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Academic Labor Supply

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Abstract

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Keywords

labor market, academia, Ph.D., higher education, graduate study

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II Academic Labor Supply

Ronald G. Ehrenberg

6 Projections of Shortages

6.1 An Overview of the Study

Projections of forthcoming shortages of Ph.D.s abound. A major book coauthored by a former president of Princeton University, who is now president of a major foundation, is announced to the world in a front-page story in the *New York Times* (Bowen and Sosa 1989; Fiske 1989). The book concludes that by the late 1990s there will be large shortages of faculty in the arts and sciences and that these shortages will be especially large in the humanities and social sciences, where there may be as few as seven candidates for every ten faculty positions. A National Science Foundation internal staff report projects a substantial shortfall in science and engineering doctorates starting in 1994 (National Science Foundation 1989a). A National Research Council committee projects substantial shortages of biomedical doctorates by the year 2000 (National Research Council 1990). These projections all lead the president of the American Association for the Advancement of Science to talk about the need for immediate corrective actions (Atkinson 1990).

Economists typically define shortages as arising when, at the prevailing salaries in an occupation, the quantity of labor demanded exceeds the quantity of labor supplied (Ehrenberg and Smith 1991, chap. 2). As long as salaries are free to rise, shortages will eventually be eliminated. Concern over potential shortages of doctorates in academe occurs both because academic institutions may not possess the resources to increase faculty salaries substantially, and because, even if they do, the time it takes graduate students to complete doctoral degrees is sufficiently long that an increase in graduate enrollments in response to a salary increase would increase the supply of new doctorates only many years later. Thus, if shortages do materialize in the future, they may persist for a number of years.

Among the policies proposed to avert these projected shortages are increased financial support for graduate students and the shortening of the time it takes graduate students to complete their degrees. Yet, as is indicated below, empirical evidence on the magnitudes of likely supply responses to such proposed changes is actually quite scanty.

How these estimates of shortages are arrived at can be illustrated by briefly summarizing Bowen and Sosa's (1989) projection model of the demand and supply in the arts and sciences for faculty with doctorates. At the risk of simplifying, their analysis proceeds as follows. First, they use data on the current age distribution of faculty and estimates of departure rates (to nonacademic jobs, retirement, and death) by age to project the replacement demand for faculty each year. Quite strikingly, they show that plausible changes in retirement behavior that might be induced by the abolition of mandatory retirement have only small effects on replacement demand.

Next, data on population trends and age-specific college enrollment rates are used to project college enrollments, and data on trends in enrollment by major are used to project enrollments in the arts and sciences. Data on trends in student/doctoral faculty ratios (which have been decreasing) and assumptions about whether these ratios are likely to rise or fall in the future are then used to project how changes in enrollment will translate into changes in the demand for new faculty with doctorates.

As shown below, while the number of Ph.D.s granted by U.S. universities has been roughly constant in recent years, nonacademic job opportunities are increasingly available to new Ph.D.s. In addition, new Ph.D. recipients are increasingly citizens of foreign countries who are temporary residents in the United States, and these new doctorates' probabilities of obtaining employment in the United States are low.[1] Projections of future academic labor supply are made on the basis of these trends and projections of the number of college graduates. Supply and demand forces are then integrated and the projections of future shortages obtained. Even Bowen and Sosa's most "optimistic" set of assumptions lead to projections of a 43 percent underproduction of new doctorates in the arts and sciences as a whole and a 66 percent underproduction in the humanities and social sciences during the period 1997–2002 (Bowen and Sosa 1989, table 8.5).

As noted by Bowen and Sosa, their projections of the supply side of the academic labor market, which are typical of those used in other studies, are based on a number of simplifying assumptions and "avowedly rough judgments" (Bowen and Sosa 1989, p. 166). Similarly, some of their proposed policy remedies, such as increasing financial aid for graduate students and shortening the time it takes students to receive degrees, are made without presenting any evidence on the likely magnitude of supply responses to these changes. As such, this part of the book reviews the academic literature and

1. These probabilities depend on foreign students' desired employment, academic employers' desires to hire foreign students, and U.S. immigration policies. I return to this point later.

available data (from a wide range of sources) to summarize what we know about academic labor supply and what we need to know to make informed policy decisions. Among the issues to be addressed are the following.

1. Why is the proportion of U.S. college graduates completing doctoral programs today substantially lower than it was 20 years ago? Does this reflect a changing relative financial attractiveness of employment opportunities for people with doctorates or simply a limitation over the last decade in academic employment opportunities? How and why has the distribution of undergraduate majors across fields changed, and how has this affected enrollments in doctoral programs? Has the quality of Ph.D. students declined in recent years?

2. Why has there been a growing lag between college graduation and entry to doctoral programs and a lengthening in the time students require to complete such programs? Do undergraduate loan burdens influence the former and financial support for graduate students and postgraduate job opportunities influence the latter? Do these factors also influence the proportion of graduate students who are studying part-time?

3. Why has the proportion of graduate students accepting postdoctoral appointments prior to permanent employment been rising? Would a shortage of Ph.D.s reduce the proportion of students accepting these appointments, and would a reduction in this proportion increase new applicants to graduate study?

4. Why has the proportion of new Ph.D.s choosing employment in the nonacademic sector increased? Is academe currently losing its best new Ph.D.s to the nonacademic sector? If shortages of new Ph.D.s materialize, will improved job opportunities and increasing wages in academe relative to the nonacademic sector induce more new Ph.D.s to enter the academic sector, more experienced nonacademic Ph.D.s to enter or reenter the academic sector, or fewer experienced academic Ph.D.s to leave the academic sector?

5. How will the changing age structure of faculty influence faculty productivity? How will the uncapping of mandatory retirement affect the academic labor supply?

6. Why are minorities and women underrepresented in academe? What policies may lead to increased representation of these groups?

7. Should (and can) American universities seek to increase employment of foreign students who receive their Ph.D.s here? Should (and can) they increase their employment of American and foreign-born academics currently employed in foreign universities?

8. Would a "Ph.D. shortage" really matter? That is, which institutions are likely to be "hurt" by a shortage of Ph.D.s? Are faculty at these institutions currently major contributors to our stock of research, the production of new Ph.D.s, or the production of undergraduates who go on to Ph.D. study? Could the Ph.D. shortage be averted by the use of more faculty without doctorates? Is there any evidence that a substitution of faculty without for faculty with

doctorates would lead to a reduction in the quality of undergraduate instruction?

The plan of this study is as follows. In the remainder of this chapter, some background data are presented on the academic labor market and new Ph.D. production in the United States. Chapter 7 describes a schematic model of academic labor supply and indicates the underlying trends since 1970 in a number of variables that contribute to projections of shortages of faculty. In Chapter 8, a general model of occupational choice and the decision to undertake and complete graduate study is sketched. This framework, available data, and the prior academic literature are then used to address students' choice of college majors, decisions to undertake and complete graduate study, decisions on the time it takes to complete Ph.D. programs, and decisions on choices of sectors of employment for new and experienced Ph.D.s. Chapter 9, addresses issues relating to the age structure of the faculty and retirement policies as well as minority and female representation in academe. Finally, Chapter 10 considers whether a shortage of American Ph.D.s would really matter and/or could be eased by increased reliance on foreign students trained in the United States, faculty currently employed in foreign institutions, and faculty without doctorates. It also briefly summarizes the implications of the study for both future research needs and public policy.

6.2 Background Data on the Academic Labor Market

In 1987, approximately 722,000 faculty were employed at institutions of higher education in the United States, and about 64 percent of these were full-time employees (Anderson, Carter, and Malizio 1989, table 104). These faculty were employed at over 3,000 different institutions. Table 6.1 presents some background data on their distribution in a recent year across various Carnegie Foundation categories of institutions.[2]

As the table shows, doctorate-granting institutions represent slightly more than 6 percent of all institutions of higher education (col. 2); however, they employ 40 percent of full-time faculty (col. 3). In contrast, undergraduate liberal arts colleges and two-year institutions, which in turn represent about 17 and 40 percent of all institutions, employ only 7 and 20 percent, respectively, of full-time faculty. While the vast majority of faculty at four-year institutions are full-time, more than half of all faculty at two-year institutions are part-time employees (col. 4).

Columns 5 and 6 make clear that not all faculty have doctorates. At major doctorate-granting universities, on average less than two-thirds of full-time faculty have doctorates, while, at selective liberal arts colleges (Liberal Arts I institutions), this number rises to over three-quarters. In contrast, only 12 percent of full-time faculty at two-year colleges have doctorates, and part-

2. These categories were described in this volume's introduction.

Table 6.1 Faculty Employment in Institutions of Higher Education in the Late 1980s in the United States

Institution Type	(1)	(2)	(3)	(4)	(5)	(6)
Total	**3,389**					
Doctorate Granting	**213**	**.062**	**.40**			
Research University I	70	.021	.22	.77	.65	.29
Research University II	34	.010	.07	.82	.58	.20
Doctorate Granting I	51	.015	.06	.69	.64	.20
Doctorate Granting II	58	.017	.05	.73	.65	.18
Comprehensive	**595**	**.176**	**.26**			
Comprehensive I	424	.125	.23	.66	.54	.14
Comprehensive II	171	.050	.03	.66	.51	.15
Liberal Arts	**572**	**.169**	**.07**			
Liberal Arts I	142	.042	.03	.77	.72	.28
Liberal Arts II	430	.127	.04	.63	.50	.17
Two-Year Institutions	**1,367**	**.403**	**.20**	.43	.12	.03
Specialized Institutions	**642**	**.189**	**.05**	.58	.38	.21

Sources: Columns 1 and 2: Carnegie Foundation for the Advancement of Teaching (1987, table 2). Columns 3–6: Authors' calculations from the College Entrance Examination Board, *1988–89 College Characteristics Tapes*. All proportions are weighted (by faculty size) means of individual institution proportions.

Note: Columns are identified as follows: (1) number of institutions of higher education in 1987; (2) share of institutions of higher education in 1987; (3) share of full-time total faculty employment in 1988–89; (4) proportion of faculty who are full-time in 1988–89; (5) proportion of full-time faculty with Ph.D.s in 1988–89; and (6) proportion of part-time faculty with Ph.D.s in 1988–89.

time faculty at all institutions rarely have such degrees. While some faculty are employed in fields where the terminal degree typically is not a doctorate (e.g., fine arts, physical education), these data suggest that academics without doctorates may be viewed as possible substitutes for academics with doctorates, especially at non-research-oriented institutions, if a "shortage" of doctorates materializes.

How much are academics paid? Table 6.2 contains information obtained by the American Association of University Professors (AAUP) from their annual survey of institutions of higher education on average faculty salaries by institutional category, affiliation (public, private, or church related), and rank for the 1989–90 academic year. The AAUP institutional categories are similar, but not identical, to the Carnegie Foundation classifications used in Table 6.1. Data are presented here for doctoral-level, comprehensive (some masters' programs), general baccalaureate (four-year institutions), and two-year institutions; the latter include only those institutions whose faculty have the standard professional ranks (professor, associate professor, and assistant professor) for which the data are reported in the table.[3]

3. For brevity, data for instructors (employed primarily at two-year institutions), lecturers, and individuals without ranks are omitted from these tables.

Table 6.2 **1989–90 Average Faculty Salaries by Institutional Categories, Affiliation, and Academic Rank**

		Affiliation		
			Private	
Rank and Category	All	Public	Independent	Church Related
Professors:				
Doctoral level	59,920	57,520	68,360	61,210
Comprehensive	49,710	49,610	51,000	48,020
General baccalaureate	42,180	43,270	46,830	37,620
Two-year colleges[a]	42,430	43,000	31,560	26,040
All categories	53,540			
Associate professors:				
Doctoral level	42,830	42,010	46,440	43,810
Comprehensive	39,520	39,690	39,740	38,090
General baccalaureate	34,030	35,850	35,940	31,410
Two-year colleges[a]	35,540	35,990	27,830	25,130
All categories	39,590			
Assistant professors:				
Doctoral level	36,110	35,380	39,110	36,330
Comprehensive	32,640	32,730	32,780	31,900
General baccalaureate	28,210	29,650	29,520	26,390
Two-year colleges[a]	30,080	30,560	24,620	22,490
All categories	32,970			

Source: "The Annual Report on the Economic Status of the Profession, 1989–90," *Academe* 76 (March–April 1990), table 3.

[a]Only two-year colleges where faculty have standard academic ranks are included in these tabulations.

On average, full professors', associate professors', and assistant professors' nine-month academic salaries were $53,540, $39,500, and $32,970, respectively, in 1989–90.[4] As Table 6.2 indicates, however, salaries vary widely across categories of institutions.[5] Among the four-year institutions, doctoral-level institutions pay higher salaries than comprehensive institutions, which in turn pay higher salaries than general baccalaureate institutions. Within each four-year institutional category, private independents tend to pay more than public institutions, which in turn pay more than church-related institutions. While the salary differences across institutional categories and affiliations are most pronounced at the full professor level, they exist at other ranks as well.

Why do such differences exist? In part, research-oriented institutions may compete more aggressively for scholars, and the private independent sector

4. These figures exclude employee benefits (which typically exceed 20 percent of salary), summer earnings paid by the institution for teaching or research (from externally funded grants), and all forms of income earned from other sources (such as consulting and royalties).

5. Average salaries also vary widely within each institutional category. Data on average salary by rank for individual universities and colleges are found in the American Association of University Professors (1990).

may have the most flexibility to adjust salary levels to compete in this academic market. While other factors may also be involved—for example, faculty whose primary interests lie in undergraduate teaching may be willing to accept lower salaries at baccalaureate institutions because of the nonpecuniary advantages such institutions offer them—it is reasonable to assume that, if a shortage of doctorates were to materialize, the institutions that would have the most difficulty attracting faculty would be those with the lowest salaries. In fact, the smaller variability across institutions of average salaries at the assistant professor than at the full professor level suggests that, at the faculty entry level, average salaries are currently set to allow institutions to compete for faculty.

