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Ronald G. Ehrenberg
Cornell University, rge2@cornell.edu

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Does America Face a Shortage of Scientists and Engineers?

Abstract
[Excerpt] As someone who served on the committee that issued the 1998 study of the early careers of life scientists that Teitelbaum talks about in his article and who has critiqued models that projected shortages of new PhDs, I am very sympathetic to many of the points that he makes (National Research Council, 1998; Ehrenberg, 1991). What I want to focus on today is the word we in his title, because, as Teitelbaum emphasizes, the question of shortages or surpluses is often in the eye of the beholder. For example, from the perspective of faculty members involved in the academic enterprise, increased research project budgets lead to increased demand for graduate research assistants and postdoctoral fellows. Each faculty member wants to maximize his own research output, and concern about future employment prospects for one's students often falls by the wayside.

Keywords
scientists, engineers, faculty, technology, labor market, employment, research

Comments

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CHAPTER FOUR

Does America Face a Shortage of Scientists and Engineers?

Ronald Ehrenberg[1]

Michael Teitelbaum's paper "Do We Need More Scientists?" (see Chapter Two in this volume) provides a provocative start to this meeting. The notion of shortages or surpluses existing in markets in which prices are free to adjust is somewhat alien to economists because, ultimately, price changes will bring markets into equilibrium. At best, concern might be expressed over the length of time it takes a market to adjust; in situations in which there are long lags in the response of supply to prices (such as in the production of PhDs), policies might be needed to facilitate the adjustment (such as *temporarily* changing the number of government-sponsored assistantships, fellowships, and traineeships provided for PhD students).

As someone who served on the committee that issued the 1998 study of the early careers of life scientists that Teitelbaum talks about in his article and who has critiqued models that projected shortages of new PhDs, I am very sympathetic to many of the points that he makes (National Research Council, 1998; Ehrenberg, 1991). What I want to focus on today is the word we in his title, because, as Teitelbaum emphasizes, the question of shortages or surpluses is often in the eye of the beholder. For example, from the perspective of faculty members involved in the academic enterprise, increased research project budgets lead to increased demand for graduate research assistants and postdoctoral fellows. Each faculty member wants to maximize his own research output, and concern about future employment prospects for one's students often falls by the wayside.

From the perspective of an academic institution, budget situations dictate the extent to which the institution has the resources to bid for top new faculty prospects or is forced to settle for lesser quality faculty members whose lower salaries it can afford. Most American college students are educated at public institutions, and hence, most American faculty members are employed at public higher education institutions. Over the last 25 years, the budget problems faced by state governments, coupled with the increased demand on their budgets for expenditures in areas other than higher education, have led state appropriations per student in public higher education to decline relative to tuition levels at private higher education institutions. Percentage increases in tuition levels at public higher education institutions have been roughly the same as those at private higher education institutions; however, because the publics started at a lower absolute level of tuition, their increases have not been

[1] Ronald G. Ehrenberg is the Irving M. Ives Professor of Industrial and Labor Relations and Economics at Cornell University in Ithaca, New York, and a research associate at the National Bureau of Economic Research, Washington, D.C. The author is grateful to the Andrew W. Mellon Foundation and the Atlantic Philanthropies (USA) Inc. for their financial support of CHERI. He emphasizes, however, that all thoughts expressed here are strictly his own.

large enough to permit their expenditure levels to rise at the same rate as expenditure levels in private higher education.

As a result, full-time faculty salaries have declined substantially in public higher education relative to the salaries of faculty in private higher education (Ehrenberg, 2003). In addition, a growing tendency to substitute part-time and non–tenure-track full-time faculty for full-time tenure and tenure-track faculty has occurred. Most people are unaware of the magnitude of these shifts, but at some campuses they have been enormous. For example the share of undergraduate credit hours generated by full-time tenured and tenure-track faculty members declined from 81 percent to 58 percent at the State University of New York (SUNY) University Centers (doctorate-granting institutions) between the fall of 1992 and the fall of 2001; the comparable decline at the SUNY University Colleges (master's-granting institutions) was from 84 percent to 70 percent (Ehrenberg and Klaff, 2003, table 2). The attractiveness of public higher education institutions, as potential employers for new PhD students, has declined, and the voluntary turnover of existing faculty at public institutions is now higher than that of their faculty counterparts at private institutions (Nagowski, 2003).

Along with the growing dispersion of resources between public and private higher education has come a growing dispersion of resources across private higher education institutions. Fueled by growing dispersions of endowment wealth caused by changes in stock market levels over the last 25 years and the tendency of the richest institutions to devote more of their annual giving to further building their endowments than do the poorer institutions, there has been a growing dispersion of average faculty salaries in private higher education (Ehrenberg, 2003; Ehrenberg and Smith, 2003).

