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AUTHOR Rapoport, Alan I.
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ABSTRACT

This brief examines changes in research and development emphasis in the academic sector--which conducts roughly half of the nation's basic research--by analyzing shifts in the science and engineering field shares during the 1970s, 1980s, and 1990s. Both the shifting distribution of overall funds among science and engineering fields and the effects of these changes in terms of their impacts on the individual fields are discussed. Data is examined to determine whether major differences exist in the shifts in field shares for federal and nonfederal funds for academic research and development. (CCM)

How Has the Field Mix of Academic R&D Changed?

By Alan I. Rapoport

SRS Issue Brief
December 2, 1998

National Science Foundation

NATIONAL SCIENCE FOUNDATION
Directorate for Social, Behavioral, and Economic Sciences

HOW HAS THE FIELD MIX OF ACADEMIC R&D CHANGED?

by Alan I. Rapoport

Division of Science Resources Studies

ISSUE BRIEF

December 2, 1998

The shares of academic engineering and medical sciences R&D increased by about 5-percentage points each between 1973 and 1996.

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99-309

Many Federal agencies support research and development (R&D) in furtherance of their missions. Changes in agency budgets tend to raise concern in the scientific community about potential impacts on particular science and engineering (S&E) fields and the overall balance of Federal R&D support. For example, a declining Department of Defense budget in the post-Cold War period led to fears of declining support for engineering and the physical sciences. In recent years, strong increases in the budgets of the National Institutes of Health have stirred anxiety about funding imbalances between the life sciences and other fields.

This Issue Brief examines changes in R&D emphasis in the academic sector, which conducts roughly half of the Nation's basic research, by analyzing shifts in S&E field shares during the 1970s, 1980s and 1990s. Tradeoffs among fields are examined—i.e., whether certain fields have gained or lost "market share." Two points are important to bear in mind:

- A shift of 1-percentage point among academic R&D fields may appear small but involves significant resources—$230 million in 1996.
- The impact on a given field of a percentage point change in the overall funds distribution critically depends on its size. In 1996, $230 million for the life sciences amounted to 1.8 percent of their total; for the smaller social sciences, to 20.8 percent.

Thus, the Issue Brief discusses both the shifting distribution of overall funds among S&E fields and the effects of these changes in terms of their impacts on the individual fields.

Finally, the Issue Brief also examines whether major differences exist in the shifts in field shares for Federal and nonfederal funds for academic R&D. This focus is introduced because the Federal Government provides about 60 percent of the financial support for academic R&D.

Changes in Absolute Shares of Academic R&D

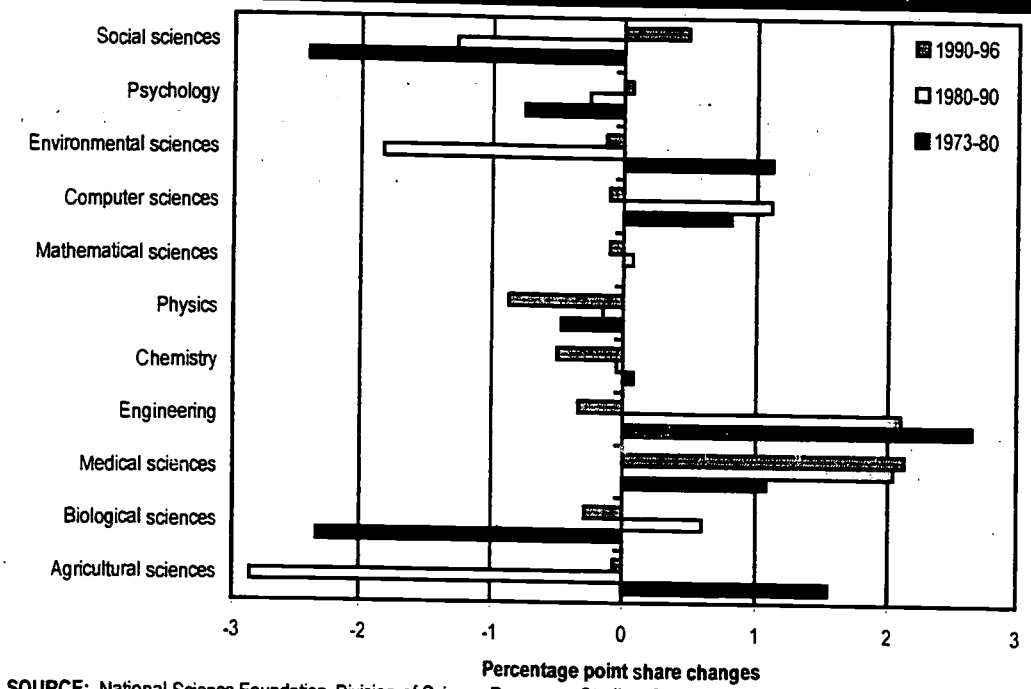
From 1973-96, absolute shares of academic R&D have:

- increased for the medical sciences, engineering, computer sciences, and astronomy;
- remained roughly constant for the mathematical sciences; and
- declined for the social sciences, psychology, environmental (earth, atmospheric, and oceanographic) sciences, physics, chemistry, biological sciences, and agricultural sciences.

