	31	23	33
Alabama	27	26	32	20
Arizona	28	28	22	23
DC	29	11	25	17
Lousiana	30	24	33	32
Rhode Island	31	42	31	35
Kansas	32	33	28	31
Hawaii	33	35	40	45
South Carolina	34	29	29	29
Oklahoma	35	27	35	40
Nebraska	36	41	34	48
New Hampshire	37	40	41	30
Kentucky	38	32	36	44
Vermont	39	48	44	42
Mississippi	40	36	30	41
Idaho	41	39	47	24
Wyoming	42	49	45	43
North Dakota	43	50	46	46
Arkansas	44	43	42	49
West Virginia	45	38	39	37
Alaska	46	45	51	47
Delaware	47	37	38	34
Maine	48	44	49	38
Nevada	49	47	48	19
Montana	50	46	43	51
South Dakota	51	51	50	50

(a) Excludes federal R&D to universities and colleges.

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.

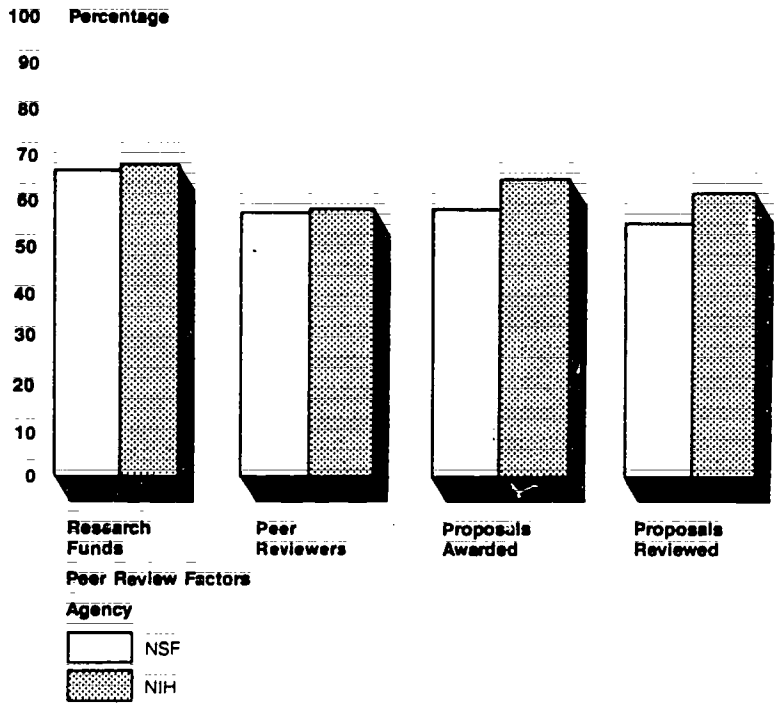
SECTION 5

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



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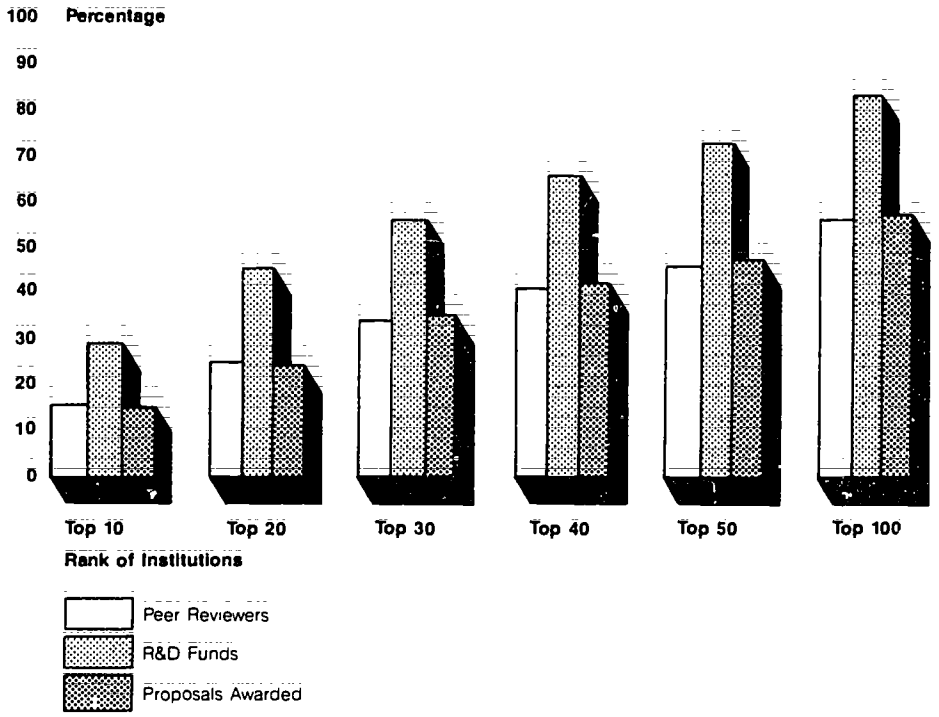
[4] Success rate is the percentage of proposals which receive awards relative to the total number of proposals reviewed.

Figure 5.2

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



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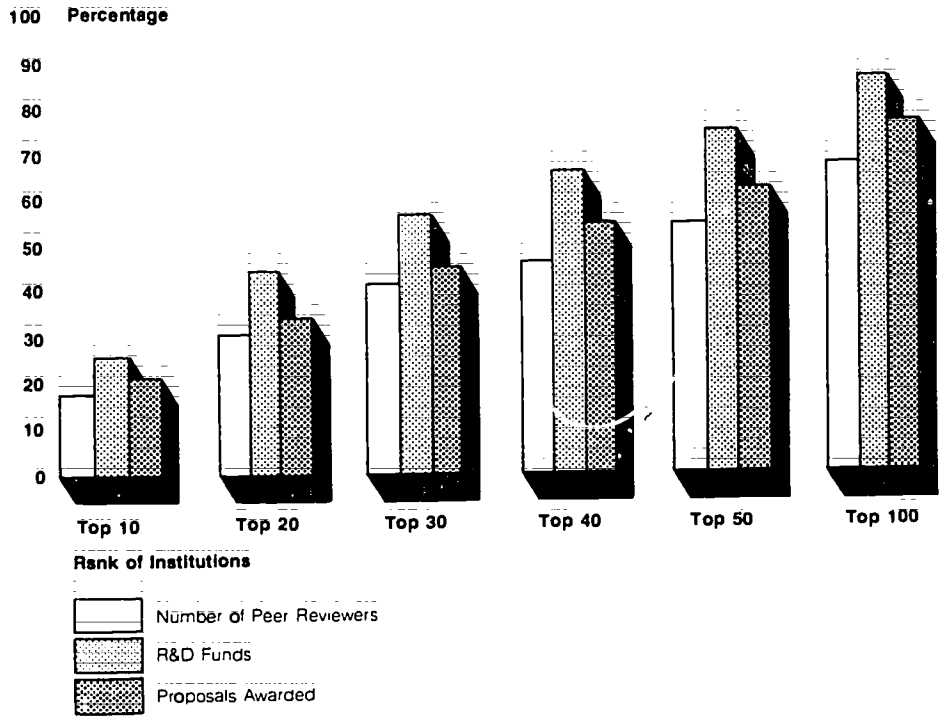
By institution, distribution of peer reviewers showed similar relationships. (See figures 5.2 and 5.3.) The data showed that:

-- 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



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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.

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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		Agency internal review
	NSF	NIH	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.

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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.

APPENDIX I

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