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WILLIAM ZUMETA  
JOYCE S. RAVELING

# Attracting the Best and the Brightest

Are careers in scientific research still attractive to the most talented young Americans? This is a critical question since it is widely held that innovation in science depends less on the many “worker bees” in the enterprise than on a decent sprinkling of the very best minds. In one sense such careers surely remain attractive because breathtaking advances in fields such as neuroscience, genomics, and computer science are intellectually exciting. But there are also less attractive aspects that top students must consider in making choices about advanced education and careers. Training and apprenticeship times in science have become very long: ten years or more counting the postdoctoral appointment that has become nearly obligatory for most attractive career positions. Compensation for graduate students and

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postdoctoral appointees is very modest for professionals who are often in their mid-thirties. Probably most important, prospects for autonomous research positions in academe and elsewhere that most would-be scientists aspire to at the end of this long road are uncertain and increasingly slim.

Why should society and policymakers worry about this? In most fields we depend on market signals and mechanisms to guide people to educational and career tracks. If our best and brightest

choose to become lawyers and investment bankers rather than scientists and engineers, why not say, “So be it”? A laissez-faire approach will not work in this case because public policy largely determines the demand for scientists and engineers with advanced degrees. Most PhD-trained scientists are employed in research or teaching, and the most of the support in both areas comes from government. From a policy perspective, it is critical to recognize that the research and teaching most scientists do has an important public good element, meaning that society as a whole benefits in ways not fully valued in market signals such as compensation levels. Government’s role is to ensure through policy that the value of the public good is recognized. If policies serve to make scientific research careers inadequately attractive to the best young minds, this will surely work to society’s detriment in an age when scientific and technological advances are basic to key values such as economic growth, environmental protection, public health, and national security. In short, we cannot leave these decisions to the market without recognizing that we, the citizenry, are a

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William Zumeta (zumeta@u.washington.edu), professor and associate dean, Daniel J. Evans School of Public Affairs, and Joyce S. Raveling, PhD candidate, College of Education, at the University of Washington, are the authors of *Best and Brightest for Science: Is There a Problem Here?*, a report to the Alfred P. Sloan Foundation, available at <http://www.cpst.org>.

large part of the market.

Unfortunately, current policies for human resources in science and engineering are not responding to clear signs that our best and brightest are turning in growing numbers to other career paths. Our investigation showed that little attention is being paid to student quality issues. It seems to be assumed that, as long as graduate programs are of high quality, top students will be attracted without much direct attention from policymakers. We think there is good reason to doubt this premise in several natural sciences disciplines as numbers of top U.S. students headed for graduate school have declined and as it becomes more difficult to recruit and enroll international students as well.

Moreover, to the extent policies do respond to perceived shortages, they tend to be shortsighted and to exacerbate longer run problems. This is true of recent policies that simply expand the number of visas granted to foreign scientists to fill empty job slots in industry, and of government R&D support policies that pay little heed to impacts on graduate students. Expanding imports of young scientists to fill empty slots at bargain wages dampens the market signal that more opportunities and higher salaries would provide to domestic talent. Similarly, R&D support policies often have counterproductive impacts on graduate student incentives and flows because the policies are largely oblivious to such considerations. When R&D funding declines in an area, such as in the physical sciences where it fell 18.5 percent between 1992 and 2000, supported graduate research assistant positions de-

cline and top students with other attractive alternatives are dissuaded from pursuing the field. This might be justified to a point if the field was in long-term decline, but such is not plausible in fundamental areas of science.

Conversely, in hot fields such as many of the life sciences, research assistant positions have grown rapidly in recent years, whereas the growth of "permanent" research and teaching positions has not kept pace. The result has been a logjam in numbers of recent PhDs caught sometimes for years in postdoctoral positions with very modest salaries that generally provide little autonomy in selecting research topics or applying for grants. At this point, still-apprentice scientists are typically in their mid-thirties and well into what should be their most creative and productive years when intellectual and professional autonomy is most desirable. Women in these circumstances may be especially discouraged as their prime childbearing years pass by. Most troubling, as PhD numbers continue to climb, the career prospects for many long-term postdocs are dim. The National Research Council study *Trends in the Early Careers of Life Scientists* (1998) found that the proportion of life sciences PhDs holding faculty positions nine to 10 years after earning their degree fell from 61 percent in 1973 to 39 percent in 1995, and the proportion not holding full-time jobs in science increased to 20 percent by the latter year. The signals this sends the next generation of the best and brightest cannot be encouraging. Clearly, more systematic policy thinking, taking explicit

account of the need to maintain the flow of top domestic talent into graduate programs, is needed.