In addition to variation across institutional type and affiliation, salaries also vary across disciplines. Table 6.3 presents data on the average salaries of full professors and new assistant professors in 1989–90 for 21 disciplines obtained from a survey of state universities and land-grant colleges. These institutions are primarily public; hence, they are not representative of the entire

Table 6.3 **Average Salaries for Full Professors and New Assistant Professors by Discipline, 1989–90**

Discipline	(1) Average Full Professor Salary	(2) Average New Assistant Professor Salary	(3) Ratio of Average Full to Average New Assistant Professor Salary
Business	66,492	48,023	1.38
Law	78,875	43,434	1.82
Engineering	65,342	41,845	1.56
Computer information	67,026	40,672	1.65
Physical sciences	59,122	34,003	1.74
Mathematics	57,237	32,858	1.74
Agricultural sciences	51,034	32,246	1.58
Library	56,541	32,056	1.76
Architecture	53,337	32,013	1.67
Biology	53,997	31,994	1.69
Psychology	56,599	31,492	1.80
Public affairs	55,582	31,204	1.79
Home economics	50,420	31,139	1.62
Communications	52,117	30,887	1.69
Social sciences	56,637	30,546	1.85
Education	50,677	29,339	1.73
Area studies	55,799	29,304	1.92
Letters	53,083	27,596	1.92
Interdisciplinary studies	57,562	27,579	2.09
Foreign languages	52,613	26,832	1.96
Fine arts	46,819	26,667	1.76

Source: "The Annual Report on the Economic Status of the Profession, 1989–90," *Academe* 76 (March–April 1990), table III. These data are taken from the 1989–90 Faculty Survey by Discipline of Institutions Belonging to the National Association of State Universities and Land-Grant Colleges, conducted by the Office of Institutional Research, Oklahoma State University.

academic labor market. Nonetheless, these data make clear how large disciplinary differences in salary are, even when one eliminates medical schools (which the data do), where salaries tend to be the highest.

As table 6.3 shows, at the full professor level (col. 1), salaries in the highest-paying discipline in the sample, law, are almost 1.7 times the salaries in the lowest-paying discipline, fine arts ($78,875 vs. 46,819). At the new assistant professor level (col. 2), the differences are even more pronounced. Here, average salaries in the highest-paid discipline, business, are over 1.8 times the average salaries paid in the lowest, fine arts ($48,023 vs. 26,667). Not surprisingly, those disciplines with the highest starting salaries tend to be those in which there are both high student demand for instruction and highly paid nonacademic employment opportunities for faculty. They also tend to be disciplines in which the ratio of the average full to average new assistant professor salaries (col. 3) are relatively low.[6]

Full professors have much more institutional and academic "specific human capital" and also tend to have stronger ties to their communities than do their younger colleagues. As such, their probability of leaving their institutions is relatively low (Ehrenberg, Kasper, and Rees, in press); thus, institutions are under somewhat less pressure to raise their salaries in response to tightening labor market conditions. However, the broad disciplinary differences that exist, even at the full professor level, suggest that labor market conditions do influence faculty salaries and that projections of future shortages must take this into account.

Tables 6.1–6.3 paint a portrait of the academic labor market at one point in time. However, the academic labor market is fluid and has undergone several swings over the last two decades. For example, between academic years 1970–71 and 1980–81, the salary of the average faculty member in the United States fell by about 21.1 percent in real terms. In contrast, between 1980–81 and 1989–90, the salary of the average faculty member rose by about 16.6 percent in real terms (American Association of University Professors 1990, table I). To take another example, between 1970 and 1980, full-time-equivalent employment of faculty in the United States rose from 402,000 to 522,000, an increase of more than 2.6 percent a year. In contrast, by 1987, full-time-equivalent faculty employment had risen only to 547,000, an increase of less than 0.7 percent a year, and was projected to remain constant through 1990 (Anderson, Carter, and Malizio 1989, table 105).

In further contrast to these swings, Table 6.4 indicates that, after a tripling of the production of doctorates between 1960–61 and 1970–71, annual production of new doctorates in the United States has remained roughly constant—in the 32,000–34,000 range throughout the 1970s and 1980s (col. 5). However, this relative stability masks a number of substantial changes that did

6. Formally, the correlation across fields between starting assistant professor salaries and the ratio of full to starting assistant professor salaries is −0.66.

Table 6.4 **Earned Degrees Conferred by Institutions of Higher Education in the United States, 1960–61 to 1986–87**

Year	Associate's Degrees (1)	Bachelor's Degrees (2)	Master's Degrees (3)	First Professional Degrees (4)	Doctoral Degrees (5)	Ratio of First Professional to Doctoral Degrees (6)	Ratio of Doctoral to Bachelor's Degrees 6 Years Earlier (7)
1960–61	*	369,995	81,690	25,253	10,575	2.39	*
1961–62	*	388,680	88,414	25,607	11,622	2.20	*
1962–63	*	416,928	95,470	26,590	12,822	2.07	*
1963–64	*	466,944	105,551	27,209	14,490	1.88	*
1964–65	*	501,713	117,152	28,290	16,467	1.72	*
1965–66	111,607	520,923	140,548	30,124	18,237	1.65	*
1966–67	139,183	558,852	157,707	31,695	20,617	1.54	*
1967–68	159,441	632,758	176,749	33,939	23,089	1.47	.056
1968–69	183,279	729,656	193,756	35,114	26,088	1.34	.063
1969–70	206,023	792,656	208,291	34,578	29,866	1.16	.064
1970–71	252,610	839,730	230,509	37,946	32,107	1.18	.064
1971–72	292,119	887,273	251,633	43,411	33,363	1.30	.064
1972–73	316,174	922,362	263,371	50,018	34,777	1.44	.062
1973–74	343,924	945,776	277,033	53,816	33,816	1.59	.053
1974–75	360,171	922,933	292,450	55,916	34,083	1.64	.047
1975–76	391,454	925,746	311,771	62,649	34,064	1.84	.043
1976–77	406,377	919,549	317,164	64,359	33,232	1.94	.040
1977–78	412,246	921,204	311,620	66,581	32,131	2.07	.036
1978–79	402,702	921,390	301,079	68,848	32,730	2.10	.035
1979–80	400,910	929,417	298,081	70,131	32,615	2.15	.034
1980–81	416,377	935,140	295,739	71,956	32,958	2.18	.036
1981–82	434,515	952,998	295,546	72,032	32,707	2.20	.035
1982–83	456,441	969,510	289,921	73,136	32,775	2.23	.036
1983–84	452,416	974,309	284,268	74,407	33,209	2.24	.036
1984–85	454,712	979,477	286,251	75,063	32,943	2.28	.036
1985–86	446,047	987,823	288,567	73,910	33,653	2.20	.036
1986–87	437,137	991,339	289,557	72,750	34,120	2.13	.036

Source: U.S. Department of Education (1989, table 200).

*Not reported or not calculated.

occur during the latter period. While the production of doctorates remained roughly constant, the number of bachelor's degrees granted in the United States roughly doubled between the mid-1960s and the mid-1970s. As a result, the ratio of doctorates granted to bachelor's degrees granted six years earlier fell from .0064 in 1970–71 to .035 in 1978–79 and has remained roughly constant at the lower level since (col. 7). A much smaller proportion of college graduates are obtaining doctoral degrees now than 20 years ago.[7] Moreover, as will be shown in the next chapter, the proportion of doctorates awarded to foreign residents has increased substantially during the past two decades; thus, the proportion of American citizen college graduates receiving doctorates has actually continued to decline.

Part of the reason that this has occurred is that American college graduates have increasingly turned to other forms of postcollege study. In 1970–71, the ratio of first professional degrees (law, dentistry, medicine, and other professions) to doctoral degrees granted stood at 1.18 (col. 7); approximately the same number of first professional and doctoral degrees were awarded. However, by 1977–78, over twice as many first professional degrees as doctoral degrees were awarded, and this has continued in every year since. The ratio of master's degrees granted (col. 3), which includes MBAs, to doctoral degrees granted (col. 6) has also risen; this stood at 7.18 in 1970–71 but rose to 8.58 in 1974–75 and since then has remained close to or above that level. More college graduates are thus entering terminal master's programs (such as the MBAs) and/or starting study toward a doctoral degree but terminating at the master's level.

7. What is true in the aggregate is not necessarily true in every field. However, the scope of this study precludes detailed analyses by field. For a recent analysis of production of doctorates in the biomedical fields, see National Research Council (1990).

7 A Stock Flow Model of Academic Labor Supply

7.1 A Conceptual Model

Figure 7.1 presents a schematic representation of the various components of academic labor supply.[1] After tracing through the figure to highlight the wide variety of areas at which public policies might be directed, the following section presents data on a number of the component stocks and flows.

The potential flow of American undergraduate students into doctoral study depends initially on the number of undergraduate seniors and the major fields they have chosen to study. Choice of undergraduate major is important because in many fields it is rare for students to enter doctoral study from anything other than an undergraduate major in the same, or a closely related, field. In 1988, for example, 73 percent of new doctorates in physics and astronomy, 80 percent of new doctorates in chemistry, 76.4 percent of new engineering doctorates, 62 percent of new doctorates in economics, and 57 percent of new humanities doctorates had undergraduate majors in their doctorate field (National Research Council 1989d, app. A, table 2).

Once students receive undergraduate degrees, they face a number of options. They can enter graduate study directly and become Ph.D. students at American institutions of higher education, they can search for employment, they can pursue graduate study toward other degrees (e.g., business, law, medicine, or the other professions), or they can pursue foreign study. Some of the individuals who fail to enter doctoral study at American institutions directly after receiving their undergraduate degrees may enter at some later date.

1. For expository convenience, Figure 7.1 assumes that all academics have doctoral degrees. I return to a discussion of substituting faculty with for faculty without doctorates in chapter 10. Since the vast majority of faculty at two-year colleges do not have doctoral degrees (Table 6.1), this figure and the discussion that follows should be thought of as applying to the four-year college market.

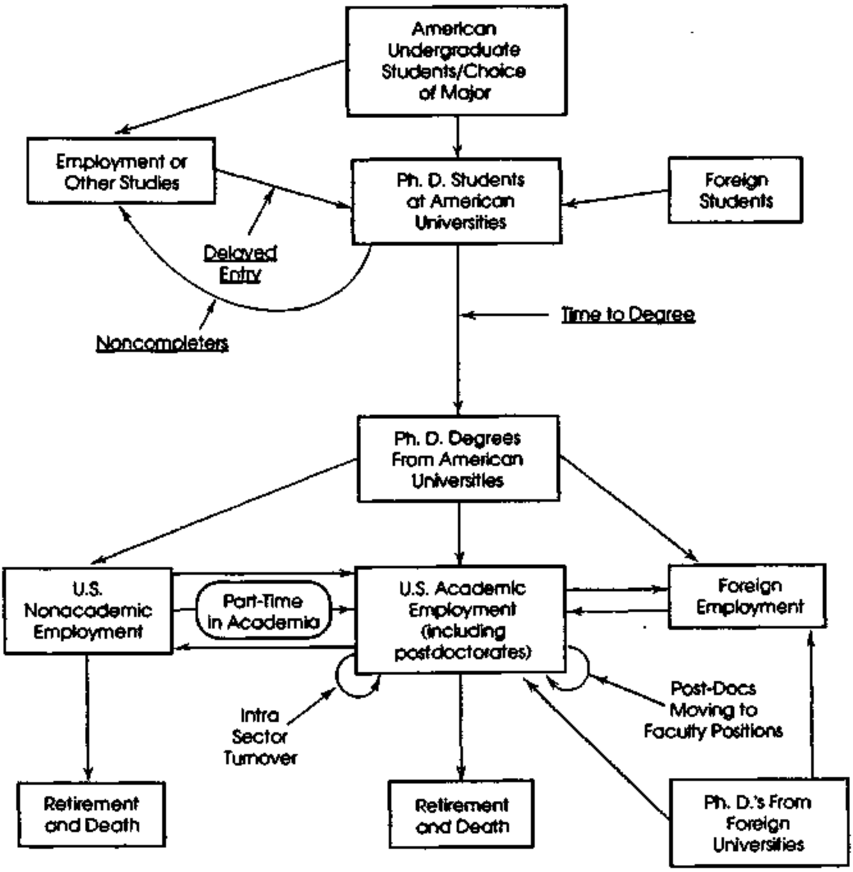

Figure 7.1 Academic labor supply.

The sum of American students who are direct and delayed entrants and of foreign students who both want to pursue doctoral study in the United States and are admitted determines the flow of students into doctoral programs in American universities.

Doctoral study is a risk endeavor, and some students will fail to complete their programs, either because they prove unsuitable academically, because their interests change, or because finances force them to drop out. These students will accept employment in the United States or abroad or enroll in other types of educational programs. The remaining students will ultimately receive doctoral degrees from American universities. Of key concern is the length of time that it takes these students to complete their degrees. Other things being equal, the longer it takes to complete degrees, the less attractive prospective students will find doctoral programs, and the greater noncompletion rates are likely to be.

Students who receive doctorates from American universities face a number of options. Some move directly into academic positions in the United States. Others, especially in the sciences, accept postdoctoral research positions in which they receive additional research experience for one or two years, and then some of these ultimately obtain faculty positions. Others accept nonacademic positions in the United States, and still others accept foreign employment. Some of those initially employed in the nonacademic sector in the United States or in the academic or nonacademic sectors abroad may at a later date find employment in the U.S. academic sector. In addition, American colleges and universities may try to hire new doctorates produced at foreign universities directly as faculty members. Finally, doctorates employed full-time in the nonacademic sector may "moonlight" and also be employed part-time in the academic sector.

Each year, approximately 15 percent of full-time assistant professors and 7–10 percent of the full-time associate and full professors who are employed in American colleges and universities "turn over" and are not employed at the same institution in the next year (Ehrenberg, Kasper, and Rees, in press, tables 1–3). At the assistant professor level, turnover reflects both voluntary movement to other U.S. academic institutions, foreign institutions, or the nonacademic sector and involuntary mobility to these places owing to denial of reappointment or tenure. At the associate professor level, turnover reflects primarily voluntary mobility. Finally, at the full professor level, it reflects voluntary mobility to other positions, retirements, and deaths. The age distribution of the faculty obviously has a major effect on out-mobility from the academic sector: younger faculty are more likely to move to a nonacademic employer, and older faculty are more likely to retire or die.

7.2 Trends in Academic Labor Supply

7.2.1 The Production of Doctorates

During the last two decades, substantial changes have occurred in the distribution of college students' majors. Table 7.1 presents information on the share of bachelor's degrees conferred by U.S. academic institutions in different disciplines for the period 1970–71 to 1987–88. During this period, the proportion of students majoring in business almost doubled, rising to nearly one-quarter of all bachelor's degrees granted. The shares of engineering and other professional degrees increased substantially, while the shares of education and arts and science degrees declined substantially. Within the arts and sciences, the humanities and social sciences were hit the hardest, with the former's share declining by over one-third and the latter's share declining by an even greater amount. Presumably, many students who in previous years would have majored in the social sciences now major in business. More generally, changes in decisions about field of study made by women are an impor-

Table 7.1 **Share of Bachelor's Degrees Conferred by U.S. Institutions of Higher Education in Different Disciplines**

Category	1970–71	1975–76	1980–81	1985–86	1987–88
Business	.137	.154	.213	.241	.246
Education	.210	.167	.116	.088	.092
Engineering	.059	.050	.081	.097	.099
Other professional	.096	.177	.203	.189	.171
Arts and sciences	.488	.442	.390	.385	.359
Humanities	.147	.118	.097	.090	.095
Life sciences	.043	.059	.046	.039	.037
Physical sciences	.058	.046	.054	.081	.070
Psychology	.045	.054	.044	.041	.045
Social sciences	.185	.136	.107	.095	.101
Interdisciplinary	.010	.030	.042	.040	.041

Sources: Author's computations from data in U.S. Department of Education (1989, table 205) and unpublished tabulations of the data for 1987–88 provided by the Education Information Branch, Office of Educational Research and Improvement, U.S. Department of Education.