Another byproduct of the growing dispersion of wealth and the efforts by universities to attract the best possible new faculty members to their ranks has been an escalating competition for top scientists and engineers that is manifested in large start-up cost packages. A survey conducted by the Cornell Higher Education Research Institute (CHERI) in the spring and summer of 2002 of science and engineering departments at our nation's research and doctoral universities found that start-up cost packages for new assistant professors at private research universities were typically in the $400,000 to $500,000 range, while packages at public universities were somewhat lower (Ehrenberg, Rizzo, and Condie, 2003).[2] So in spite of what one might consider a surplus of new PhDs in some science and engineering fields, the "price" needed to attract the best candidates is high. Because private universities more often have access to endowments and annual giving streams from which they can obtain funds for these start-up cost packages, it is not surprising that the public universities, more often than private universities, reported to us that they obtained at least part of the funding for their start-up cost packages by keeping positions vacant until salary savings can be achieved to cover the start-up costs. To the extent that institutions face a continual need to attract new faculty, this suggests a further permanent reduction in the size of the full-time tenure track faculty at many public institutions.

Is this trend, especially at public institutions, of substituting part-time and non–tenure-track full-time positions likely to continue in the future and thus, in the context of Teitelbaum's paper, to further reduce the attractiveness of PhD study in the sciences? To the extent that governors and state legislatures are concerned more about the undergraduate degrees that are generated by their public higher education institutions and less about these

[2] Start-up cost packages for senior faculty members are considerably larger and often exceed one million dollars.

institutions' faculty members' research, I fear that the answer will be yes, unless researchers can demonstrate that these shifts in faculty composition are having adverse effects on undergraduate students (such as increasing dropout rates and/or slowing time to degree). After all, from the perspective of an economist, substituting cheaper for more-expensive inputs and achieving the same output is very rational.

However, saying that state governments are behaving rationally is not saying that their actions are socially optimal from the perspective of the broader "we." Paul Romer and others have argued that the rate of growth of productivity in our economy depends upon the rate of growth of innovation in the economy, which in turn depends upon the share of our nation's educated workforce with degrees in science and engineering (Romer, 2000). So even if labor markets are in balance, there may not be a socially optimal number of American citizens and permanent residents pursuing science education.

Even if state government officials realize that income growth in their states depends upon the share of their residents that are educated in science and engineering, it does not follow that states are irrational in cutting back on their expenditures on public higher education. Recent research suggests that the proportion of the adult population in a state that is college educated is only very loosely tied to the expenditures that state governments are currently making on their public higher education systems (Bound et al., 2001). Mobility of college-educated workers across areas moderates the linkage between a state's expenditures on higher education and the composition of its adult workforce.

So to the extent that it is socially optimal to have more people trained as scientists and engineers in our workforce, how do we accomplish this? My reasoning above suggests that, ultimately, it is the federal government that must play the role of guaranteeing that "we" generate an adequate supply of scientists and engineers. However, there are roles for individual academic institutions to play.

For example, the changing structure of grading at many selective American colleges and universities, which has led average grades in the humanities and soft social sciences to rise relative to average grades in the sciences and economics, is surely a problem—it is easier for students to "do well" in nonscience disciplines, and this discourages them from pursuing science careers (Sabot and Wakeman-Linn, 1991; Parekh, 2002). Institutional policies that would require all classes (of a given level) to assign the same median grade, as is done in some law schools, might help. It might also help to provide more information on the nature of careers in science and engineering, on the fact that many individuals trained in science and engineering often wind up in management positions, and on the earnings of people who choose such careers.

Finally, some people have pointed to the growing share of PhD degrees in science and engineering being granted to foreign nationals as evidence that foreign students are crowding out potential U.S. students and have argued that limitations should be placed on their admission. As Teitelbaum points out, the growth in foreign enrollments is a logical response by American universities to the declining interest of American students in PhD study in the sciences and engineering. The only study that I know of that looked at the preferences of American universities for foreign graduate students found that the universities "discriminated" against foreign students. More precisely, American citizen student applicants had a higher probability of being admitted to doctoral programs than did foreign applicants with the same admission credentials (test scores) (Attiyeh and Attiyeh, 1997). So if we are concerned about not having enough PhDs in science and engineering, making it easier for

PhD graduates of our nation's universities who come from foreign countries to stay and work in the United States should be a desirable policy.

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