

II. THE ISSUES IN CONTEXT

To understand the context of the issues, trends for the following indicators were analyzed: the NSF's overall and research budget, award size and duration, proposal submission rates, funding rates for proposals, and funding rates for PIs.

The NSF Budget

As noted in the introduction, the competition for NSF funding has grown more intense in recent years as the funding rate for research proposals has decreased from 30% in FY 2000 to 21% in FY 2006. This decrease occurred even though the NSF budget increased annually through FY 2004 (Figure 1). The NSF budget was cut in FY 2005, but was then increased in FY 2006. Although the overall FY 2006 budget was still below the FY 2004 level, the level of the Research and Related Activities (R&RA) account within the overall FY 2006 budget was slightly higher than the FY 2004 amount. Clearly, the proposal funding rate is being influenced by other factors beyond the size of the NSF budget.

Figure 1
Comparison of Trends in Research Proposal Funding Rates
and Growth of the NSF Research Budget

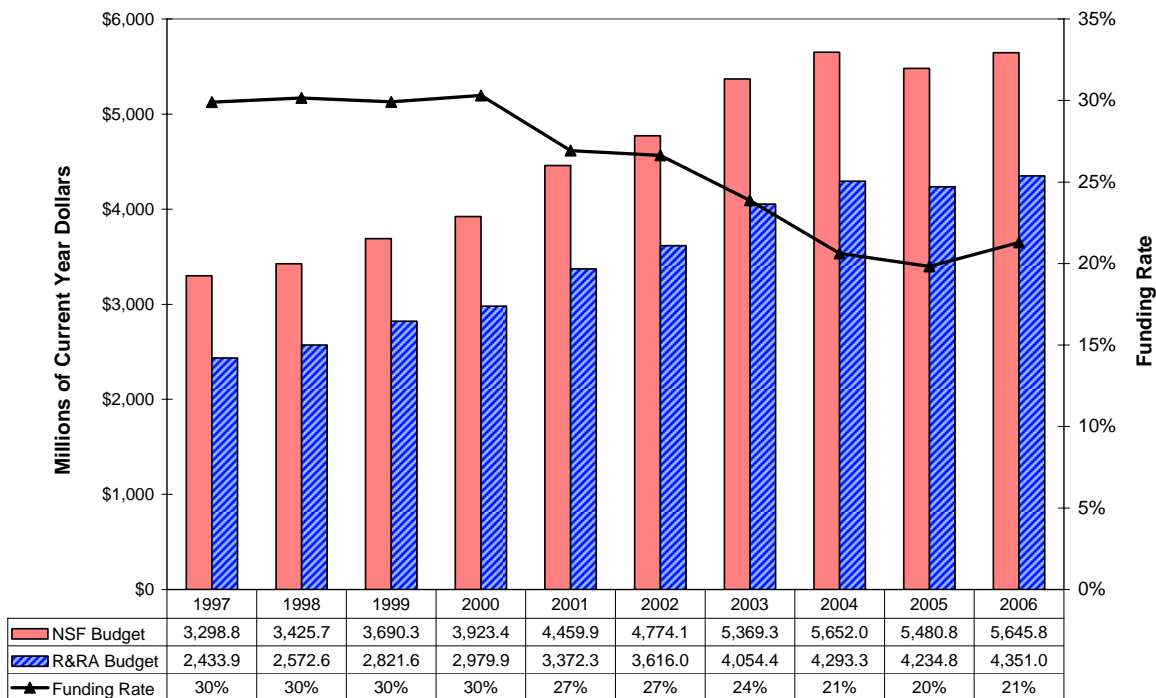


Figure legend: A comparison of trends in the growth of the total NSF budget and the Research and Related Activities (R&RA) portion of the NSF budget with changes in the research proposal funding rate shows that the decline in funding rate occurred at the same time that both the R&RA account and the NSF budget as a whole were increasing (the research portion of NSF's budget is approximately 75% of the total budget). Budget numbers are shown as current dollars, i.e., not adjusted for inflation. Source: NSF Budget Division