Table 7.2 **Discipline Distribution of Doctorates Awarded by U.S. Colleges and Universities, 1960–88**

	Share of Doctorates Awarded in the:						
	Physical Sciences	Engineering	Life Sciences	Social Sciences	Humanities	Education	Professional/ Other
1960	.221	.082	.178	.171	.164	.159	.025
1964	.217	.116	.165	.158	.151	.164	.028
1968	.203	.124	.162	.152	.151	.176	.032
1972	.168	.106	.154	.165	.153	.214	.040
1973	.157	.100	.153	.171	.160	.214	.045
1976	.137	.086	.153	.189	.148	.234	.053
1980	.133	.080	.176	.189	.125	.245	.053
1984	.142	.093	.184	.189	.113	.217	.062
1988	.159	.125	.184	.172	.106	.190	.064

Source: *Summary Report 1988: Doctorate Recipients from United States Universities* (Washington, D.C.: National Academy Press, 1989), tables A, C.

tant cause of these changing proportions, and, presumably, these reflect, at least partially, a widening of career options for women (Turner and Bowen 1990).

Some of these trends are reflected in the disciplinary distribution of doctorates awarded by American colleges and universities, which is presented for the period 1960–88 in Table 7.2. What is most striking is the one-third drop since the early 1970s in the proportion of doctoral degrees awarded in the humanities, which reflects the importance influence that an individual's undergraduate major has on his or her field of graduate study (see the previous section). The share of doctoral degrees granted in the social sciences has not declined substantially; this apparent divergence from the comparable undergraduate trend may partially reflect the possibility that the shift in students from undergraduate social science to business majors was a shift of students who were unlikely to choose doctoral study.

The shift in the distribution of degrees awarded is also heavily influenced by the inflow of foreign graduate students. As Table 7.3 indicates, over the last 30 years the share of new doctorates from American universities awarded to U.S. citizens and permanent residents has fallen from about 90 to 80 percent. The decline has been most pronounced in the physical sciences and engineering, where foreign students (temporary residents in the United States) represented about 30 and 35 percent, respectively, of new doctorates awarded in 1988. As will be shown below, foreign students are less likely to remain in the United States once they receive their degrees. Thus, given the total number of new doctorates produced, an increase in the proportion who are foreign may reduce the potential academic labor supply to American colleges and universities.[2]

While the number of doctorates produced in American academic institutions has remained roughly constant, the time it takes for students to complete their degrees has lengthened during the past two decades. Data on median years of time spent enrolled as a doctoral student are reported for the period 1968–88 by field and year of degree in Table 7.4. Median *registered time* to degree rose over the period by almost a year and a half, from 5.5 to 6.9 years. The increase in registered time to degree was somewhat smaller in the sciences and engineering but considerably larger in other fields, including the humanities, where registered time to degree rose by three years, from 5.5 to 8.5 years.[3]

2. The distinction made between permanent and temporary residents depends on an individual's immigration status. Permanent residents are noncitizens who have been granted immigrant status or permission to stay in the United States permanently. Temporary residents, or, more precisely, nonimmigrants, are people who have been admitted to the United States for specified purposes (e.g., tourist, student, exchange visitor) for a fixed period of time. As discussed in Chapter 10, temporary residents sometimes subsequently become permanent residents.

3. An important qualification about these time-to-degree data (first recognized by Bowen, Lord, and Sosa, in press) is in order here. The data in Table 7.4 are grouped by year of completion of degree, not by year of entry into doctoral programs. As a result, even if the distribution of times to degree in each entering cohort remains constant over time, these reported average times to degree by year of completion will change if the sizes of entering cohorts are systematically changing over time. In particular, if entering cohorts are increasing in size, average time to degree by year of completion will spuriously appear to decrease, while, if entering cohorts are declining in size, average time to degree by year of completion will spuriously appear to increase. This would occur because, in the former case, those completing degrees in a given year would disproportionately come from "fast" completers from relatively large cohorts, while, in the latter case, those completing degrees in a given year would disproportionately come from "slow" completers from relatively large cohorts.

A simple numerical example illustrates this point. Suppose that all entering students receive degrees, that (unrealistically) half of each year's entering doctoral cohort complete in one year, and the other half complete in two years. Average time to degree by year of entering cohort is thus

Table 7.3 **Share of New Doctorates Going to U.S. Citizens and Permanent Residents**

	Total Doctorates	Physical Sciences	Engineering	Life Sciences	Social Sciences	Humanities	Education	Professional/Other
1960	.907	.896	.836	.852	.910	.970	.953	.898
1964	.896	.886	.837	.822	.907	.962	.949	.871
1968	.899	.888	.850	.840	.909	.955	.954	.871
1972	.923	.886	.845	.874	.914	.959	.960	.903
1973	.904	.869	.850	.872	.908	.953	.959	.887
1976	.894	.840	.813	.863	.909	.951	.954	.885
1980	.879	.829	.705	.867	.914	.945	.931	.880
1984	.839	.770	.646	.853	.887	.925	.918	.826
1988	.801	.702	.654	.815	.865	.895	.919	.801

Source: *Summary Report 1988: Doctorate Recipients from United States Universities* (Washington, D.C.: National Academy Press, 1989), table C.

Understanding the causes of the lengthening of registered time to degree is important because longer times to degree probably discourage people from entering doctoral study, may increase the likelihood that initial enrollees fail to complete their programs, and increase the length of time it takes new graduate students to enter the academic labor market. Indeed, even if time to degree had no effect at all on the number of people electing graduate study or their completion rates, a reduction in time to degree of one year would create a doubling for one year in the number of doctorates produced and thus contribute to increased academic labor supply.[4]

Data are also presented in Table 7.4 on *total time* to degree, the total length of time between an individual's receipt of the bachelor's degree and his or her receipt of a doctoral degree. Median total time to degree has risen by 2.4 years

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constant at 1.5 years. Suppose that, in years 0 and 1 (and all previous years), entering cohort size is 100. The top half of the table below shows that reported time to degree by year of completion will decrease from 1.5 to 1.476 years if, starting in year 3, entering cohort size increases by 10 percent per year. Similarly, the bottom half shows that reported time to degree by year of completion will increase from 1.5 to 1.526 years if starting in year 3, entering cohort size decreases by 10 percent per year:

Year	Entering Cohort Size	No. Who Will Complete in t + 1	No. Who Will Complete in t + 2	Average Time to Degree of Completers in the Year
0	100	50	50	1.5 ([50 × 1] + [50 × 2])
1	100	50	50	1.5 ([50 × 1] + [50 × 2])
2	110	550	55	1.5 ([50 × 1] + [50 × 2])
3	121	60.5	60.5	1.476 ([55 × 1] + [50 × 2])
4	133.1	66.55	66.55	1.476 ([60.5 × 1] + [55 × 2])
0	100	50	50	1.5 ([50 × 1] + [50 × 2])
1	100	50	50	1.5 ([50 × 1] + [50 × 2])
2	90	45	45	1.5 ([50 × 1] + [50 × 2])
3	81	40.5	40.5	1.526 ([45 × 1] + [50 × 2])
4	72.9	36.45	36.45	1.526 ([40.5 × 1] + [45 × 2])

While the total number of doctorates awarded in the United States remained roughly constant over the period 1970–88 (Table 6.4), the share and hence the absolute number awarded in the humanities fell substantially (Table 7.2). One can infer from these data that entering cohorts of humanities doctoral students were declining. Bowen, Lord, and Sosa (in press) compute that slightly over half the reported increase in time to degree, reported in Table 7.4, is spuriously due to the declining humanities cohort sizes. This line of reasoning suggests that, while time to degree has increased in the humanities, the increase is not as large is suggested by Tables 7.4 and 7.5 below. Similar studies of how changing cohort sizes affect reported times to degree in other fields have yet to be undertaken.

4. A numerical example illustrates this point. Suppose that it initially takes six years to complete a degree, that 100 students enter the program, and that all complete their degrees. Then, in steady state, there will be 100 first-year, 100 second-year, 100 third-year, 100 fourth-year, 100 fifth-year, and 100 sixth-year students enrolled each year. If time to degree could be reduced to five years in year *t*, both the fifth- and the sixth-year cohorts would receive degrees that year. Hence, there would be 200 doctorates produced in year *t*, and median time to degree would be 5.5 years. In year *t* + 1 and all subsequent years, only the fifth-year cohort would receive degrees. Thus, median time to degree would drop to, and thereafter remain at, five years, and doctorate production would return to 100 a year.

Table 7.4 **Median Years to Degree for Doctorate Recipients by Broad Field, 1968–88**

	All Fields	Physical Sciences	Engineering	Life Sciences	Social Sciences	Humanities	Education	Professional/Other
Registered time:								
1968	5.5	5.1	5.1	5.3	5.1	5.5	5.8	5.1
1970	5.5	5.3	5.2	5.3	5.5	6.1	6.2	5.4
1972	5.7	5.6	5.5	5.5	5.6	6.2	6.1	5.6
1974	5.9	5.6	5.6	5.5	5.7	6.6	6.3	6.0
1976	6.0	5.6	5.6	5.6	5.8	6.9	6.3	6.1
1978	6.1	5.8	5.6	5.7	6.0	7.3	6.5	6.2
1980	6.3	5.8	5.6	5.8	6.4	7.7	6.9	6.4
1982	6.5	5.8	5.7	6.0	6.7	8.0	7.2	6.7
1984	6.8	6.0	5.7	6.3	7.1	8.2	7.6	7.1
1986	6.8	6.0	5.9	6.4	7.2	8.2	7.8	7.3
1988	6.9	6.1	5.9	6.5	7.4	8.5	8.1	7.3
Total time:								
1968	8.1	6.0	7.1	7.1	7.7	9.5	13.9	10.9
1970	7.9	6.1	6.9	6.6	7.3	9.1	12.7	10.2
1972	8.2	6.5	7.5	7.0	7.5	9.0	12.5	9.7
1974	8.5	6.8	7.6	7.2	7.7	9.3	12.4	9.8
1976	8.6	6.7	7.5	7.3	7.8	9.7	12.7	10.3
1978	8.9	7.0	7.5	7.3	8.1	10.2	12.7	10.3
1980	9.3	6.9	7.6	7.4	8.6	10.6	13.2	11.1
1982	9.6	6.9	8.0	7.6	9.2	11.2	13.6	11.6
1984	10.0	7.2	8.0	8.2	9.7	11.5	14.6	12.3
1986	10.4	7.3	8.1	8.7	10.1	12.1	15.7	12.8
1988	10.5	7.4	8.1	8.9	10.5	12.2	16.9	13.0

Source: Summary Report 1988: Doctorate Recipients from United States Universities (Washington, D.C.: National Academy Press, 1989), table I.

Table 7.5 **Mean Number of Years between Receipt of Baccalaureate Degree and Taking of the GREs for Students Planning Doctoral Study[a]**

	Field of Planned Graduate Study											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1976	2.2	2.1	6.3	2.5	2.0	1.1	1.8	.8	1.8	1.5	1.1	2.2
1977	2.4	2.2	6.2	2.8	2.0	1.2	2.0	1.0	1.8	1.7	1.0	2.3
1978	2.7	2.4	6.8	3.0	2.1	1.3	2.5	1.1	2.0	2.0	.9	2.6
1979	2.9	2.5	7.2	3.2	2.3	1.8	2.7	1.4	2.0	2.1	1.0	2.8
1980	2.8	2.7	7.4	3.3	2.3	1.6	3.1	1.4	2.0	2.2	1.1	2.9
1981	3.2	2.9	8.0	3.9	2.6	1.6	3.2	1.6	2.1	2.5	1.2	3.1
1982	2.8	3.2	8.5	3.5	2.6	1.7	3.6	1.6	2.2	2.6	1.3	3.1
1983	2.9	3.1	8.6	4.1	2.6	1.8	3.6	1.8	2.3	2.7	1.2	3.2
1984	3.3	3.2	8.8	4.4	2.7	2.0	3.8	2.2	2.3	2.8	1.2	3.3
1985	3.9	3.2	9.1	4.6	2.7	2.0	3.9	2.2	2.4	2.8	1.4	3.4
1986	4.3	3.5	9.2	4.7	3.0	2.2	4.4	2.5	2.8	3.0	1.6	3.7
1987	4.5	3.5	9.4	5.0	2.9	2.3	4.5	2.5	2.8	3.0	1.7	3.7

Source: Author's computations from Educational Testing Service (1988), table 42, and the comparable table from the prior years' reports.

[a]Year student took the GRE (e.g., the 1986–87 academic year is treated as 1987 since most students would enter doctoral study in the fall of 1987) minus the year the student reported receiving the bachelor's degree. The fields are as follows: (1) arts; (2) other humanities; (3) education; (4) other social sciences; (5) behavioral sciences; (6) biological sciences; (7) health; (8) applied biology; (9) engineering; (10) mathematical sciences; (11) physical sciences; and (12) total (including fields not reported separately above and intended field not reported by the student).

from 8.1 to 10.5 years; again, much smaller increases are observed for the sciences and engineering, with larger increases for other fields. Total time to degree will be larger than registered time to degree if students delay entry to graduate programs, if they start study in one field and then switch to another at a later date, or if they spend some time not enrolled in graduate study after their initial entry. Evidence presented from the Educational Testing Service in Table 7.5 on the mean number of years between the time students planning doctoral study first take the Graduate Record Examination (which is required for admission by many institutions) and when they received their bachelor's degrees suggests that college graduates are increasingly delaying entry to doctoral study. On average, test takers waited a year and a half longer in 1987 than they did in 1976 (col. 12).

Completion rates for entrants into doctoral programs vary widely across fields and institutions. Data for a set of selected major research universities for periods during the 1970s and early 1980s appear in Table 7.6. These data suggest that completion rates tend to be higher in the sciences than in the humanities and that in most of these programs doctoral completion rates lie in the 40–70 percent range.[5] Even the very best science graduate students, those

5. The rates reported in Table 7.6 may understate the true completion rates slightly because some people who were noncompleters as of the survey dates will ultimately complete their degrees and because one school (University D) reports only those who completed degrees within seven years of their first enrollment.