The medical sciences' share has risen in each of the three decades, and the percentage point share increase has grown in each succeeding decade—this is the only field for which this is true (figure 1). The medical sciences' share of academic R&D increased by over 5-percentage points between 1973 and 1996, rising from 22.4 to 27.6 percent of total academic R&D. The only other field with an increase of similar magnitude was engineering, which increased from 11.6 to 16.0 percent of academic R&D over the same period. However, the engineering share declined slightly since 1990 (-0.3 of a percentage point) after increasing by more than 2-percentage points in both the 1970s and 1980s. The computer sciences also increased their share by about 1-percentage point in both the 1970s and 1980s but may have had a slight decline in the 1990s. Within the physical sciences, astronomy's share also increased in all three decades but only by 0.4 of a percentage point overall (table 1).

The approximate 12-percentage point increase in the four fields above whose R&D shares rose over the past three decades was balanced by decreases in share for the social sciences (-3.2 percentage points), biological sciences (-2.0 percentage points), other sciences (-1.8 percentage points), agricultural sciences (-1.4 percentage points), psychology (-0.9 of a percentage points), environmental sciences

Figure 1. Changes in the share of academic R&D in S&E fields: 1973-80, 1980-90, 1990-96



SOURCE: National Science Foundation, Division of Science Resources Studies, Survey of Scientific and Engineering Expenditures at Universities and Colleges; CASPAR Database System (http://caspar.nsf.gov/webcaspar/).

(-0.8 of a percentage point), and in two fields within the physical sciences—physics (-1.5 percentage points) and chemistry (-0.5 of a percentage point). The physics share declined in all three decades.

Within the social sciences, the R&D shares for each of the three main fields—economics, political science, and sociology—declined over the entire period. Although the economics share declined in each of the three decades, the shares for both political science and sociology appeared to increase slightly in the 1990s. Within the environmental sciences, the three major fields—atmospheric sciences, earth sciences, and oceanography—each experienced a decline in its share between 1980 and 1996 (data for the environmental sciences were not disaggregated until 1980).

As indicated previously, a 1-percentage point share loss or gain represented $230 million in R&D funds in 1996. However, the change in the R&D stock—the cumulative amount expended, assuming no depreciation—for a given field that had an increased or decreased share over a three decade period would be considerably greater than the dollar flows lost or gained in any given year. For instance, the change in engineering share between 1973 and 1996 resulted in a gross academic engineering R&D stock that is about $10 billion (current dollars) higher than it would have been if engineering's share of the academic R&D budget had remained constant over that period.

The data show a clear recent shift in emphasis towards the medical sciences. In the 1970s, the shares of agricultural sciences and engineering rose more than that of the medical sciences. In the 1980s, only the engineering share increased slightly more than did the medical sciences share; the other fields experiencing share increases—computer and biological sciences—rose less than the medical sciences. In the 1990s, the medical sciences' share rose far more than that of any other field. With the exception of modest share gains for astronomy, some of the social sciences fields, psychology, and a couple of engineering fields, all other fields have either lost or maintained share during the 1990s.

Changes in Relative Shares of Academic R&D

The absolute shifts in share that occurred during the past three decades had differential relative effects—i.e., measured against their own begin-

In the 1990s, the academic R&D share of the medical sciences increased in absolute terms far more than any other S&E field.