Award Size and Duration

In the FY 2001-2006 NSF Government Performance and Results Act (GPRA) Strategic Plan, NSF discussed the need to increase the average award size and award duration.¹⁰ It had become increasingly apparent that individual NSF research awards were not large enough to enable a PI's research efforts.¹¹ It was thought that longer, larger grants would increase productivity by minimizing the time PIs would spend writing multiple proposals and managing administrative tasks, providing increased stability for supporting graduate students, and facilitating collaborations to address particularly complex issues. In its December 2003 report to Congress, the NSB said that "increasing the average NSF research award size and duration" was one of its highest priorities for increased NSF investment.¹²

In response to these policy statements, NSF made a concerted effort to increase award size and duration. Between FY 2000 and FY 2005, the mean annual award size of research awards increased 41% (from approximately \$101,200 per year to approximately \$142,600 per year), decreasing somewhat in FY 2006 (to approximately \$134,500 per year). During this same period of time, the average award duration stayed fairly stable at close to three years. Figure 2 shows that as the award size (mean and median) increased, the overall research proposal funding rate decreased.

Figure 2
Comparison of Trends in Changes in Award Size and Research Proposal Funding Rates

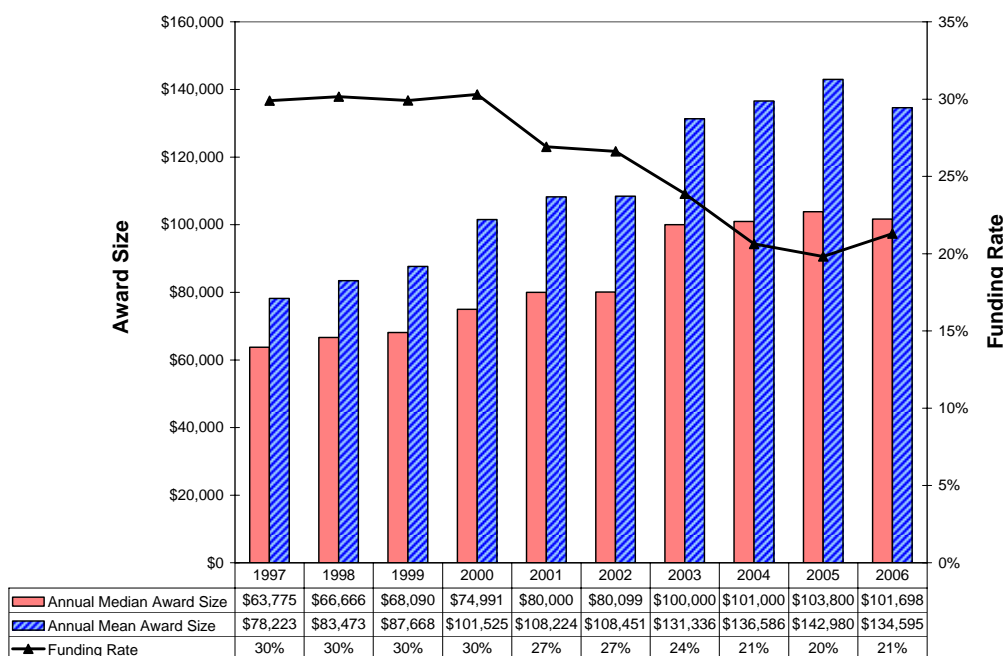


Figure legend: Trends in the median and mean annual award size in current dollars (i.e. not adjusted for inflation) are contrasted with the change in research proposal funding rate. The data show that funding rates decreased at the same time that award sizes increased. Source: NSF Budget Division

¹⁰ NSF GPRA Strategic Plan, FY 2001-2006 (NSF 01-04, <http://www.nsf.gov/pubs/2001/nsf0104/nsf0104.pdf>).

¹¹ NSF Report on Efficiency of Grant Size and Duration (NSF 04-205, prepared by Mathematica Policy Research, Inc., <http://www.nsf.gov/pubs/2004/nsf04205/>)

¹² "Fulfilling the Promise: A Report to Congress on the Budgetary and Programmatic Expansion of the National Science Foundation" (NSB 03-151).