Table 7.6 **Doctoral Completion Rates at Selected Major Research Universities**

	Entering Class Years											
	University A (1975–77)		University B (1975–80)		University C (1970–82)		University D (1974–80)		University E (1975–77)		University F (1975–77)	
Field	No. of Observations	Completion Rate (%)	No. of Observations	Completion Rate (%)	No. of Observations	Completion Rate (%)	No. of Observations	Completion Rate (%)	No. of Observations	Completion Rate (%)	No. of Observations	Completion Rate (%)
Anthropology	66	43.9	49	43.0	152	39.0	30	33.3	31	51.0	69	55.1
Architecture	24	37.5					28	39.3			25	44.0
Astronomy	15	60.0			65	72.0					10	70.0
Biochemistry and molecular biology	68	77.9			134	75.0	59	64.4			60	75.0
Biology							67	73.1	57	63.0		
Business administration	59	54.2			103	62.0					56	66.1
Chemical engineering	42	83.3			90	53.0	88	85.2			35	60.0
Chemistry	213	83.1	93	87.0	424	68.0	157	75.8	84	60.0	66	74.2
City regional planning	21	42.9			141	51.0					34	61.8
Civil engineering	152	55.9			235	57.0	53	73.6			38	57.9
Classics	28	25.0	23	61.0	47	51.0	41	36.6			21	52.4
Comparative literature	66	19.7	21	71.0	50	52.0	61	50.8			14	50.0
Dramatic art	24	25.0			38	39.0					14	78.6
Economics	97	59.8	66	48.0	247	51.0	41	36.6			21	52.4
Education	230	43.9			385	64.0					707	50.9
Electrical engineering and computer science	211	50.2	26	46.0	502	55.7	102	89.2			106	53.8
English	109	34.9	94	46.0	211	57.0	102	60.8	82	49.0	90	55.6

French	20	35.0	23	52.0					34	50.0		
Genetics	23	82.6			59	52.0					18	50.0
Geology & geography	43	60.5	51	61.0	118	45.0	65	72.3			14	71.4
German	27	33.3	6	17.0	68	37.0	39	48.7			11	36.4
History	105	19.0	54	31.0	153	41.0	111	32.4	61	52.0	88	42.1
Industrial engineering / operational research	51	39.2			152	58.0						
Linguistics	36	47.2	22	55.0	160	47.0	6	100.0			49	40.8
Material science and engineering	57	66.7			137	64.0					9	44.4
Mathematics	199	46.7	47	72.0	169	54.0	116	77.6			68	50.0
Mechanical engineering	122	58.2			123	35.0	70	75.7			35	62.9
Music	24	75.0	6	50.0	84	54.0	64	37.5			111	54.1
Near East studies	26	23.1					55	45.4			31	45.2
Nuclear engineering	32	50.0			25	68.0					49	73.5
Philosophy	30	43.3	37	49.0	80	46.0	64	40.6	42	40.0	35	28.6
Physics	147	67.3	102	70.0	400	60.0	141	79.4	56	71.0	51	58.9
Physiology	21	71.4			44	59.0			7	86.0	15	66.7
Political science	92	51.1			210	45.0	110	29.1			74	40.5
Psychology	72	68.1	31	90.0	165	64.0	76	67.1	57	56.0	165	73.3
Romance language and literature	6				152	50.0	75	38.7			42	42.9
Slavic language and literature	23	21.7	23	52.0	60	32.0					18	33.3
Sociology	70	41.4	63	65.0	135	59.0	63	41.3			72	52.8
Statistics	45	62.2			32	63.0	39	69.2			14	14.3

Source: Unpublished tabulations prepared by the University of California, Berkeley, Graduate Division, dated 3 May 1989.

Note: University A: Completion rate as of May 1988. University C: Completion rate as of May 1988. University D: Completion rate after seven years following the first enrollment for each cohort. University E: Completion rate as of December 1987. University F: Completion rate as of January 1988.

who win prestigious National Science Foundation Graduate Fellowships, had completion rates of 80 percent or less during the period 1962–76 (Harmon 1977, table 1; J. Snyder 1988). These completion rates should be contrasted with completion rates of over 98 percent in the top 20 American law schools, of over 90 percent in major American medical schools, and of 80–95 percent for top MBA programs in the United States.[6] Doctoral study is considerably riskier than its alternatives.

7.2.2 Initial Postdegree Experiences of New Doctorates

Each year, when doctoral candidates submit their dissertations to their graduate schools for final approval, they are asked to respond to the Survey of Earned Doctorates (SED), which is administered by the National Research Council. Among the questions asked in the SED are whether respondents have made definite employment plans in the United States and, if so, whether their employment is in the academic or the nonacademic sector.[7] Data on the sectoral distribution of employment for U.S. citizen and permanent resident new doctorates from the SED are reported in Table 7.7 for 1968, 1978, and 1988. Quite strikingly, the share of these employed new doctorates finding employment in academe has declined in the aggregate from two-thirds in 1968 to about half in 1988. With the exception of the health sciences and business and management fields, the academic share declined in all fields. Indeed, while almost 94 percent of employed new doctorate humanists were employed in academe in 1968, by 1988 slightly less than 80 percent were initially so employed.

Of crucial concern for public policy is whether the declining academic share of employed new doctorates is due to an increasing demand and higher relative salaries for new doctorates in the nonacademic sector or simply due to a scarcity of job openings in the academic sector during the period. While the answer will likely vary across fields, if the former is the case, it will be necessary to increase academic salaries vis-à-vis nonacademic salaries to attract a greater share of new doctorates into academe. If the latter is the case, an expansion of academic job opportunities in itself (without any increase in academic salaries) may lead a greater share of new doctorates to enter aca-

6. The law school data come from *Barrons' Guide to Law Schools* and are for the mid-1980s. The American Medical Association (1988) reports a net attrition rate of 2.6 percent of 1986–87 enrollments at AMA approved medical schools. Since most medical schools have a four-year curriculum, this implies that completion rates exceed 90 percent. Finally, while completion rates of MBA programs are not collected, James Schmotter, associate dean at Cornell's Johnson School of Management, reports that Cornell's MBA completion rate is 98 percent, and other top MBA program rates are also greater than 90 percent, save perhaps Harvard and Virginia. This latter two use the case-study method, and, apparently, test scores and undergraduate records cannot predict which applicants will succeed in these programs, at least not as well as they do for other programs.

7. It is rare for the U.S. citizens holding doctorates to have definite employment plans outside the United States. For example, of those U.S. citizen new doctorates whose future location was known when they returned the SED, 97.6 percent (15,778 of 16,182) had plans in the United States in 1988 (see National Science Foundation 1989e, table 15).

Table 7.7 **Sector of Employment of U.S. Citizen and Permanent Resident Doctorate Recipients with Employment Commitments in the United States, 1968, 1978, and 1988 (%)**

	Employment Sector											
	Academe			Industry			Government			Other		
Field	1968	1978	1988	1968	1978	1988	1968	1978	1988	1968	1978	1988
Total all fields	66.6	56.4	49.8	14.8	15.3	20.4	7.4	12.5	10.8	11.2	15.9	19.1
Physical sciences	50.1	37.9	36.2	34.6	45.2	50.0	9.4	14.4	11.8	5.9	2.4	1.9
Physics/astronomy	52.1	25.9	26.1	25.0	46.9	48.2	16.1	24.1	23.4	6.7	3.1	2.3
Chemistry	29.5	18.4	15.3	58.9	71.4	77.7	4.9	7.7	5.0	6.7	2.5	2.0
Earth, atmospheric, marine	50.7	33.2	39.3	25.9	36.1	30.4	17.8	27.9	29.5	5.6	2.9	.9
Mathematics	79.9	70.8	75.9	12.6	19.1	19.0	3.7	8.2	2.3	3.9	1.9	2.8
Computer sciences	*	58.2	56.6	*	35.8	32.7	*	6.0	8.8	*	.0	1.8
Engineering	33.3	23.5	28.5	47.0	57.1	55.5	10.6	17.5	15.0	9.1	2.0	.9
Life sciences	65.9	59.0	51.9	11.8	20.4	23.7	14.0	16.3	16.8	8.4	4.3	7.6
Biological sciences	68.0	60.9	47.7	9.0	17.7	27.1	13.0	16.4	18.0	9.9	5.0	7.2
Health sciences	56.8	62.9	63.1	23.7	17.2	13.8	6.8	14.5	12.5	12.7	5.5	10.6
Agricultural sciences	62.2	53.7	44.3	16.1	26.7	30.8	19.3	17.3	20.4	2.4	2.4	4.4
Social sciences (including psychology)	75.3	58.5	45.1	4.8	9.6	19.4	10.6	16.0	14.2	9.2	16.0	21.3
Psychology	61.0	40.0	29.6	6.5	12.4	24.6	17.0	20.7	16.5	15.6	26.9	29.3
Other social sciences	85.1	76.2	66.2	3.7	6.9	12.3	6.3	11.4	11.1	4.9	5.5	10.4
Humanities	93.9	82.6	79.3	6.0	4.9	5.8	1.4	3.8	3.7	4.3	8.7	11.2
Education	68.1	51.9	43.8	1.0	3.4	7.3	3.9	12.5	9.0	26.9	32.2	39.8
Professional/other	80.9	74.1	73.8	8.9	7.0	8.2	3.9	7.2	6.4	6.3	11.8	11.6
Business and management	84.6	87.0	90.0	9.1	7.9	7.0	1.9	4.3	2.6	4.4	.8	.4
Communications	88.9	83.9	81.9	8.3	9.3	8.1	.0	4.1	2.0	2.8	2.6	8.1

Source: Summary Report 1988: Doctorate Recipients from United States Universities (Washington, D.C.: National Academy Press, 1989), table R. "Other" includes elementary/secondary schools, nonprofit institutions, self-employment, and other employers.

*Not available.

demic life and may also induce some doctorates currently employed in the nonacademic sector to enter or reenter academe.

Table 7.7 may present a misleading picture of the proportion of new doctorates entering academic careers directly because it focuses on those new doctorates who have accepted employment and ignores the increasing share of new doctorates accepting one- or two-year postdoctoral appointments (postdocs). These positions, found in universities, government, and the private sector, offer doctorates additional opportunities to develop their research skills before moving on to more permanent employment.

Table 7.8 contains data on the share of new doctorates with definite plans in the United States going on to postdocs and academic employment between 1970 and 1988. During this period, the share of new science/engineering U.S. citizen doctorates with definite plans who were starting postdocs rose from 0.22 to 0.39, which was almost equal to the decline from 0.44 to 0.24 in the share accepting academic employment.[8] The trends for permanent residents were very similar. In contrast, in the nonscience/nonengineering fields, very few students accept postdocs, and the small increase that occurred over the last 20 years cannot "explain" the large decline in the share of new doctorates with definite plans accepting academic employment.

When one examines more narrowly defined science/engineering fields, one finds variations in behavior across them. In some of the specific fields listed in Table 7.8, the increase in the share accepting postdocs between 1970 and 1988 was approximately equal to, or greater than, the decrease in the share accepting academic employment (physical sciences, earth and material sciences, life sciences, mathematical sciences, engineering). In other fields, such as the social and psychological sciences, the decline in the share accepting academic employment far exceeded the increase in the postdoc share.

These trends suggest a number of policy issues. Is the increasing share of postdocs in most fields caused by a deepening of knowledge and hence a required longer training period before faculty appointments can be obtained? Or does it represent a response to a relatively loose academic labor market and attempts by doctorates to enhance their attractiveness in the search for permanent academic positions by accepting these lower-paying training positions?[9] Are differences in the growth of postdocs across fields caused at least partially by differences in the strength of the nonacademic labor market across fields? Do postdocs eventually wind up in academic positions so that the net effect on the academic labor supply is simply to lengthen the pipeline? Is the increasing "need" for a postdoc partially responsible for the decline in the

8. In Table 7.8, the social sciences and psychology are included as sciences, and the nonscience/nonengineering fields include the humanities, education, and other professional doctoral fields.

9. As of 1979, the median postdoc stipend was, on average, less than 60 percent of the median salary of full-time-employed new doctorates, although this percentage varied across fields (see National Research Council 1981, table 53).

share of college graduates seeking doctorates? If the increased use of postdocs is a result of a "loose" academic labor market, would a "tight" market lead to an increase in the number of new doctorates directly accepting academic employment? If this occurs, would the decline in the probability that a postdoc is required for academic employment make doctoral study more attractive and increase the flow of college graduates into doctoral programs?

Table 7.8 also contains data on temporary resident (foreign) new doctorates who reported having definite plans in the United States. Although temporary resident new doctorates with definite plans are less likely to remain in the United States than U.S. citizen and permanent resident new doctorates, the share of the former doing so has increased from 0.42 to 0.55 in the total sciences/engineering fields and from 0.22 to 0.30 in the nonscience/nonengineering areas over the period 1970–88. Of those who do stay, a much greater proportion obtain postdocs than do citizen or permanent resident degree holders. Moreover, in 1988, in the total science/engineering area, the share of temporary resident doctorates who stay and find academic appointments was actually as high as the comparable shares of U.S. citizen new doctorates finding academic employment, and, in the nonscience/nonengineering area, it was greater. In part, this may be because temporary resident doctorates may have difficulty obtaining visas to work in the U.S. nonacademic sector. Whether an expansion of temporary resident U.S. academic employment is possible, or desirable, will be discussed in a later chapter.

What do postdocs actually do on completion of their appointments? Every two years, the Office of Scientific and Engineering Personnel of the National Research Council conducts a national probability survey of all doctorates residing in the United States. The Survey of Doctoral Recipients (SDR) is longitudinal in design and allows one to track individuals' changes in status over two-year periods if they respond to the survey in two consecutive periods.

Special tabulations from the SDR presented in Table 7.9 indicate that the percentage of those doctorates who held postdoctoral appointments in 1985 that were employed in the U.S. academic sector in 1987. In the aggregate, 63.6 percent of U.S. citizen and permanent resident postdocs in 1985 were employed in academe in 1987, and over 50 percent were employed in faculty positions. Both these percentages exceed the 49.8 percent of all employed new doctorates in 1988 who were employed in academe (Table 7.7). Indeed, contrasting the percentages of 1985 postdocs employed in the academic sector in 1987 in the physical sciences (54.0), life sciences (67.7), and social sciences and engineering (61.7) with the comparable percentages of new doctorates employed in academe in 1988 (Table 7.7), it is clear that in each field postdocs *are* more likely to enter academe than are new doctorates who accept employment immediately on graduation.