Table 1. Changes in the share of academic R&D in an S&E field: 1973-96

Fields	[percentage point share changes] 1973-80	1980-90	1990-96	1973-96
Engineering	2.7	2.1	-0.3	4.4
Aeronautical and astronautical	NA	0.1	0.0	0.1
Chemical engineering	NA	0.3	0.0	0.4
Civil engineering	NA	0.4	0.2	0.6
Electrical engineering	NA	1.0	-0.3	0.8
Mechanical engineering	NA	0.1	-0.1	-0.1
Metallurgical and materials	NA	NA	-0.1	-0.1
Other engineering	NA	-1.6	0.0	-1.6
Physical sciences	-0.2	-0.1	-1.3	-1.6
Astronomy	0.1	0.1	0.2	0.4
Chemistry	0.1	0.0	-0.5	-0.5
Physics	-0.5	-0.2	-0.9	-1.5
Other physical sciences	0.0	0.0	-0.1	0.0
Environmental sciences	1.1	-1.8	-0.1	-0.8
Atmospheric	NA	-0.2	-0.1	-0.3
Earth sciences	NA	-0.9	-0.2	-1.1
Oceanography	NA	-0.6	-0.1	-0.7
Other environmental sciences	NA	-0.1	0.2	0.1
Mathematical sciences	0.0	0.1	-0.1	0.0
Computer sciences	0.8	1.1	-0.1	1.8
Life sciences	0.0	0.5	1.6	2.2
Agricultural sciences	1.5	-2.9	-0.1	-1.4
Biological sciences	-2.3	0.6	-0.3	-2.0
Medical sciences	1.1	2.0	2.1	5.2
Other life sciences	-0.3	0.7	-0.1	0.3
Psychology	-0.7	-0.3	0.1	-0.9
Social sciences	-2.4	-1.3	0.5	-3.2
Economics	-0.2	-0.3	-0.1	-0.5
Political science	0.0	-0.2	0.1	-0.1
Sociology	-0.7	-0.6	0.2	-1.1
Other social sciences	-1.6	-0.2	0.2	-1.5
Other sciences	-1.3	-0.3	-0.2	-1.8

NOTES: For metallurgical and materials engineering, the change in shares is from 1990-96; for all other engineering subfields and for environmental sciences subfields, the change is from 1980-96. NA=not available.

SOURCES: National Science Foundation, Division of Science Resources Studies, Survey of Scientific and Engineering Expenditures at Universities and Colleges; CASPAR Database System (http://caspar.nsf.gov/webcaspar/).

ning share base—for the fields affected. In relative terms, the fields with the largest increases in their shares between 1973 and 1996 were:

- the computer sciences (147 percent, from 1.2 to 3.1 percent);
- astronomy (45 percent, from 0.8 to 1.2 percent);
- engineering (38 percent, from 11.6 to 16.0 percent); and
- the medical sciences (23 percent, from 22.4 to 27.6 percent).

The fields with the largest declines in their relative shares were the social sciences (-40 percent, from 8.0 to 4.8 percent), psychology (-37 percent, from 2.6 to 1.6 percent), and physics (-26 percent, from 5.8 to 4.3 percent) (table 2).

Federal and Nonfederally funded Academic R&D

There are notable differences in the field patterns of academic R&D supported by Federal versus nonfederal funds. In general, Federal funding has put relatively more emphasis on the physical, environmental, medical, and biological sciences; nonfederal support has placed relatively more emphasis on agricultural and social sciences (table 2).

Changes in the absolute shares of both federally and nonfederally funded R&D behaved similarly to total academic R&D. On the Federal side, medical sciences had the largest absolute share increase in both the 1980s and 1990s with engineering having the largest absolute share increase in the 1970s. In contrast to its declining share of total academic R&D, the engineering share of federally supported academic R&D increased slightly during the 1990s. Declining absolute shares on the Federal side in the 1990s were in the mathematical sciences, physics, chemistry, and the biological sciences. Most other fields had increases, albeit small ones except for those in the medical and social sciences. On the nonfederal side the medical sciences, social sciences, astronomy, aeronautical and astronautical engineering, and civil engineering have increased shares in the 1990s; the increase in the medical sciences share has been the largest in absolute magnitude. Conversely, nonfederal R&D shares dropped by about 0.5-percentage points in the computer sciences, environmental sciences, physical sciences, and agricultural sciences during the 1990s, and by 1.1-percentage points in engineering (table 2).

This Issue Brief was prepared by:

Alan Rapoport
Division of Science Resources Studies
National Science Foundation
4201 Wilson Boulevard, Suite 965
Arlington, VA 22230

703-306-1776 x7208
arapopor@nsf.gov

Table 2. Share of academic R&D in an S&E field--total, Federal, and nonfederal: 1973, 1980, 1990, and 1996