Research Proposal Submission Rates

Figure 3 shows that from FY 1997 through FY 1999 NSF received and acted upon a fairly constant number of research proposals annually (approximately 20,000), and made a fairly constant number of awards, sustaining a funding rate of approximately 30%. Beginning in FY 2000, there was a steady increase in the number of research proposals submitted each year. By FY 2004, proposal submissions had climbed to over 31,000 per year, an increase of nearly 50%. As the number of research proposals rose, the funding rate began to decline.

Figure 3
Comparison of Trends in Changes in Research Proposal Numbers and Funding Rates

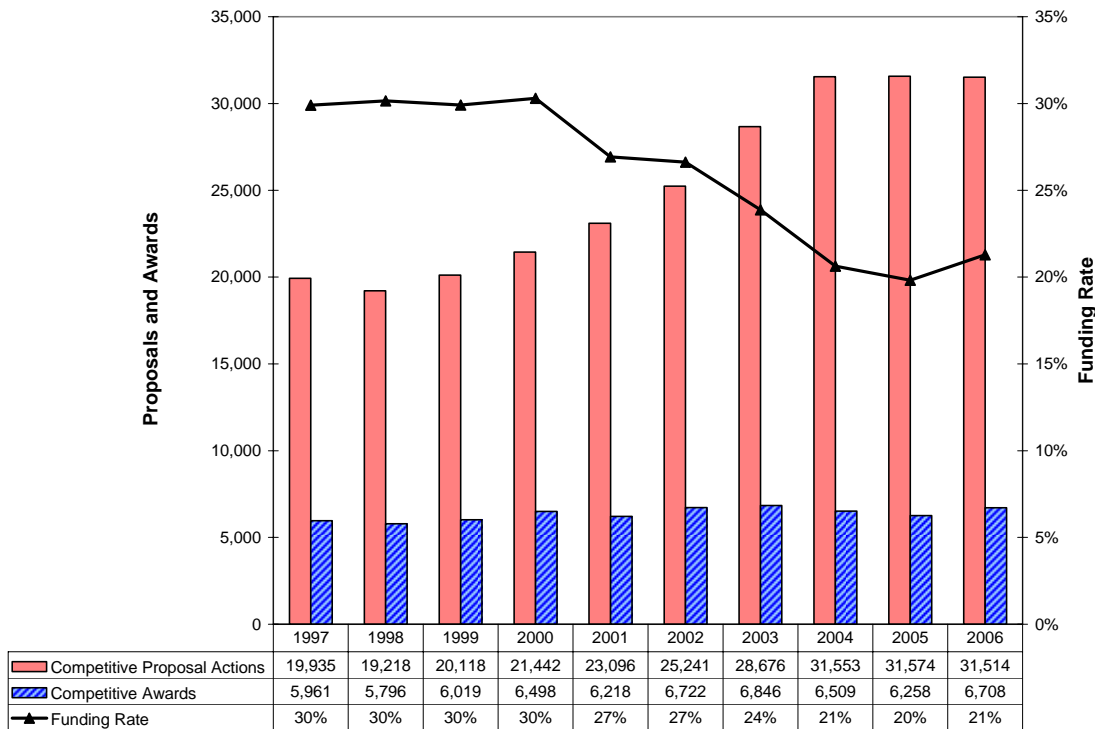


Figure legend: Relationship between the number of proposals processed each year, the number of awards made each year and the proposal funding rate. As the number of proposals processed each year grew significantly, the proposal funding rate dropped. Source: NSF Budget Division

PI Submission Rates

As seen in Figure 4, one reason proposal submissions increased was that the average number of proposals submitted by successful PIs before receiving an award increased from 1.7 in the three-year period between FY 1997-1999, to 2.2 in the three-year period between FY 2004-2006. This represents a 30% increase in the number of proposals an individual submitted, on average, before receiving an award. An analysis of the distribution of proposal submissions per PI for all PIs, whether or not they received an award (shown in Figure 5), indicates that fewer PIs submitted only one proposal and more submitted four or more proposals between FY 2004-2006 than between FY 1997-1999.