It is somewhat more difficult to use the SDR to draws conclusions about temporary residents because nonresponse rates for temporary residents increase substantially in the SDR with time since degree. Partially, this reflects

Table 7.8 **Share of New Doctorates with Definite Plans in the United States Going on to Postdoctorate and Academic Appointments**

	Total		U.S. Citizen		Permanent Resident		Temporary Resident		
	SPDOC	SACAD	SPDOC	SACAD	SPDOC	SACAD	SPDOC	SACAD	SDEFU
Total science/engineering:									
1970	.24	.43	.22	.44	.28	.36	.51	.31	.42
1975	.28	.37	.26	.39	.35	.23	.50	.22	.40
1980	.33	.29	.32	.30	.27	.21	.50	.21	.45
1985	.36	.26	.35	.26	.28	.27	.50	.28	.49
1988	.42	.24	.39	.24	.35	.28	.58	.25	.55
Total nonscience/nonengineering:									
1970	.02	.79	.02	.79	.06	.86	.15	.75	.22
1975	.02	.66	.02	.65	.07	.73	.22	.64	.20
1980	.03	.58	.03	.58	.07	.67	.25	.61	.15
1985	.03	.55	.03	.55	.08	.77	.11	.72	.21
1988	.05	.56	.04	.56	.05	.70	.15	.76	.30
Selected fields:									
Physical science (physics/astronomy and chemistry):									
1970	.38	.21	.35	.23	.51	.13	.72	.15	.63
1988	.61	.07	.54	.08	.59	.09	.89	.03	.70

Earth and material sciences:								
1970	.21	.43	.18	.45	.26	.31	.70	.25	.36
1988	.39	.23	.35	.26	.50	.08	.88	.04	.33
Life sciences:								
1970	.46	.37	.43	.39	.57	.26	.81	.14	.35
1988	.74	.12	.72	.13	.76	.09	.92	.06	.47
Social sciences:								
1970	.04	.82	.04	.82	.05	.90	.09	.75	.25
1988	.09	.65	.08	.64	.05	.64	.12	.74	.38
Psychological sciences:								
1970	.14	.52	.14	.52	.35	.42	.25	.56	.35
1988	.21	.24	.21	.24	.14	.32	.52	.32	.60
Mathematical sciences:								
1970	.06	.75	.06	.76	.06	.66	.20	.73	.52
1988	.20	.65	.15	.65	.23	.55	.30	.67	.51
Engineering:								
1970	.07	.27	.05	.27	.12	.21	.27	.28	.48
1988	.20	.26	.11	.26	.12	.29	.40	.27	.59

Source: National Science Foundation (1989e, table 15).

Note: SPDOC = share of doctorates with definite plans in the United States going on to postdoctoral appointments; SACAD = share of doctorates with definite plans in the United States going on to academic appointments; and SDEFU = share of those with definite plans with plans in the United States.

Table 7.9 Percentage of Postdocs in 1985 Who Were Employed in the U.S. Academic Sector in 1987[a]

	Total	Physical Sciences	Life Sciences	Social Sciences and Engineering
		Field		
U.S. citizens and permanent residents:				
Total number of postdocs in 1985	6,722	1,551	4,176	965
% in academe in 1987	63.6	54.0	67.7	61.7
% in faculty positions	50.3	41.0	53.1	53.4
% in nonfaculty positions	7.9	9.6	8.6	2.3
% faculty status not reported	5.4	3.4	5.9	6.0
Temporary residents:				
Total number of postdocs in 1985	924	451	277	196
% in academe in 1987	27.3–58.0	23.1–52.0	53.8–92.0	[b]
% in faculty positions	20.2–42.9	21.7–49.0	32.1–54.9	[b]
% in nonfaculty positions	2.2– 4.6	.7– 1.5	6.1–10.5	[b]
% faculty status not reported	5.0–10.6	.7– 1.5	15.5–26.5	[b]

Source: Special tabulations prepared from the *Survey of Doctorate Recipients* by the Office of Scientific and Engineering Personnel, National Research Council.

[a]Based on respondents to the 1985 *Survey of Doctoral Recipients* who received their doctorates in 1980–84. The figures for U.S. citizens and permanent residents assume that nonrespondents to the 1987 *Survey* were distributed across employment categories in an analogous manner to respondents. The upper-bound estimates for temporary residents similarly assume this, while the lower-bound estimates assume that all temporary resident nonrespondents in 1987 were employed abroad or outside the U.S. academic sector in 1987.

[b]Sample was too small to compute percentages.

a tendency, based on both immigration law and their desires, for temporary resident doctorates to leave the United States and return to their home countries. If one assumes that all nonrespondents in 1987 returned to their home countries, one can compute a lower-bound estimate of the proportion of temporary resident postdocs in 1985 employed in the U.S. academic sector in 1987. If instead one assumes that all nonrespondents in 1987 in fact remained in the United States and were distributed across employment categories in a manner similar to 1987 respondents, one can compute an upper-bound estimate.

Both these estimates are presented in the bottom half of Table 7.9. In both the physical and the life sciences, even the lower-bound estimates of the proportion of 1985 temporary resident postdocs employed in the U.S. academic sector in 1987 exceed the proportion of 1985 and 1988 temporary resident new doctorates directly entering employment in the U.S. academic sector (Table 7.8). While this provides evidence that temporary resident new doctorates contribute to academic labor supply in the United States, both directly on receipt of their doctorates and subsequently to postdoc appointments, no evidence is available on their expected length of academic careers here. However, since their immigration status does directly affect their ability to remain in the United States, one suspects that this expected length is shorter than that of otherwise comparable citizen and permanent resident new academics.

7.2.3 Stocks and Flows of Experienced Doctorates

The age distribution of doctorates employed in academe at a point in time depends on patterns of growth of positions in the past and decisions by experienced doctorates to enter or leave academe and retire from the work force. Over the period 1977–87, the age distribution of doctoral scientists, social scientists, and engineers employed by educational institutions shifted to the right as relatively few new faculty positions were created during the 1980s.[10] As a result, the proportion of these faculty below age 35 fell from 21.7 to 12.2 percent, while the proportion of faculty age 55 and over rose from 15.0 to 21.6 percent (Table 7.10).

As the share of faculty who are age 55 and older increases, so does concern over the impending growth in retirements and thus the increased replacement demand for faculty that will occur. As of 1994, faculty will no longer be subject to mandatory retirement, and concern over whether research and teaching productivity decline, on average, with age leads to discussion of policies that might be pursued to "encourage" older faculty to retire. Alternatively, given projections of future faculty shortages, some wonder whether encouraging older faculty to postpone retirement will have a substantive effect on the magnitude of these shortages.

The changing age distribution also has implications for the mobility pattern of experienced doctorates between the academic and the nonacademic sectors. Table 7.11 presents data (for three age groups) on the share of doctorates employed in either the academic or the nonacademic sector in 1985 who moved to the other sector by 1987. These data, which come from analyses of the SDR, make clear that on average the proportion of faculty who move to the nonacademic sector declines substantially with age while the proportion that move from the nonacademic to the academic sector is much less dependent on age.

There are also substantial differences in these proportions across fields, relating presumably to differences in the relative availability and attractiveness of employment opportunities in the two sectors. In most fields, the proportion of academics moving to the nonacademic sector is greater than the proportion of nonacademics moving to the academic sector for the two age groups under 50, but the inequality is reversed for the older cohorts. A notable exception is the humanities, where for all age groups the proportion of nonacadem-

10. Similar trends have been observed in the age distribution of all humanities doctorates (see National Research Council 1989b, tables 2, 9; National Research Council 1986, table 3; National Research Council 1982, table 2.3; and National Research Council 1978, table 2.3).

Table 7.10 Age Distribution of Doctoral Scientists, Social Scientists, and Engineers Employed by Educational Institutions

	% in:					
Category	1977	1979	1981	1983	1985	1987
Under 30	3.3	2.6	2.4	1.8	1.5	1.2
30–34	18.4	16.3	14.9	12.4	12.0	11.0
35–39	22.7	22.8	20.5	18.7	18.1	16.3
40–44	15.8	16.9	19.2	20.9	20.1	18.9
45–49	13.7	13.6	13.1	14.1	15.7	18.5
50–54	11.0	11.2	11.5	11.9	11.6	12.4
55–59	8.1	8.9	9.3	9.7	9.5	10.0
60–64	4.8	5.3	6.0	6.8	7.4	7.5
65 and over	2.1	2.5	3.2	3.6	4.0	4.1
No report	.1	.0	.0	.1	.1	.2

Source: National Science Foundation (1988a, table 3).

Table 7.11 Shares of Doctorates Employed in Both 1985 and 1987 Who Changed Sectors between 1985 and 1987, by Field and 1987 Age

	Age 35 and Under		Age 35–50		Age 50 and Over	
	AN	NA	AN	NA	AN	NA
All fields	.107	.078	.052	.043	.024	.047
Physical sciences	.206	.030	.052	.019	.014	.034
Mathematical sciences	.074	.059	.018	.039	.006	.046
Computer sciences	.064	.000	.071	.025	.000	.267
Environmental sciences	.026	.084	.062	.026	.043	.052
Life sciences	.122	.144	.068	.063	.025	.053
Psychology	.152	.084	.090	.032	.047	.032
Social sciences	.029	.116	.044	.093	.035	.089
Engineering	.069	.038	.041	.023	.032	.030
Humanities	.065	.191	.036	.074	.013	.081

Source: Special tabulations prepared by the Office of Scientific and Engineering Personnel, National Research Council, from the *Survey of Doctorate Recipients*. These computations assume that nonrespondents in 1987 are distributed across sectors in an identical manner to respondents.

Note: AN = share of those employed in the academic sector in 1985 who were employed in the nonacademic sector in 1987; and NA = share of those employed in the nonacademic sector in 1985 who were employed in the academic sector in 1987.

ics moving to academe is substantially greater than the proportion of academics moving to the nonacademic sector.

Of course, the number of people moving from each sector depends not only on the proportions of people leaving the sector but also on the number of people initially in the sector. Table 7.12 presents estimates from the SDR on the number of experienced doctorates (by field in 1985) employed in the academic and nonacademic sectors. On average, the number employed in the

Table 7.12 **Estimated Number of Doctorates by Field, Sector of Employment, and Age in 1985**

	Age 35 and Under		Age 35–50		Age 50 and Over	
	A	N	A	N	A	N
All fields	30,740	27,697	146,266	134,513	79,673	51,795
Physical sciences	4,062	7,137	17,015	28,673	10,718	13,915
Mathematical sciences	1,822	565	8,378	4,138	3,751	975
Computer sciences	567	351	792	1,267	61	62
Environmental sciences	738	809	3,413	4,642	1,818	1,764
Life sciences	9,699	6,009	33,195	24,462	16,850	9,841
Psychology	3,471	5,005	13,126	19,472	5,630	7,642
Social sciences	4,276	2,050	24,093	12,299	13,088	4,401
Engineering	2,872	4,671	11,964	25,407	6,637	8,322
Humanities	3,233	1,100	34,290	14,153	21,120	4,873

Source: Special tabulations prepared by the Office of Scientific and Engineering Personnel, National Research Council, from the *Survey of Doctorate Recipients*. Approximately 0.1 percent of doctorates did not report their ages and are excluded from these totals.

Note: A = employed in academic sector; and N = employed in nonacademic sector.

academic sector exceeds the number employed in the nonacademic sector, and, on balance, the net flow of experienced doctorates is from the academic to the nonacademic sector, rather than vice versa, except for the age 50 and over group. There are, of course, substantial differences by field. However, even for the humanities (because of the greater proportion of doctorates employed in the academic sector), the net flow is from the academic to the nonacademic sector. Later chapters will discuss whether the potential exists for these net flows to be reversed and for experienced doctorates currently employed in the nonacademic sector to help avert projected shortages of doctorates.

8 Decisions to Undertake and Complete Doctoral Study and Choices of Sector of Employment

This chapter beings with a general model of the decision to undertake and complete doctoral study and then summaries what prior studies by economists tell us about the magnitudes of various behavioral relations. The conclusion is that, unfortunately, they tell us very little. The next section then presents data on trends in various variables to see if these can help "explain" the decline in U.S. citizen and permanent resident new doctorates over the past two decades. Given the important role that time to degree likely plays in attracting people to doctoral study, models of and empirical evidence on the determinants of time to degree are then discussed and implications for public policy affecting this outcome and the number of students entering doctoral programs highlighted.

After a brief digression on whether the "quality" of new doctoral students has been declining, the chapter then turns to a discussion of the allocation of new and experienced doctorates between the academic and the nonacademic sectors. It addresses whether the academic sector can hope in the future to attract a greater share of new doctorates, to reduce the proportion of its experienced doctorates who leave, and to increase the proportion of those experienced doctorates employed in the nonacademic sector who move to the academic sector.

8.1 The Decision to Undertake and Complete Doctoral Study

Viewed from the perspective of an economist, the decision to undertake and complete doctorate study is a special case of the theory of occupational choice (Ehrenberg and Smith 1991, chap. 8). Individuals are assumed to evaluate the expected pecuniary and nonpecuniary benefits and costs that will result over their lifetimes if they choose various options and then to choose the option that maximizes their expected well-being. These decisions are made with imperfect information about current and future benefits and costs as well as about an individual's expected productivity in any occupation. As such, these choices involve considerable uncertainty.

What are the theoretical implications of this general approach? First, given an individual's aptitudes, interests, and family background, his or her choice of undergraduate major will depend, at least partially, on a comparison of the expected labor market returns that are available from various majors. Other things being equal, the higher the expected labor market returns available from a major, the greater the share of students who will choose that major. Note that, in principle, the returns available from a major may depend on the option it provides for further study (e.g., majoring in business likely precludes entering a doctoral program in physics) and the benefits and costs (including forgone earnings) of such study.

Second, given an individual's interests, aptitude, family background, and undergraduate major, the decision to enter and ultimately complete doctoral study in a field depends on a number of factors. The expected current and future streams of pecuniary and nonpecuniary benefits from entering the work force directly, from pursuing graduate study in the field, from pursuing graduate study in other fields, and from pursuing study leading to a professional degree and career surely all matter. So does the cost of pursuing each of these options, which depends on the tuition levels charged to students, the levels and availability of financial aid to subsidize each type of study, the completion rates, and the lengths of time (and thus the forgone earnings) it takes to complete each option. Other things being equal, higher benefits (higher earnings, better working conditions) and lower costs (lower tuition, more generous aid policies, higher completion rates, and shorter times to degree) will encourage more people to undertake and complete doctoral study in a field.