### Signs of decline

According to the National Science Foundation, from 1993 to 2000 the number of U.S. citizens and permanent residents enrolling in graduate programs in the natural sciences and engineering (S/E) decreased more than 14 percent, with the greatest declines in mathematics (32 percent), engineering (25 percent), and physical sciences (18 percent). Enrollments increased slightly in biological sciences and computer science. PhD awards in the S/E fields fell by more than 10 percent between 1995 and 2000, and preliminary 2001 data show further declines.

We wondered how the most outstanding students were affected. To study trends among top students enrolling in S/E graduate programs, we analyzed Graduate Record Examination (GRE) scores over several years using data provided by the Educational Testing Service. We focused on U.S. citizens and permanent residents scoring 750 or above on the GRE quantitative scale (5 to 7 percent of all examinees) since this scale is usually of greatest interest to admissions committees in S/E fields.

Between 1992 and 2000, the total number of examinees scoring at this level with plans for graduate study in S/E fields fell by 8 percent (to around 8,000), while the number planning study in non-S/E fields increased by 7 percent (to about 4,650). Engineering and mathematics saw the largest declines in top scorers, 25 percent and 19 percent respectively. There

were moderate declines in top scorers headed for physical sciences and computer science through 1998 but these trends reversed by 2000. Within the S/E total, biological sciences were increasingly popular among top-scorers, showing a 59 percent gain between 1992 and 2000, though from a relatively low base. The non-S/E area attracting the largest growth in top scorers was the ETS category "health sciences" (really health professions), consisting largely of short-training-cycle graduate professional fields such as physical therapy, speech/language pathology, and public health. As a group these fields attracted 88 percent more 750+ scorers in 2000 than in 1992 (878 individuals in 2000). Significantly, the overall declines in top scorers headed for S/E graduate programs were not the result of a decline in the proportion of top scorers among GRE examinees but rather reflected a general decrease in total numbers taking the GRE and expressing an interest in S/E. This suggests that more top students may have been pointing toward professional schools that require other admission tests.

One encouraging sign is that the number of high-scoring women and minorities intending to pursue graduate S/E training increased during the 1990s.

### **Where are top students going?**

We also studied trends in other large professional tracks—law, medicine, and business—to try to discern paths of top students who might have pursued S/E studies. We found scant evidence that top

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## *Government should support a significant number of new selective research assistant professorships.*

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undergraduate S/E majors were being attracted to law school. Between 1992 and 2001 the number of S/E majors taking the Law School Admission Test (LSAT) fell almost 19 percent. Unduplicated applicants to law schools decreased 24 percent, enrollments were flat, and mean LSAT scores of examinees and applicants fell slightly. So, it is unlikely that more top S/E students applied to law school.

A more ambiguous picture emerged in medicine. The number of U.S. applicants (unduplicated) increased from 1992 to 1996, then fell almost 25 percent by 2001. The number of new MD matriculants was flat and those with S/E undergraduate degrees declined by 3 percent between 1992 and 2001. Although these patterns do not suggest that more top S/E students entered medical school, the scores of applicants and matriculants on the Medical College Admission Test (MCAT) rose appreciably during this time on both the biological and physical sciences scales. The scores of non-S/E majors increased comparably, making it difficult to determine whether the proportion of top students in the pool in-

creased or whether changes in the test may have led to the higher scores.

There are clearer signs that more top S/E students were attracted to graduate business schools. The number of MBAs awarded annually grew by nearly one-third, to more than 112,000, between 1992 and 2000. S/E majors' share of all Graduate Management Admission Test (GMAT) examinees increased from 17 percent in 1992 to 20 percent in 2001. The absolute number of GMAT examinees with S/E undergraduate majors grew 31 percent between 1998 and 2001 alone. Additionally, the mean GMAT quantitative scale scores of S/E majors rose from 34 to 37 (on a 0-60 scale) between 1992 and 2001. (The scores of non-S/E undergraduate majors also increased, but less.) All in all, these patterns suggest that business schools very likely attracted a larger share of high scoring S/E majors during the 1990s.

To further investigate changes in the graduate study and career plans of top S/E students, we obtained data from the Consortium for Financing Higher Education (COFHE), a group of 31 highly selective private colleges and universities. We focused on the five COFHE schools with response rates above 50 percent on surveys of their seniors in 1984, 1989, and 1998. This spans a substantial period, including one year when the labor market was relatively sluggish following a recession (1984), and two years characterized by prosperity and robust labor markets (1989 and 1998). Thus, consistent trends emerging during the

entire period cannot easily be attributed to labor market variations.