Figure 4
Average Number of Research Proposals Submitted Per PI before Receiving One Award

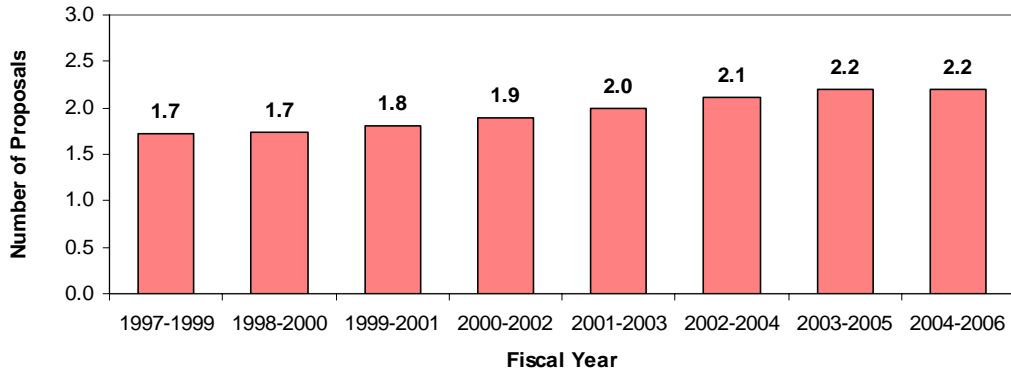


Figure legend: The average number of research proposals submitted in a three-year period before one award was received was calculated for all successful PIs. Source: NSF Budget Division

Figure 5
Distribution of Single vs. Multiple Submissions per PI

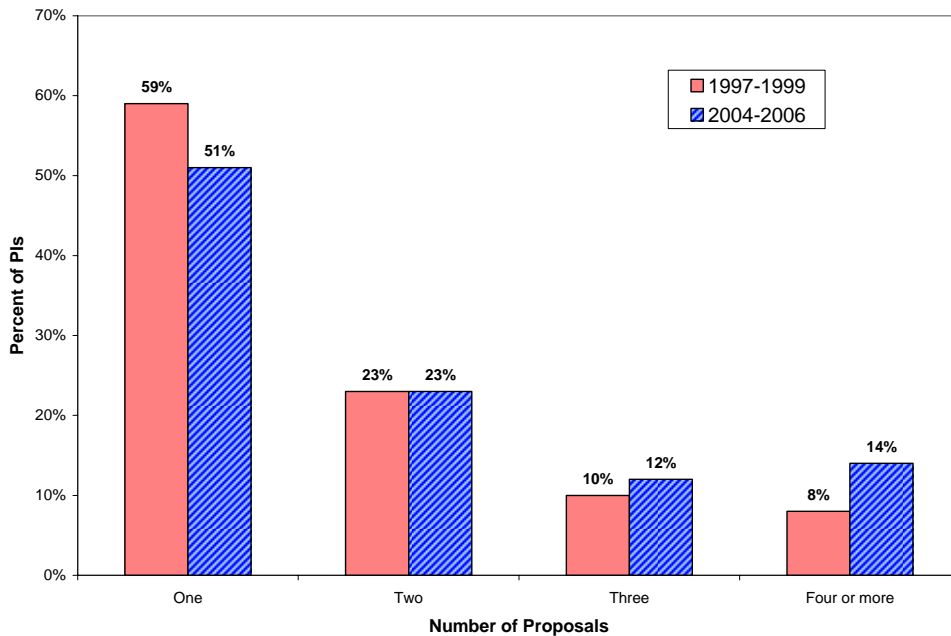


Figure legend: Comparison of the number of research proposals submitted by each PI during the three year period from FY 1997 to 1999, and the three year period from FY 2004 to 2006. The proportion of PIs submitting only one proposal declined by eight percentage points, while the proportion submitting four or more proposals nearly doubled when comparing these two periods. Source: NSF Budget Division

One factor associated with the increase in the number of proposal submissions per PI per award is that, because of decreased funding rates, more declined proposals are being revised and resubmitted. Whereas some degree of revision and resubmission is expected and is, in fact, a positive aspect of the merit review system, when funding rates drop, many highly rated proposals

enter this recycling, or “churning”, of declined proposals. NSF policy indicates that proposals that have not been substantially revised after having been previously reviewed and declined may be returned without review. However, revising proposals that are already fundable is a non-productive use of both PI and reviewer time. Because NSF treats all proposals as independent submissions, it is not possible to determine from NSF data how many proposals are being revised and resubmitted. As a proxy, IPAMM determined the degree to which PIs submitted proposals to the same or multiple programs before receiving an award.