Three points are worth stressing here. To the extent that capital markets are imperfect and/or individuals dislike incurring debt, high debt levels accumulated from an individual's undergraduate days may discourage him or her from pursuing graduate study. To the extent that academic positions provide greater nonpecuniary returns (such as tenure, freedom to choose research topics, more freedom to allocate time) than nonacademic positions, a decline in academic employment opportunities in a field may discourage people from pursuing doctoral study in that field, even if the average pecuniary benefits from earning a doctorate do not change. Finally, to say that individuals base decisions partially on expected current and future pecuniary benefits does not provide any insight into how these expectations are formed. Do prospective doctoral students look at starting salaries at the time they are making decisions, or do they try to project what starting salaries are likely to be when they complete their program and how salaries are likely to grow over their work lives?

Empirical studies suggest that the model outlined above can help explain undergraduate students' choices of majors. Some studies use institutional-level data or data for the nation as a whole and show that the flow of students into different majors or the share of degrees granted in each major depends on starting salaries received by graduates in the field (Cebula and Lopes 1982; Fiorito and Dauffenbach 1982). Other studies use individual-level data and find that, other things being equal, an increase in a student's verbal aptitude increases and an increase in his or her mathematical aptitude decreases, the probability of majoring in the humanities (Polachek 1978). One recent study of a national probability sample of American youths found that, after controlling for measures of ability and other personal characteristics, the probability that a student would major in one of five broad fields (business, liberal arts, engineering, science, or education) depended on the individual's expected present value of earnings (over the first 12 years of a career) in each field but *not* on his or her expected starting salary (Berger 1988).[1] Both expected present value of earnings and expected starting salaries in each field were estimated from models that took account of an individual's background characteristics; they were not based solely on published nationwide average salary data. I return to these points in the next section.

Studies of individuals' decisions to enter and complete doctoral study are surprisingly few, and all follow in the tradition of Richard Freeman's (1971) analysis. Table 8.1 summarizes the results of these studies and also of two related studies for MBAs and medical school students. For each study, the author's estimates (or my estimates from the author's results) are reported of the elasticities of the number of new entrants or doctorates awarded in a field with respect to each of nine variables. That is, they report what the effects are, in percentage terms, on the outcome of a 1 percent increase in each of the nine variables. A "dot" in a column indicates that the variable was not included in the analyses performed in the particular study.

The nine variables are listed at the bottom of the table; they are a subset of the variables that the theory outlined above suggests should influence entrance into and completion of doctoral study.[2] It is remarkable that each study took account of three or fewer of the hypothesized important factors and that no study included earnings opportunities and financial aid in closely allied doctoral fields or students' debt levels on graduation from college in its analyses. In part, these omissions reflect data and sample size limitations; most studies use aggregate time-series data for relatively short time spans. However, the omissions suggest that the elasticity estimates presented in the table should be considered quite tentative.

Virtually all studies find that the earnings of doctorates in the field matter. Some find the supply of doctorates very sensitive to earnings, while others

1. None of these studies includes in the analysis the "option" that a particular major provides to pursue doctoral study and the expected earnings if such study is pursued.

2. For brevity, undergraduate loan burdens, the probability of obtaining academic jobs, and completion rates of doctoral and other programs are omitted from Table 8.1. None of the cited studies considers these variables.

find elasticities less than unity. Similarly, while most studies agree that higher earnings in other professions reduce the supply of doctorates, the estimated magnitude of this effect varies across studies.

The three studies that control for the number, or fraction, of doctoral students receiving financial support find that increases in financial support do increase the number of doctoral students, although the magnitude of the response varies across studies. In contrast, the two that control for stipend levels find inelastic responses, and they imply that a 10 percent increase in graduate student stipend levels, other things being equal, would probably result in only a 2–3 percent increase in the number of new doctorates. Finally, only one study has included average time to degree as an explanatory variable. While it finds that longer times to degree tend to reduce the supply of doctorates, it was based on only 12 observations, and the estimated effect was not statistically significantly different from zero.

In the main, then, these studies are of limited use for policy simulations. While both doctorates' relative earnings and financial support for graduate students clearly influence the supply of doctorates our knowledge of the magnitude of these responses is too imprecise to be useful. Furthermore, the studies summarized in Table 8.1 are in the main based on analyses of science or social science fields. It may well be the case that the responses of potential humanities doctorates to economic variables are different than those of potential scientists and social scientists.

8.2 Underlying Trends

8.2.1 Choice of Major

Data on average starting salaries of college graduates, by major, for the period 1973–88 appear in Table 8.2. These data come from annual surveys conducted by the College Placement Council, save for the education salaries, which are collected by the American Federation of Teachers and are averages for beginning teachers (not all beginning teachers are education majors, and many have master's degrees or some postgraduate course work). In addition to the salary levels, the ratio of each major's average salary to the average salary in engineering (the highest paid major in the set) is included in the table.

Given the swings in the distribution of majors across fields that occurred during the 1970s and 1980s (Table 7.1), it is somewhat surprising to observe that the dramatic decline in the shares of humanities and social science majors was not accompanied by a substantial decline in relative starting salaries in these fields. Similarly, the dramatic growth in business majors was apparently not due to a rise in their relative starting salaries. While the starting salary in education fell substantially relative to engineering during the period 1974–

Table 8.1 Estimated Elasticities of Doctoral and Other Postgraduate Educational Outcomes with Respect to Various Variables

Study	Years	Coverage	Outcome	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Freeman (1971)	1956–64	52 fields (changes across fields)	New Ph.D.s	·	·	·	·	.18*	.23**	·	·	·
Sloan (1971)	1934–66	Medical schools	Applicants	·	·	[a]	[b]	·	·	·	·	[c]
Freeman (1975)	1956–72	Physics	New Ph.D.s,	·	·	.82*	−.42	·	·	·	·	·
			entrants grad school	·	·	.87	−1.04*					
Scott (1979)	1965–74,	Economics	New Ph.D.s, entrants	·	·	1.25*[d]	·	·	·	·	·	·
	1961–74		grad school	·	·	·	·	.16*	·	·	·	·
Kuh and Radner (1980)	1967–76	Mathematics	New Ph.D.s	·	·	.44	−1.67*	·	·	·	·	
Hoffman and Low (1983)	1962–76	Economics	Entrants grad school	·	·	2.6*[e]	−1.2*[e]	·	·	·	·	·
						4.8*[f]	−4.0*[f]					
Alexander and Fry (1984)	13 years	MBAs	Ratio MBAs/pool potential applicants	·	·	1.44*[g]	·	·	·	·	·	−.48

				(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Hoffman and Orazem (1985)	1962–82	Agricultural economics	New Ph.D.s, entrants	·	·	3.0*	−2.80*	·	.33*[h]	·	·	·
			grad school	·	·	.43	−.70	·	.57*[h]	·	·	·
Baker (1989)	1975–87	Biomedical sciences	Entrants grad school	·	·	.59**	·	1.36*	·	·	−.50	·
Stapleton (1989)	1961–85	Economics	New Ph.D.s	·	·	.91*	.64	·	·	·	·	·

Source: Author's interpretations of the original studies.

Note: Columns represent the following: (1) current earnings opportunities if do not go on to graduate school; (2) debt level upon graduation from college; (3) earnings opportunities with degree; (4) earnings opportunities with alternative professional degrees; (5) number or fraction of graduate students with aid; (6) average stipend level; (7) earnings opportunities with degree and financial aid in closely allied doctoral fields; (8) average time to get degree; and (9) tuition. A dot in a column indicates that the variable was not included in the analyses performed in the particular study.

[a]Computation of elasticity not possible. Estimate suggests an additional 0.4–1.3 individuals apply per dollar increase in salary.

[b]Computation of elasticity not possible. Estimate suggests that, if biologist earnings increase by 10 percent, there would be 1,002 fewer medical school applicants.

[c]A dollar increase in the direct cost of medical school (tuition-stipends) generates 6 to 14 applicants.

[d]Elasticity with respect to ratio of starting salary to median professional salary.

[e]Rational expectations model estimate.

[f]"Naive" model estimate.

[g]Elasticity with respect to ratio of MBAs' salaries to undergraduates' salaries.

[h]Elasticity with respect to teaching/research assistants' salaries.

Table 8.2 **Average Starting Salaries for College Graduates, by Major, Selected Fields**

Year of Graduation	Humanities	Social Sciences	Chemistry	Engineering	Business	Education
1973	7,968	8,280	9,912	11,022	9,036	*
	(.72)	(.75)	(.90)		(.82)	
1974	8,292	8,844	10,608	11,967	9,636	8,058
	(.69)	(.74)	(.89)		(.81)	(.67)
1975	8,676	9,240	11,422	13,386	10,116	*
	(.65)	(.69)	(.85)		(.76)	
1976	9,300	9,840	12,336	14,169	10,464	9,085
	(.66)	(.69)	(.87)		(.74)	(.64)
1977	9,720	10,356	13,224	15,351	11,124	*
	(.63)	(.67)	(.86)		(.72)	
1978	10,452	10,716	14,292	16,710	11,916	10,062
	(.63)	(.64)	(.86)		(.71)	(.60)
1979	11,796	11,664	15,984	18,210	13,224	*
	(.65)	(.64)	(.88)		(.73)	
1980	12,888	12,864	17,508	20,139	14,616	11,676
	(.64)	(.64)	(.87)		(.73)	(.58)
1981	14,448	15,992	19,644	22,674	16,555	*
	(.64)	(.71)	(.87)		(.73)	
1982	15,396	15,432	21,012	24,906	18,040	13,539
	(.62)	(.62)	(.84)		(.72)	(.54)
1983	16,560	15,840	20,504	24,723	18,217	*
	(.67)	(.64)	(.83)		(.74)	
1984	17,724	17,424	21,072	25,424	18,997	15,482
	(.70)	(.69)	(.83)		(.75)	(.61)
1985	17,532	18,540	22,764	26,364	19,861	*
	(.66)	(.70)	(.86)		(.75)	
1986	19,296	19,980	23,376	27,075	20,705	17,667
	(.71)	(.74)	(.86)		(.77)	(.65)
1987	20,256	21,876	25,572	27,504	21,341	18,657
	(.74)	(.80)	(.93)		(.78)	(.68)
1988	19,828	21,715	26,004	28,614	23,358	19,683
	(.69)	(.76)	(.91)		(.82)	(.69)

Sources: College Placement Council, *Inflation and the College Graduate: 1962–1985* (Bethlehem, Pa., 1986), and *CPC Salary Survey* (various issues). The figures for engineering and business are unweighted averages each year of more detailed occupations. Beginning teachers' salaries are from American Federation of Teachers, *Survey and Analyses of Salary Trends, 1988* (Washington, D.C., July 1988), table III-2.

Note: Numbers in parentheses are the category's average salary relative to the average salary of engineering majors. All salaries are in current dollars.

*Not available.

82, it has risen back to its initial level since then. The share of education majors, which fell through the mid-1980s has in fact increased slightly in more recent years (Table 7.1).

For the most part, the major shifts in the distribution of college majors that have occurred do not appear to be supply responses to changing relative starting salaries. What, then, might explain these shifts? One possibility is that, as noted above, it is not starting salaries but rather the expected present value of career earnings that influence choice of major (Berger 1988). If the steepness of age/earnings profiles has increased for majors in fields like business and engineering and declined for majors in fields like the humanities and the social sciences, this might explain the shift. No evidence is currently available, however, on this point.

Alternatively, it is possible that the changing distribution of college majors represents not a supply response of a given population to changes in economic variables but rather a change in the nature of the population of college graduates. Despite well-publicized concerns by academic institutions about the decline in the college age population, the number of bachelor's degrees awarded by American colleges and universities has either remained roughly constant or risen in every year since 1974–75, and, by 1986–87, it was over 10 percent higher than it was in 1971–72 (Table 6.4). This growth in degrees was due to a number of factors, including small increases in high school graduation rates, small increases in college attendance rates of new high school graduates, and an increased likelihood that older adults were enrolled in colleges (Anderson, Carter, and Malizio 1989, tables 11, 15; Bowen and Sosa 1989, table 3.1).

Some of the growth in high school graduation rates and college attendance rates of new high school graduates came about because of an expansion in opportunities for underrepresented minorities with high ability levels. However, some may have simply reflected high schools' increased propensity to graduate and colleges' increased propensity to enroll more marginal students. To the extent that the increased college enrollments thus come from "lower-quality" and older students, these student's interests are likely to be more pragmatic in nature, which may help explain the shift in majors toward business and away from the arts and sciences.

Finally, as noted by Turner and Bowen (1990), to a large extent recent shifts in the distribution of college graduates by major reflect shifts in the curriculum decisions of women. In part, they view these shifts as a consequence of the removal of culturally imposed constraints, which has led to a greatly widened range of career alternatives for women.

8.2.2 Doctoral and Professional Degrees

Table 6.4 illustrated the dramatic growth in the ratio of first professional to doctoral and master's to doctoral degrees that has occurred since the early 1970s. Are fewer American college graduate students entering doctoral programs because earnings opportunities in the professions are now so much better? Some suggestive evidence is found in Table 8.3, which contains starting salary information for the period 1970–88 for new assistant professors in mathematics (col. 1), physics (col. 2), and economics (col. 3) as well as for MBAs (col. 4), new lawyers in non-patent-law firms (col. 5), and new graduates with master's degrees in engineering (col. 6). Presumably, individuals contemplating doctoral study in economics might also consider getting MBAs

Table 8.3 **Average Starting Salaries for Ph.D. Economists, Mathematicians, Physicists, MBAs, Lawyers, and Master's Degree in Engineering Graduates**

	Ph.D.s			MBAs	Lawyers	Engineers
Year of Degree	(1)[a]	(2)[b]	(3)[c]	(4)[d]	(5)[e]	(6)[f]
1970	11,000	*	11,897	12,528 (.95)	*	12,057 (.91)
1971	11,000	*	12,112	12,528 (.97)	*	12,210 (.90)
1972	11,500	*	12,481	12,684 (.98)	*	12,324 (.93)
1973	11,600	*	12,659	13,308 (.95)	*	12,753 (.91)
1974	12,100	*	13,319	14,172 (.94)	*	13,400 (.90)
1975	12,800	*	14,044	15,000 (.94)	15,688 (.90)	15,123 (.85)
1976	13,300	*	14,875	15,876 (.94)	16,188 (.92)	16,020 (.83)
1977	14,000	14,760	15,482	16,920 (.92)	17,688 (.88)	17,181 (.81)
1978	14,500	13,930	16,605	17,976 (.92)	17,813 (.93)	18,702 (.78)
1979	15,700	15,960	17,880	19,332 (.92)	19,063 (.94)	20,418 (.77)
1980	17,100	16,800	19,529	21,540 (.91)	20,875 (.94)	22,458 (.76)
1981	19,000	20,400	21,917	24,000 (.91)	22,688 (.97)	25,470 (.75)
1982	20,600	23,880	24,074	25,620 (.94)	23,938 (1.01)	28,116 (.73)
1983	21,700	23,880	25,750	25,580 (1.01)	24,938 (1.03)	27,738 (.78)
1984	23,000	26,520	26,930	28,500 (.95)	30,688 (.87)	29,487 (.78)
1985	25,000	29,400	29,340	28,584 (1.03)	32,438 (.90)	30,603 (.82)
1986	26,900	29,400	31,320	30,348 (1.03)	34,188 (.92)	31,647 (.85)
1987	28,000	28,920	34,670	31,524 (1.10)	36,875 (.94)	32,688 (.86)
1988	29,300	29,400	35,700	39,024 (.91)	39,438 (.90)	33,231 (.88)

Sources: Columns 4 and 6: College Placement Council, *Inflation and the College Graduate: 1962–85* (Bethlehem, Pa., 1986), and *CPS Salary Survey* (various issues). Column 5: *Student Lawyer's* "Annual Salary Survey" (various issues). Column 2: American Institute of Physics, *Graduate Student Survey* (various issues). Column 3: American Economic Association, *Annual Salary Survey* (data prior to 1985 provided by David Stapleton at Dartmouth). Column 1: annual AMS-MAA Survey, *Notices of the American Mathematical Society* (various issues).