We analyzed data from more than 2,000 senior natural science majors (U.S. citizens and permanent residents only) who responded to the survey shortly before graduation regarding their plans for the next autumn. The trends are striking. The number of science majors planning advanced study in any field the next fall declined steadily from 48 percent in 1984 to 28 percent in 1998. Those planning immediate graduate study in S/E fields dropped from 17 percent to 12 percent during this span. Plans to attend medical school declined from 16 percent in 1984 to 10 percent in 1998. The paths showing substantial increases in shares of these graduates were: employment, up from 48 percent to 60 percent, and “undecided,” up from 4 percent to 10 percent, between 1984 and 1998. The basic patterns were similar across gender and ethnic groups, and the values for the 1989 cohort nearly always fell between those for the earlier and later years. For the elite subset of COFHE S/E majors with A or A- GPA’s, proportions headed immediately to graduate school were higher but declines were steeper: from 68 percent of the 1984 cohort down to 43 percent by 1998. The proportion headed straight to graduate school in S/E declined from 25 percent to 18 percent and to medical school from 25 percent to 17 percent.

The share of all COFHE S/E majors indicating no plans at all for advanced study during the course of their careers more than doubled, from 9 percent in 1984 to 19 percent in 1998. Among the A students, this proportion grew

from under 3 percent in 1984 to more than 12 percent in the 1998 cohort. These increases may understate the true picture. It seems likely that plans to attend graduate school later are more likely to be derailed than immediate plans, especially in S/E where the traditional norm has been to enroll immediately after college.

In sum, the evidence is highly suggestive that top U.S. students with potential to become scientists are turning away from S/E graduate school (except in biological sciences) toward other career paths. It appears that significant numbers are choosing professional schools, notably business and non-MD health professions, which promise careers with good income prospects without the long years of schooling and apprenticeship that science requires. The comparison with S/E careers in which, after successfully negotiating a decade or more in training, the newly fledged scientist typically faces a job market with too few desirable jobs relative to the number of qualified seekers is increasingly stark.

### **A demand-side approach**

If the labor market for PhD scientists is not sending a strong enough signal to attract the highest caliber students to S/E graduate school, then public policies should focus on demand-side issues as the first priority. Policies have traditionally focused on pumping up the PhD supply side by creating more graduate and postdoctoral fellowships and assistantships, but that is not the answer to the current problem. The savviest candidates will not be interested, because they will

recognize that the career prospects are still dim. And if the policy were to succeed in attracting a large number of students, it would eventually lead to the unappealing postdoctoral logjam pattern that is now common in the life sciences.

In theory, demand-side policy responses might include a general increase in academic or R&D funding partly designed to improve career prospects for young scientists or even, as some nations have done, the creation of explicit policy to provide support to all or most PhD-trained researchers. If pursued consistently, these steps would surely increase the appeal of PhD careers, but for a variety of reasons—budget constraints, traditions of mission- and project-based funding, evidence that a significant proportion of PhDs will not be productive researchers—such policies are not in the cards in the United States today. More realistic would be a policy of modest new federal support for a significant number of selective research assistant professorships in the natural sciences and engineering at universities. These would be available only on a highly competitive basis to experienced and proven postdoctoral scholars who are U.S. citizens or permanent residents. Because of limited permanent job opportunities in academe and other research institutions relative to the current supply, some of these proven talents would otherwise have no alternative in research except another postdoctoral or similar apprentice position. Some will no doubt leave scientific research entirely just at the time of life when they are likely to be most creative and productive.

It would be essential that the new positions be designed to be as competitive, intellectually autonomous, and financially attractive as junior faculty posts at research universities and with similar periods of appointment, such as an initial three-year term with one renewal possible upon rigorous peer review analogous to the process for assistant professors. To stretch federal resources further, universities seeking eligibility to host these appointees should be given incentives not only to make the posts attractive—faculty and principal investigator status, opportunities for participation in graduate student training and departmental intellectual life, provision of appropriate research facilities—but also to leverage additional support from state and private sources.

Candidates completing these externally supported assistant professorships should have an equal chance as their more traditional-track colleagues for tenured posts available at the end of their term of support. If no such post was immediately available, the candidate could be reviewed for continuation supported by funds he or she should by then be able to secure on her/his own.

Although providing appropriate research facilities could be problematic for some institutions, such a program should be attractive to many research universities for it would improve their capacity to attract top-drawer younger scholars, increase faculty capacity, and thus research output and visibility. The main benefits to society would be to keep more of our

most able young scientists doing science on meritorious projects of their own initiative—as most post-doctoral appointees cannot do—during what are often a scientist's most innovative and productive years; and assuming the program is large and visible enough, to expand the pool of attractive research jobs perceived by outstanding young people who are at the point of choosing between graduate S/E studies and other pursuits. Given the immediate and long-term value to society of keeping our best and brightest young people involved in scientific research, a program just large enough to make an impact on these students' choices seems a very good bet to produce benefits exceeding its costs. There are probably few better investments in the federal budget portfolio today.