Multiple Proposal Submissions

As shown in Figure 6, for those PIs who submitted multiple research proposals before receiving an award, there has been an increasing tendency to submit to more than one program. Since nearly 95% of the PIs responding to the 2007 NSF Proposer Survey indicated that they either never (65.7%) or seldom (28.7%) submitted a revised version of a declined proposal to a different unit within NSF, it does not seem likely that PIs are merely moving proposals from one program to another. Instead, it appears that PIs are diversifying their efforts, submitting a larger number of different research ideas to a variety of programs, possibly in response to new types of funding opportunities. These are further discussed in Section IV, *Causal Factors*.

Figure 6
Distribution of Proposal Submissions by PIs Submitting Two or More Research Proposals Before Receiving an Award

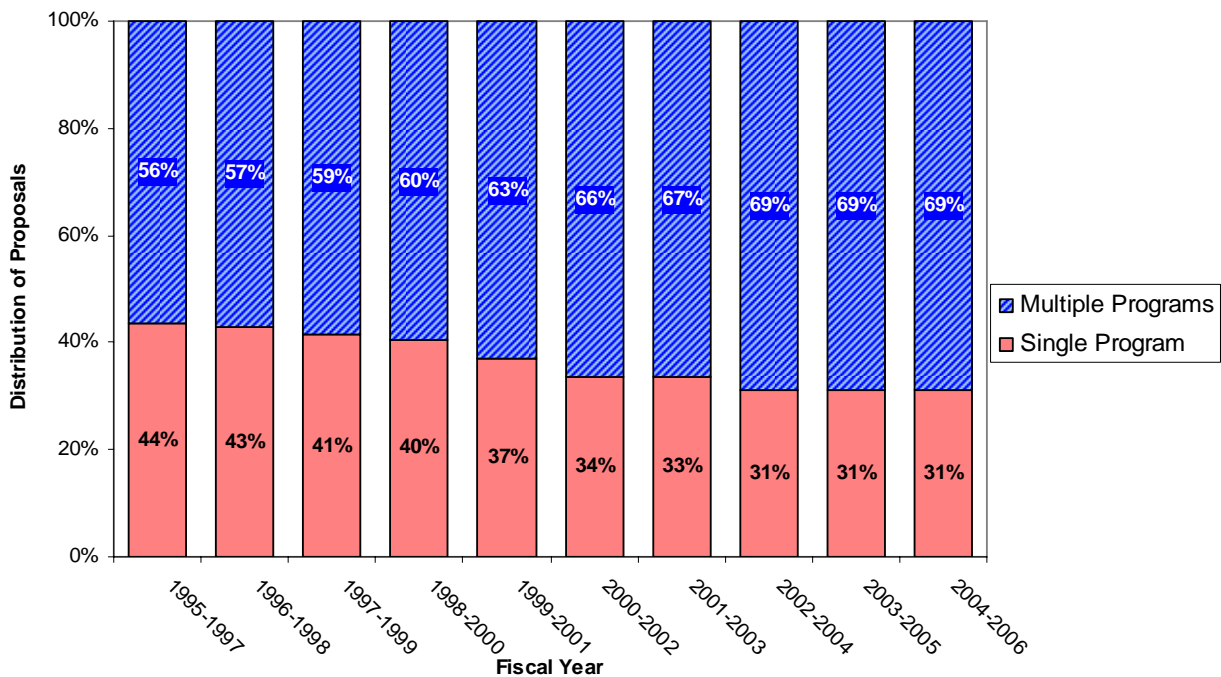


Figure legend: For those PIs who submitted two or more research proposals within a three-year period before receiving an award, the proportion that submitted those proposals to a single program decreased over time, as the proportion submitting multiple proposals to different programs increased. Source: NSF Budget Division

PI Success Rates

As previously mentioned, the proposal funding rate is defined as awards divided by proposal submissions (i.e., awards plus declinations), and is often cited as a measure of how successful the scientific community is in obtaining support for their research. However, success can be measured in a variety of other ways. For example, success can be measured as dollars awarded over dollars requested, or as a factor of the effort (i.e., how long and/or how many proposals) it takes for an individual PI or a particular idea to get funded. Success can also be defined more broadly from a community perspective, as a measure of the percentage of the PIs within a particular community that are funded. This type of measure can be useful when considering a particular scientific and engineering community (ecosystem scientists, electrical engineers, etc.), a demographic community (women, minority investigators, new PIs, etc.), or even an institutional community (all of the faculty members in a certain university system, for example).