Note: All salaries are in current dollars. Numbers in parentheses are, for col. 4, SALE/SALB; for col. 5, SALE/SALL; and for col. 6, SALM/SALG.

Table 8.3 (continued)

[a]Median nine-month academic salary for new assistant professors in mathematics department (SALM).

[b]Median monthly academic salary for new physics assistant professors employed in universities multiplied by 12.

[c]Average nine-month salary for new assistant professors in economics (SALE).

[d]Average starting salary of new MBAs with nontechnical undergraduate degrees (SALB).

[e]Average starting salary across eight cities (unweighted) of lawyers entering non-patent-law firms (SALL).

[f]Average starting salary of graduates with master's degrees in engineering (average across subfields) (SALG).

[g]Not available.

or law degrees, while those people considering doctoral training in mathematics and physics might also consider engineering programs. As such, the focus is on these comparisons.

The ratios of average starting salaries of assistant professors in economics to average starting salaries of MBAs and lawyers are found in parentheses in columns 4 and 5, respectively. These data do *not* suggest that the average starting assistant professor salary in economics declined relative to that of MBAs or lawyers during the period. Column 6 presents the ratio of starting mathematics assistant professors' salaries to starting master's of engineering graduates' salaries, and here there is some evidence of a decline. Between 1972 and 1982, the ratio declined form 0.93 to 0.73, a substantial drop; however, since 1982, it has risen back to near its initial level. For brevity, the ratio of new assistant professors of physics to new master's of engineering graduates' salaries is omitted from the table; however, no trends in that ratio were apparent during the period.

While declining relative starting salaries may have thus discouraged people from entering doctoral programs in mathematics during part of the period, they do not appear to be responsible for the decline in economics or physics doctorates. However, average starting salaries do not capture all aspects of compensation, and two other factors may have mattered.

First, as Table 6.3 indicates, in virtually all academic fields, the ratio of full professor to new assistant professor salaries is less than two. That is, the typical full professor earns less than twice as much as his or her new assistant professor colleagues. In contrast, the professions offer much more opportunity for earnings growth over a career. It is quite common, for example, for partners in law firms to earn four to six times as much as starting attorneys.[3] While the ratio of full professor to assistant professor salaries in the aggregate has remained roughly constant during the 1970s and 1980s (Hamermesh 1988), it is possible that the return to seniority in the professions may have increased during the period, and this would serve to increase the relative at-

3. See, e.g., the annual salary survey in the November issue of *Student Lawyer.*

traction of the professions vis-à-vis doctoral study. Some evidence in fact exists that this did occur between 1982 and 1989 for lawyers.[4]

This line of reasoning suggests that, to increase the flow of new doctorates, academic institutions must be concerned about raising the salaries of their full professors as well as of their entry-level faculty. Only if potential doctorates view career earnings profiles in academe as sufficiently attractive will the supply of doctorates increase (Kasper 1990b).

Second, the average salary data in professional fields may give a misleading impression of the earnings opportunities of individuals contemplating doctoral study and subsequent careers in these professions. Focusing on economics, for example, to the extent that potential doctoral students' intelligence and aptitude would make them among the "better" applicants to business and law schools, one might expect that the potential earnings of graduates from top professional and business schools would be a better measure of their alternatives.[5] Although "hard" data on this point are not readily available, one senses that the dispersion of earnings between graduates of top and lesser professional programs may have widened over time and thus that the relative economic attractiveness of professional schools may well have risen vis-à-vis doctoral study, even though the comparisons of average starting salaries presented above do not indicate this.

8.2.3. Financial Support for Graduate Students and Undergraduate Loan Burdens

The lengthening of median years of registered time to degree (Table 7.4) and the increased proportion of science/engineering graduate students taking postdoctoral (postdoc) appointments (Table 7.5) have surely discouraged potential students from undertaking doctoral study. Even if the direct costs of doctoral study and then postdocs were financed fully, first through fellowships and assistantships and then through postdoc stipends, a lengthening of the period before regular employment is possible implies increased costs in terms of forgone earnings. Hence, even if the earnings of new doctorates via-à-vis professional degree holders had not changed, the lengthening "training period" for new doctorates should lead to a reduction in doctoral enrollments.

4. See Ehrenberg (1989, table 10), where evidence is presented that the ratio of salaries of lawyers with four years of experience relative to those just starting practices rose between 1982 and 1986 in four of six large cities and was roughly constant in the other two. Data presented in the November 1989 issue of *Student Lawyer* indicate that results between 1982 and 1989 were similar.

5. Some evidence to support this conjecture was found by Hartnett (1987, table 4), who contrasted the undergraduate SAT scores of graduates from doctoral programs in the arts and sciences and from professional programs in business, law, and medical schools. The median math and verbal SAT scores in 1981 of his sample of professional school graduates were *each* 30 points *lower* than the comparable median scores for his sample of doctoral recipients. One caution, however, is that response rates for doctoral programs (72 percent) was much higher than response rates for the professional schools (36–45 percent) in the study, so it is not obvious how far the findings can be generalized.

Table 8.4 **Percentage of Full-Time Science/Engineering Graduate Students in Doctorate-Granting Institutions by Major Source of Support**

	% Federal	% Institutional	% Other Outside Support	% Self-Support
1974	24.6	38.5	8.4	28.6
1975	22.9	36.7	8.0	32.4
1976	22.7	37.0	8.3	32.0
1977	23.2	37.0	8.4	31.5
1978	23.7	36.8	8.9	30.6
1979	23.7	37.1	9.0	30.3
1980	23.0	37.6	9.1	30.3
1981	21.7	38.5	9.6	30.2
1982	19.9	39.4	10.0	30.8
1983	19.4	39.5	10.0	31.0
1984	19.3	40.6	10.0	30.1
1985	19.6	41.0	10.6	28.9
1986	19.8	41.6	10.2	28.4
1987	20.2	41.9	9.5	28.4
1988	20.4	42.2	9.5	27.8

Sources: Author's computations from National Science Foundation, *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1988* (Washington, D.C., 1990), table C15, and *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1981* (Washington, D.C., 1983), table C14.

All that is in question is the magnitude of the response; unfortunately, as described above, the econometric literature provides little guidance on this point.

Have the direct costs of doctoral study been fully subsidized? Table 8.4 presents data on the percentage of full-time science/engineering graduate students enrolled in doctorate-granting institutions by major source of support. The percentage self-supported (primarily non-university-related employment, loans, and support from other family members) was about the same in 1974, the first year data were available, as it was in the last year, 1988. The composition of support did change, however, with students receiving proportionately less federal support but more institutional and other outside (foundation, state government, foreign) support. Unless graduate stipend levels fell relative to individuals' opportunity costs of time, it appears at first glance that the direct costs of graduate study were as well subsidized in 1988 as they were in 1974.[6]

6. National data on average doctoral student stipends are not available; however, data for one university provides some evidence on this point. From 1974–75 to 1987–88, the average graduate student stipend at Cornell rose from $2,950 to $6,400, a 117 percent increase. During the same period, the average starting salaries of new assistant professors in math, new assistant professors in economics, MBAs, new lawyers in non-patent-law firms, and graduates with master's degrees in engineering rose by 129, 154, 160, 151, and 174 percent, respectively (table 8.3). So, at least for one university, graduate stipends did not keep pace over the period with earnings in some fields or with earnings in alternative professions.

Table 8.5 **Percentages of Full-time Science/Engineering Graduate Students in Doctorate-Granting Institutions, by Field and Major Source of Support, 1974 and 1988**

Field	1974	1988	Field	1974	1988
Total:			Agriculture:		
Fellowship	19.7	14.0	Fellowship	10.1	5.8
RA	20.3	27.4	RA	45.8	51.1
TA	23.6	22.9	TA	7.8	9.6
Other	36.4	35.7	Other	36.3	33.4
Engineering:			Biology:		
Fellowship	14.3	8.7	Fellowship	25.7	23.4
RA	33.0	37.8	RA	20.3	36.4
TA	15.4	17.7	TA	26.5	21.6
Other	37.3	35.8	Other	27.5	18.6
Physical Science:			Health:		
Fellowship	11.6	8.5	Fellowship	39.6	27.3
RA	30.1	42.6	RA	5.5	12.1
TA	47.3	40.4	TA	11.0	9.2
Other	10.9	8.5	Other	43.9	51.4
Environmental Science:			Psychology:		
Fellowship	10.8	9.1	Fellowship	24.2	11.0
RA	32.0	38.6	RA	12.1	14.9
TA	24.2	24.6	TA	20.8	22.0
Other	33.1	27.7	Other	42.9	52.1
Math and CIS:			Social Sciences:		
Fellowship	9.5	7.5	Fellowship	21.0	17.4
RA	10.3	15.6	RA	11.0	11.8
TA	46.5	40.2	TA	17.5	20.2
Other	33.7	36.9	Other	50.5	50.6

Sources: Author's computations from National Science Foundation, *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1988* (Washington, D.C., 1990), table C16, and *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1981* (Washington, D.C., 1983), table C23.

Note: RA = research assistantship; TA = teaching assistantship; CIS = computer and information sciences.

This would be an erroneous conclusion, however, for two reasons. First, as Table 8.5 indicates, the proportion of these full-time students on fellowships declined in all fields, as increasingly students' graduate training was financed (depending on the field) either through research or through teaching assistantships. Because students increasingly had to "work" for their graduate support, time to devote to studies, and thus the desirability of doctoral study, may well have decreased.[7]

7. Both teaching and research assistantships contribute to a doctoral candidate's development as a teacher and a researcher. However, time spent preparing to teach classes, talking with students, and grading exams is time that could have been spent on studies. Similarly, while in some disciplines and some situations a research assistantship may permit a student to work on his or her own dissertation research, in other cases it again diverts time from the student's own research.

Table 8.6 Percentage of Science/Engineering Doctoral Students Enrolled Part-Time

Field	1974	1977	1980	1983	1988
Total	26.3	29.1	30.9	32.0	31.5
Engineering	40.5	43.6	40.2	38.1	36.4
Physical science	13.3	12.3	12.4	11.7	11.0
Environmental science	16.8	18.2	19.8	19.6	23.7
Math and computer and information science	33.3	33.7	39.7	41.0	39.2
Agriculture	14.8	15.0	17.2	18.4	16.0
Biology	14.4	16.2	16.1	15.3	14.5
Health	24.7	35.3	38.7	46.1	48.1
Psychology	24.0	24.2	26.6	26.6	28.5
Social sciences	28.0	31.1	35.8	37.0	34.4

Sources: Author's computations from National Science Foundation, *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1988* (Washington, D.C., 1990), tables C2, C5, and *Academic Science/Engineering: Graduate Enrollment and Support, Fall 1981* (Washington, D.C., 1983), tables C6, C41.

Second, these data refer only to full-time students. However, as Table 8.6 shows, on balance the percentage of science/engineering graduate students who were enrolled on a part-time basis rose from 26.3 to 31.5 percent during the period 1974–88. This percentage actually declined in well-funded fields, such as engineering and the physical sciences, but it rose substantially in other fields, such as health and the social sciences. An increase in the share of students enrolled on a part-time basis may be due to an inadequate total number of fellowships and assistantships. Lengthening the average time needed to complete degrees contributes to reduced doctoral enrollments.

Of course, not only has median registered time to degree increased substantially over the last 20 years, but the median length of time between an individual's receipt of a bachelor's degree and his or her doctorate has increased by an even greater amount (Table 7.4). In part, this reflects individuals' increasingly delaying their initial entry into doctoral programs (Table 7.5). Other things being equal, the later the age at which new doctorates start their careers, the fewer the number of years that they will have to reap the "return" on their investments and thus the smaller the incentive potential doctoral students have to undertake doctoral study.[8]

What role may have undergraduate loan burdens played in both delaying and discouraging entry into doctoral study? Loans as a percentage of total financial aid awarded to undergraduate students declined from 28.9 in 1970–71 to 16.9 in 1975–76 but then rapidly grew to 48.0 in 1982–83 and have

8. Of course, other things are not equal. Federal legislation, namely, the 1978 and 1986 amendments to the Age Discrimination in Employment Act, precluded academic institutions from requiring tenured faculty to retire prior to age 70 as of 1 July 1982 and eliminated all mandatory retirement as of 1994. This lengthening of faculty members' potential work lives may partially offset their increasingly delayed career starts.