Fields	Total R&D				Federal R&D				Nonfederal R&D			
	1973	1980	1990	1996	1973	1980	1990	1996	1973	1980	1990	1996
	(1992 constant dollars in millions)											
Total Academic R&D	8,379	10,227	17,483	20,846	5,768	6,913	10,345	12,519	2,611	3,314	7,138	8,327
	(percent)											
Total of all S&E fields	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Engineering	11.6	14.2	16.3	16.0	12.0	14.4	15.8	16.0	10.6	13.8	17.0	15.9
Aeronautical and astronautical	NA	0.9	1.0	1.0	NA	1.0	1.3	1.2	NA	0.6	0.5	0.7
Chemical engineering	NA	1.0	1.3	1.4	NA	1.0	1.1	1.2	NA	1.1	1.6	1.5
Civil engineering	NA	1.4	1.7	2.0	NA	1.3	1.2	1.4	NA	1.5	2.5	2.8
Electrical engineering	NA	3.0	4.1	3.8	NA	3.4	4.5	4.3	NA	2.3	3.5	3.1
Mechanical engineering	NA	2.3	2.4	2.3	NA	2.3	2.5	2.5	NA	2.4	2.3	2.0
Metallurgical and materials	NA	NA	1.7	1.6	NA	NA	1.4	1.4	NA	NA	2.0	1.9
Other engineering	11.6	5.6	4.1	4.0	12.0	5.5	3.8	4.0	10.6	6.0	4.5	4.0
Physical sciences	11.4	11.2	11.1	9.8	13.5	13.5	13.6	11.9	6.7	6.2	7.4	6.8
Astronomy	0.8	1.0	1.0	1.2	0.9	1.1	1.2	1.3	0.7	0.7	0.9	1.0
Chemistry	3.9	4.0	4.0	3.5	4.4	4.6	4.6	4.1	3.0	2.8	3.1	2.6
Physics	5.8	5.3	5.2	4.3	7.3	6.8	6.8	5.5	2.4	2.2	2.9	2.5
Other physical sciences	0.8	0.9	0.9	0.8	0.9	1.0	1.1	1.0	0.5	0.6	0.6	0.6
Environmental sciences	7.3	8.4	6.6	6.4	7.9	9.1	7.1	7.2	5.8	6.9	5.8	5.3
Atmospheric	NA	1.3	1.1	1.0	NA	1.6	1.4	1.3	NA	0.6	0.6	0.5
Earth sciences	NA	3.1	2.2	2.0	NA	3.2	2.1	1.9	NA	2.9	2.3	2.0
Oceanography	NA	2.9	2.3	2.3	NA	3.3	2.7	2.6	NA	2.0	1.7	1.7
Other environmental sciences	7.3	1.1	1.0	1.2	7.9	1.0	0.9	1.3	5.8	1.4	1.2	1.1
Mathematical sciences	1.3	1.3	1.4	1.3	1.4	1.5	1.7	1.5	0.9	0.9	0.9	0.9
Computer sciences	1.2	2.0	3.2	3.1	1.3	2.1	3.6	3.7	1.2	1.9	2.6	2.1
Life sciences	53.0	53.1	53.6	55.2	51.1	51.0	52.7	53.5	57.3	57.4	54.8	57.8
Agricultural sciences	9.6	11.1	8.3	8.2	4.8	5.1	3.7	4.0	20.3	23.8	15.0	14.5
Biological sciences	19.3	17.0	17.6	17.3	20.1	18.6	19.1	18.6	17.6	13.6	15.3	15.3
Medical sciences	22.4	23.5	25.5	27.6	24.5	25.8	27.7	28.9	17.8	18.5	22.3	25.7
Other life sciences	1.8	1.5	2.2	2.1	1.8	1.5	2.2	1.9	1.7	1.5	2.2	2.3
Psychology	2.6	1.8	1.6	1.6	3.0	2.0	1.7	1.8	1.7	1.5	1.3	1.3
Social sciences	8.0	5.6	4.3	4.8	6.7	4.4	2.3	3.1	11.0	8.0	7.2	7.4
Economics	1.7	1.5	1.2	1.2	1.1	1.1	0.6	0.7	2.8	2.4	2.2	2.0
Political science	0.9	0.9	0.7	0.8	0.5	0.6	0.3	0.5	1.7	1.6	1.4	1.3
Sociology	2.1	1.4	0.8	1.0	2.0	1.4	0.6	0.9	2.3	1.6	1.1	1.2
Other social sciences	3.3	1.8	1.6	1.8	3.0	1.4	0.9	1.1	4.2	2.5	2.5	2.8
Other sciences	3.7	2.4	2.1	1.8	3.1	1.9	1.4	1.2	4.9	3.5	3.0	2.7

NOTE: NA=not available

SOURCES: National Science Foundation, Division of Science Resources Studies, Survey of Scientific and Engineering Expenditures at Universities and Colleges; CASPAR Database System (http://caspar.nsf.gov/webcaspar/).

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