This latter measure is a more direct way to assess NSF's effectiveness in supporting the scientific community than using the proposal funding rate. IPAMM thus investigated PI success rates, i.e., the number of PIs receiving NSF research awards divided by the number of PIs that apply for research awards over a given period of time. As Figure 7 shows, 44% of PIs who submitted one or more research proposals during the three-year period from FY 1997-1999 received at least one research award; in FY 2004-2006, this number had dropped to 36%. This decline is due at least in part to a 35% increase in the number of PIs submitting proposals to NSF.

Figure 7
NSF PI Success Rates

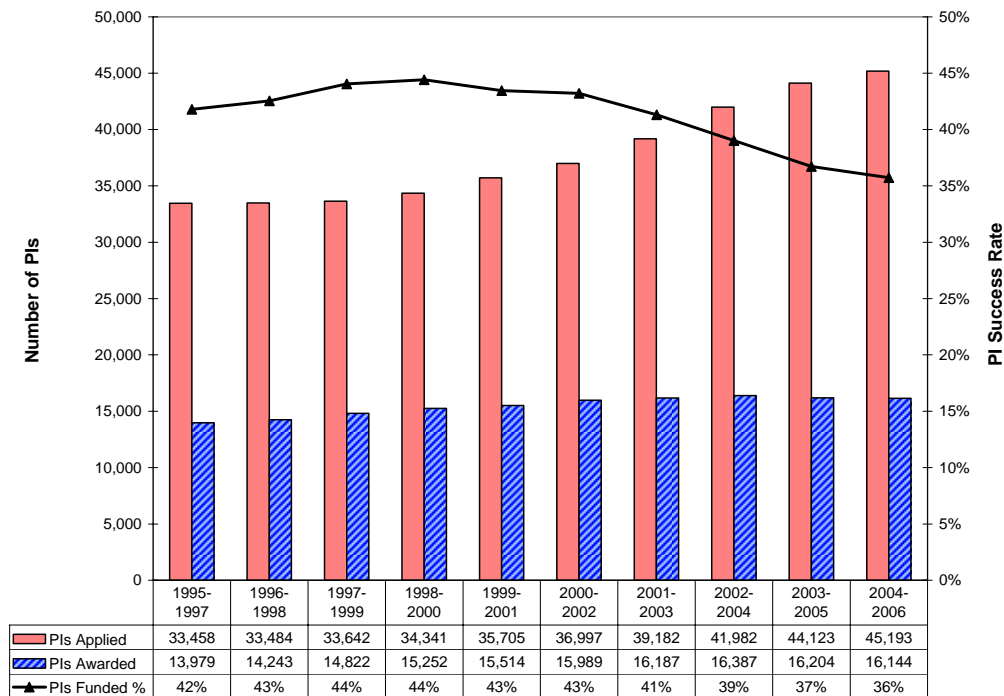


Figure legend: Percentage of PIs that received at least one research award within a period of time spanning three fiscal years. The percentage is derived by dividing the number of PIs that received an award by the number of PIs that submitted at least one proposal during each three-year period of time. Within any given three year period, each PI is only counted once, regardless of the number of proposals submitted or awards received. Source: NSF Enterprise Information System

Growth in Interdisciplinary Research

A related issue that interacts with the major trends in proposal submissions and funding rates is the shift toward interdisciplinary research and the move away from small, single-investigator projects to the dominance of teams in the production of new knowledge. One measure of this shift is the increased prevalence of multi-investigator projects within the NSF award portfolio (including single awards with multiple co-PIs and collaborative projects with multiple awards), which has grown from 26% of all NSF awards in FY 1997 to 44% in FY 2006. NSF has actively fostered this shift, both through the use of solicitations requiring interdisciplinary teams of researchers and by simplifying the mechanism for submitting collaborative projects to any NSF program through FastLane. The use of solicitations and the effect of FastLane will be discussed further in Section IV, *Causal Factors*.

Directorate-level Trends

At the NSF level, the overall research proposal submission rate and funding rate appear to be flattening in FY 2005-2006. However, a somewhat different picture emerges when looking at the data for particular Directorates and Offices. The steady rise in proposal submissions and decline in funding rate at the NSF level, as well as the recent flattening of both, gives way to higher variability at the Directorate/Office level. Although all of the units within NSF experienced increased proposal submissions and decreased funding rates, there was significant variability in the rate of change, the degree of change, and the starting and ending points for the different units.

Figure 8 shows that research proposal funding rate trends are down for all directorates, but that the local environment varied. The lowest points for CISE and SBE occurred in FY 2004, while the lowest point for GEO, ENG, and MPS was in FY 2005. The funding rates in these directorates are now trending upward. In contrast, the funding rate in BIO continues to trend downward, and may not yet have hit its lowest point.

Figure 9 shows the rates at which research proposal submissions increased in the R&RA directorates. All of these directorates experienced increases in proposal submissions, but the rate of increase varied substantially from one directorate to another. CISE experienced the greatest growth—in FY 1997, this directorate had the fewest proposals of the set shown, but by FY 2004 was surpassed only by ENG. By FY 2006, proposal submissions to CISE had dropped again, but overall CISE's FY 2006 proposal load was nearly triple that of FY 1997. In the meantime, proposals loads nearly doubled in SBE and ENG by FY 2006, those in MPS and BIO grew by 40% and 50%, respectively, while the proposal load in GEO grew by 15%. Overall, proposal submission rates continue to trend upward for all of the directorates except CISE.

Figure 8
Trends in Research Proposal Funding Rates for Selected NSF Directorates

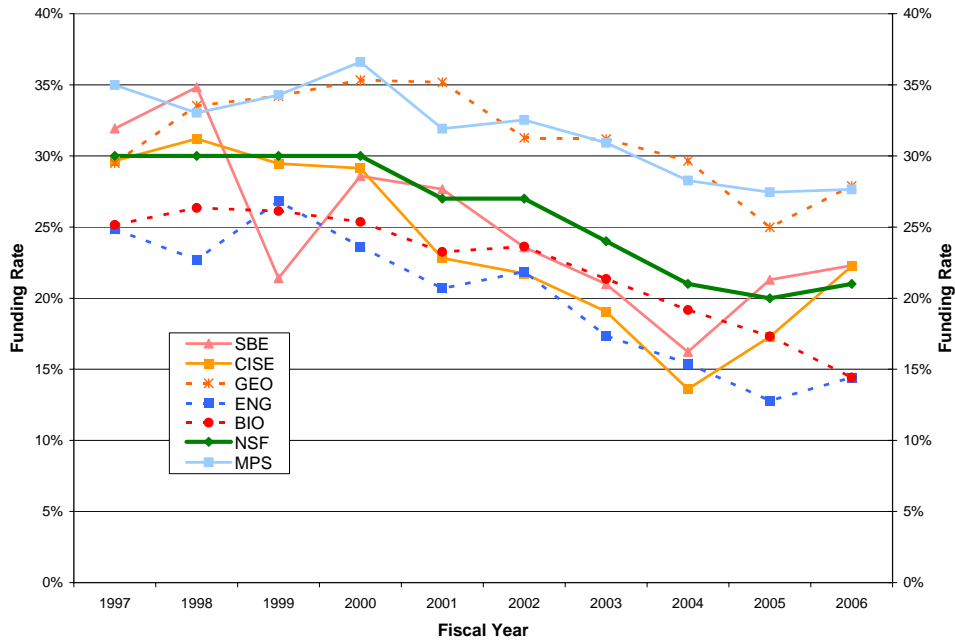


Figure legend: Funding rates for research proposals submitted to the six R&RA Directorates are shown, compared to the overall funding rate for all research proposals submitted to NSF. Funding rates also decreased over time for the research proposals submitted to EHR, OPP and O/D offices (not shown). Source: NSF Budget Division.

Figure 9
Trends in Proposal Submission Rates for Selected NSF Directorates

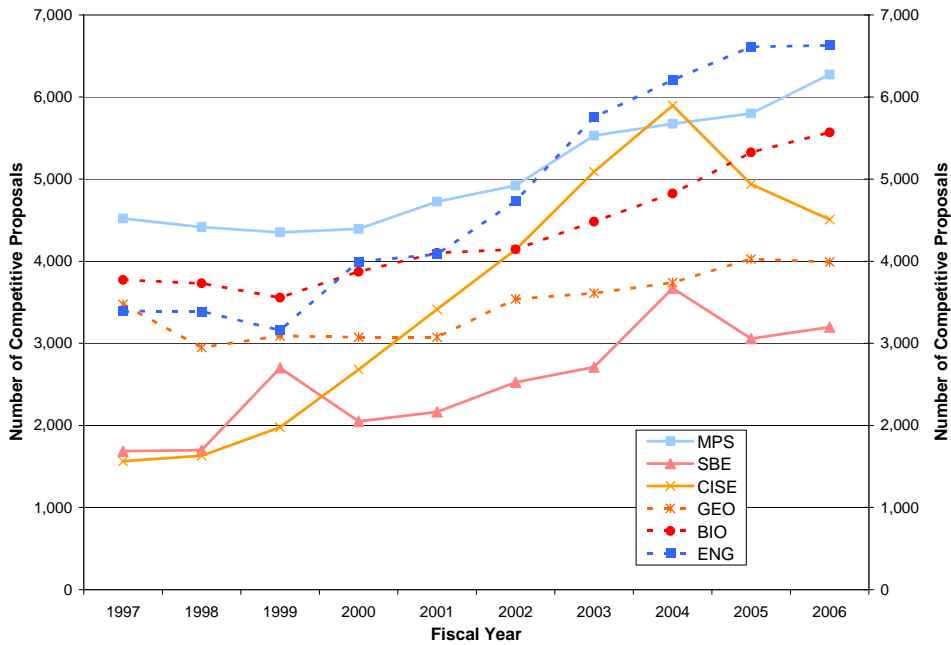


Figure legend: The number of research proposals submitted is shown for the six R&RA Directorates. EHR, OPP and O/D offices also experienced increases in the number of the research proposals submitted (not shown). Source: NSF Budget Division.

Summary

As shown in the trends analyses above, research proposal funding rates decreased significantly across NSF beginning in FY 2000; at the NSF level the decline in funding rates appeared to flatten in FY 2005-2006, although this is not the case at the directorate level. During the same time frame, proposal submissions and the overall size of the NSF budget increased significantly between FY 2000 and 2004. Meanwhile, average award sizes increased between FY 2000 and FY 2005, decreasing somewhat in FY 2006. Thus, there were a number of different variables in play at the same time, any or all of which could have contributed to the decline in the funding rate (award durations did not change much during this time frame, and so were not considered to be a significant variable). These data are summarized in Table 1.

Table 1
Summary of Funding Rate and Award Size Trends

Fiscal Year	Mean Award Size (thousands)	Number of Awards	Number of Research Proposals	NSF Budget (millions)	R&RA Budget (millions)	Funding Rate
2000	\$101.2	6,498	21,442	3,923.4	2,979.9	30%
2001	\$108.1	6,218	23,096	4,459.9	3,372.3	27%
2002	\$108.3	6,721	25,240	4,774.1	3,616.0	27%
2003	\$130.9	6,848	28,678	5,369.3	4,054.4	24%
2004	\$136.4	6,508	31,553	5,652.0	4,293.3	21%
2005	\$142.7	6,258	31,574	5,480.8	4,234.8	20%
2006	\$134.5	6,712	31,518	5,645.8	4,351.0	21%

The relationship among the important variables is expressed in the equation:

$$\$ \text{ for New Awards} = (\text{Average award size } \$) \times (\text{funding rate}) \times (\# \text{ of proposals})$$

Section IV of this report, *Causal Factors*, will explore the relationships among these variables in depth, including regression analysis of variables and the analysis of different hypothetical funding rate scenarios.