Table 8.7 Grants, Loans, and Work as a Percentage of Aid Awarded to Postsecondary Students

	Share of:		
	Grants	Loans	Work
1970–71	66.1	28.9	5.1
1975–76	80.3	16.9	2.8
1977–78	74.2	21.6	4.3
1979–80	63.5	32.3	4.2
1980–81	55.3	40.9	3.9
1981–82	52.3	44.2	3.5
1982–83	51.4	44.9	3.7
1983–84	48.2	48.0	3.9
1984–85	47.7	49.0	3.3
1985–86	49.4	47.5	3.1
1986–87	50.1	47.0	2.9
1987–88	47.1	50.4	2.6
1988–89	48.3	49.4	2.3
1989–90[a]	48.7	48.5	2.8

Sources: Gillespie and Carlson (1983, table 6); Gillespie and Carlson (1990, table 4).
[a]Estimated/predicted share.

remained in that range ever since (Table 8.7). Moreover, the rapid rise in undergraduate tuitions since the late 1970s has substantially increased the proportion of undergraduate students who receive some form of financial aid. As a result, the number of students receiving support under various federally subsidized or guaranteed loan programs more than tripled between 1970–71 and 1989–90 and over one-third of American undergraduate students now have debts on graduation (Table 8.8; Hansen 1990). While the number with debts has increased, as Table 8.8 shows, average levels of debt have remained roughly constant in recent years in nominal terms and declined somewhat in real terms.[9]

Evidence on the effects of undergraduate debt on career choice and the decision to undertake doctoral study is in the main impressionistic or based on tabulations of responses to surveys; there has been only one econometric study on the subject. A study of 2,000 borrowers under the Massachusetts Guaranteed Student Loan Program found that 35 percent of those who decided not to go on to graduate school said that concern over borrowing was "very or extremely important" in their decision (Baum and Schwartz 1988a, 1988b). Other studies reported that individuals with high undergraduate debt burdens

9. Partially, this reflects the fact that, throughout the period, the Guaranteed Student Loan (GSL) annual limit for undergraduates was capped at $2,500 in nominal terms. The 1985 Higher Education Act Reauthorization raised this limit to $4,000 per year for students in their junior and senior years, effective the fall of 1987. The data in Table 8.8 do not permit us to ascertain if the number of individuals with loans from more than one program has increased in recent years. If it has, debt levels per borrower may have increased.

Table 8.8 **Number of Recipients and Aid per Recipient, Various Postsecondary Loan Programs**

	No. of Recipients (000s)	% of Undergrads	Loan per Recipient In Current Dollars	Loan per Recipient In 1989 Dollars
NDSL/Perkins loans:				
1970–71	452	6	532	1,660
1975–76	690	7	667	1,491
1980–81	813	8	853	1,221
1981–82	684		848	1,118
1982–83	675		884	1,119
1983–84	719	6	949	1,156
1984–85	697	6	971	1,140
1985–86	701	6	1,003	1,143
1986–87	716	6	1,067	1,189
1987–88	674	6	1,145	1,280
1988–89	692	6	1,263	1,293
1989–90	826	7	1,022	998
GSL/Stafford loans:				
1970–71	1,017	13	998	3,115
1975–76	922	9	1,374	3,070
1980–81	2,904	27	2,135	3,057
1981–82	3,135		2,280	3,005
1982–83	2,942		2,208	2,789
1983–84	3,147	28	2,307	2,810
1984–85	3,546	33	2,297	2,694
1985–86	3,536	33	2,355	2,684
1986–87	3,499	31	2,381	2,655
1987–88	3,595	32	2,537	2,716
1988–89	3,626	32	2,570	2,632
1989–90	3,696	33	2,614	2,552
Plus Programs:[a]				
1980–81	1	< 1	2,509	3,592
1981–82	21		2,544	3,352
1982–83	47		2,501	3,157
1983–84	65	< 1	2,597	3,163
1984–85	92	< 1	2,636	3,093
1985–86	91	< 1	2,650	3,021
1986–87	91	< 1	2,761	3,079
1987–88	147	1	2,966	3,176
1988–89	212	2	3,075	3,148
1989–90	256	2	3,128	3,054

Sources: Gillespie and Carlson (1983, table 7); Gillespie and Carlson (1990, table 5); and *1989–90 Fact Book on Higher Education* (New York: Macmillan, 1989), table 45.

[a]Parental Loans for Undergraduate Students.

are more likely to choose careers or undergraduate majors that promise high earnings opportunities (American Council on Education 1985; Mohrman 1987). It is unclear from these latter studies, however, as to which way causation runs; individuals planning to enter relatively high-paying careers may be more willing to incur high debt levels to finance their education. Still other studies, reported in a comprehensive review of the literature (Hansen 1987), find no evidence that debt levels affect postgraduate plans.

The econometric study by Schapiro, O'Malley, and Litten (in press) used survey data collected from graduating seniors in 1982, 1984, and 1989 at institutions belonging to the Consortium on Financing Higher Education (COFHE), a group of elite private research universities and liberal arts colleges. The probability that a student planned to enroll in graduate school in the arts and sciences in the next fall was seen *not* to depend on his or her having a high debt level on graduation, after holding constant other individual and family characteristics. This study arbitrarily defined cutoff points for having high (e.g., $12,500 or higher in 1989) and low debt, and all students who planned to enroll in professional programs (e.g., law, medicine, business) were included in the "not enrolled in graduate school" group. The issues raised above about the direction of causality apply to this study as well.

Whether growing undergraduate debt burdens have, on average, caused individuals to delay, or not consider, graduate school entry is thus an open question. Of course, it is possible that growing debt burdens may have different effects on minority students from low-income families; this point is discussed in the next chapter.

8.3 Time to Degree

An economic model of the doctorate production process was developed by Breneman (1976), who sought to explain why registered time to degree, the attrition rate, and the timing of attrition varied widely across doctoral fields at the University of California, Berkeley, during the 1950s and 1960s. Rather than focusing on differences in the intrinsic nature of the disciplines studied, Breneman stressed optimizing behavior on the part of graduate students and faculty.

At the risk of overly simplifying his approach, from the perspective of students, opportunity costs were postulated to be the key variable. Other things being equal, better job market opportunities, as measured by higher starting salary levels and the availability of nonacademic alternatives (when academic positions were in short supply) for doctorates, were postulated to lead to shorter times to degree. Similarly, greater availability of financial support for graduate students in the form of fellowships or assistantships was assumed to lead to shorter times to degree.

From the perspective of faculty, the key variable that Breneman emphasized was the desire to maximize faculty members' prestige in the scholarly community and the resources flowing to their department. To the extent that, in the 1950s and 1960s, faculty members' prestige depended on the quality of their students placed in academic jobs, fields in which few nonacademic job alternatives exist for new doctorates would tend to "flunk out" their weaker students. In contrast, fields in which substantial nonacademic job opportunities exist could place their "lemons" in this sector, and attrition rates would thus be lower in these fields.[10]

Finally, the time at which attrition occurred would depend on the nature of the financial support available to graduate students and faculty members' demand for graduate students. In fields such as the sciences and engineering, in which graduate students are supported primarily by research assistantships (Table 8.5), a weak student may potentially have a substantially negative effect on a faculty member's research. As such, attrition is likely to occur early in these fields, to minimize adverse effects on faculty research. In contrast, in fields such as the humanities, graduate students are supported primarily by teaching assistantships, and relatively low flows of new graduate students suggest the need for long times to degree to provide "bodies" to serve as teaching assistants and enrollees in graduate courses; attrition is therefore likely to take place later in the program.

While formal econometric models were not estimated, Breneman found that on balance his approach explained quite well the patterns of time to degree, attrition rates, and when attrition occurred in doctoral programs across 28 fields at Berkeley during the period 1947–68. His analysis was strictly cross-sectional, and no attempt was made to explain changes in time to degree within fields over the 20-year period his data covered.

Subsequent empirical studies of time to degree have been surprisingly few and quite limited. Abedi and Benkin (1987) studied the determinants of time to degree for 4,225 doctorates from the University of California, Los Angeles, during the period 1976–85. Using stepwise regression methods, they found that individuals whose primary source of support was their own earnings (*not* assistantships) on average took longer to complete their degrees than others. In contrast, other things being equal, doctoral students supported by assistantships had unexpectedly shorter total times to degree than those on fellowships.

Abedi and Benkin's analysis had a number of shortcomings. It failed to control for individuals' ability levels (which presumably are correlated with whether they received financial support), for changing market opportunities for doctorates in different fields over time (constant field-specific effects were

10. Given that the share of newly employed doctorates accepting nonacademic employment has risen from roughly 30 to 50 percent over the last 20 years (Table 7.7), it is not obvious that faculty members' prestige in many fields is still derived from the quality of their academic placements. Thus, there should be no presumption that doctorates taking positions in the nonacademic sector today are on average of lower "quality" than their counterparts taking jobs in the academic sector. Empirical evidence that bears on this issue is discussed below.

permitted), for possible sample selection bias (only students who completed doctorates were included in the sample; see Table 7.6 for evidence on how completion rates vary across fields), or for the likelihood that the effect of having an assistantship depends on both the type of assistantship held and the field.

This latter point was emphasized by Tuckman, Coyle, and Bae (1990) in their time-series study of why median time to degree, by field, increased over the period 1968–87.[11] While teaching assistantships, which take time away from study, should presumably slow down degree progress vis-à-vis those with fellowships, research assistantships may actually speed up completion. The latter would occur if activities involved in research assistantships increase holders' research skills (by more than fellowship holders can achieve on their own) or are on or directly related to holders' dissertation topics.

Tuckman, Coyle, and Bae estimate median time-to-degree equations for each of 11 fields using national data for the 20-year period, with doctorate recipients grouped by year of degree. Explanatory variables experimented with included measures of the doctorates' personal characteristics (e.g., percentage with undergraduate degrees in the same field), financial support (e.g., percentage with *any* support from research assistantships during their doctoral study), institutional variables (e.g., percentage receiving doctoral degrees from Research I institutions), and economic and social variables (e.g., starting doctoral salaries). In all, almost 20 variables were experimented with in the various analyses; given the small sample sizes, only a subset of these could appear in any equation.

Unfortunately, these authors do not find consistent patterns of results across the 11 fields. The types of financial support matter in some fields but not in others and not always in the manner expected. One *cannot* conclude from their findings that increasing federal support for graduate students would be an effective way to shorten time to degree. Moreover, while in some cases changes in market variables, such as starting salaries or unemployment rates, appear to influence changes in time to degree, again these variables do not consistently matter across fields.

One must caution, however, against drawing negative conclusions about the effects of graduate support and market variables from such an aggregate level of analysis. As the authors note, small sample sizes in the aggregate data, coupled with high multicollinearity among the variables, surely decreased the likelihood of finding significant effects. In addition, their financial support variables related to the percentages of doctorates who received any support

11. Tuckman, Coyle, and Bae (1990) also studied changes in total time to degree and the lag between graduation from college and entry into doctoral programs. They found no trend in the latter, which is in sharp contrast to the data reported above in Table 7.5. Their data, however, covered people who *entered* doctoral programs probably, on average, between 1962 and 1980, while the data reported in Table 7.5 cover entrants between 1976 and 1987. The positive trend in the latter period is quite clear.

from various sources because data on the percentages who received their *primary* support from the various sources were not collected in the Survey of Earned Doctorates (SED) until the later years of the period. Finally, as Bowen, Lord, and Sosa (in press) have stressed, changes in median times to degree for degree recipients grouped by year of degree are subject to aggregation biases if entering doctoral student cohort sizes are systematically changing over time.

Future econometric analyses of the determinants of time to degree surely must use individual data, be institutionally based, separate out the effects of financial support from ability, and take account of noncompleters as well as completers. Nonetheless, although the prior econometric literature provides little basis for arguing that increased federal support for doctoral study would decrease times to degree, it is interesting simply to contrast the data for the period 1974–88 on changes in time to degree by field found in Table 7.4 with the data for the same period on changes in the proportion of full-time science/engineering graduate students who are receiving various forms of major financial support and of science/engineering graduate students enrolled part-time found in Tables 8.5 and 8.6, respectively.[12]

Between 1974 and 1988, median registered time to degree rose by 0.5 years or less for both the physical sciences and engineering (Table 7.4). While both fields saw the share of full-time graduate students on fellowship support decline over the period, the share of research assistants grew in both to compensate for most of these declines. Indeed, the growth in research assistants was so large that the share of full-time students on teaching assistantship actually declined by almost 7 percentage points in the physical sciences (Table 8.5). In both fields, the percentage of part-time students also declined during the period (Table 8.6).

In contrast, between 1974 and 1988, median registered time to degree rose by 1.7 years in the social sciences (which in Table 7.4 is defined to include psychology). The substantial decline in the shares of full-time students in psychology and the social sciences whose major source of support was fellowships was accompanied by increases in the share of those with teaching assistantship and self-support (Table 8.5) and increases in the share of all doctoral students in the field who were enrolled part-time (Table 8.6).

These comparisons are only suggestive, as they do not control for changing labor market conditions and personal characteristics of doctoral students. However, they do hint that increased fellowship and research assistantship support can lead to reduced median registered time to degree, or at least slow down the increase. Unfortunately, they provide little guidance about the magnitudes of likely responses.

Furthermore, even if one knew with certainty what the effect of increased

12. Unfortunately, data on the types of financial support received by doctoral students in the humanities were not separately reported in the volumes on which Tables 8.5 and 8.6 are based.

fellowship and research assistantship support would be on median time to degree and what the direct effects of increased support and reduced time to degree would be on students' decisions to enter and complete doctoral study, it would not necessarily follow that increased governmental support for doctoral students would be an effective way of expanding doctorate production. Often absent from the policy debate has been any concern for the possibility that increased federal support may simply induce institutions to redirect their own financial resources in a way that at least partially frustrates the intent of such a policy.

For example, increased federal support for science/engineering graduate students could lead institutions to cut back somewhat on (or not increase as rapidly as they had planned) their own internal support for these students and use the funds saved either to support graduate students in other disciplines or for other purposes (nongraduate student expenditures or tuition increase reductions). Conversely, cutbacks in federal support may lead institutions to attempt partially to offset the cutbacks by increasing their own expenditures. Indeed, as Table 8.4 indicates, the fall between 1974 and 1988 in the percentage of full-time science/engineering graduate students supported by federal funds was accompanied by an increase in the percentage of these full-time students supported by institutional funds. While causation should not be inferred from these aggregate time-series data, the changes are suggestive.

To the extent that changes in federal financial support for graduate education lead institutions to redirect and/or reduce their own expenditures, changes in the field composition and total number of doctorates that are produced may be different than policymakers intended.[13] To analyze the likely effects of an increase in federal support for doctoral students fully thus requires an analysis of the extent to which federal funds displace institutional funds. No existing study has addressed this issue, and research is clearly warranted on it. About all that one can currently say is that analyses that ignore potential displacement effects will likely overstate the effects of increased federal support.

8.4 Has the Quality of New Doctoral Students Declined?

Has the decline over the last two decades in the annual number of American citizen doctorates produced been accompanied by a decline in their average quality? Put another way, are our most talented undergraduates increasingly pursuing study in law, business, and medicine rather than doctoral programs?

13. The issue being raised here is very similar to one confronted by policymakers in the 1970s and early 1980s, when concern was expressed that the net job creation effects of public-sector employment programs (programs in which the federal government gave state and local governments funds to increase their employment levels) were considerably less than the number of positions funded. Empirical studies of what became known as the "displacement effect" or "fiscal substitution effect," of public-sector employment programs did indeed find that, on average, an increase in program positions typically led to a smaller increase in public-sector employment levels (Ehrenberg and Smith 1991, chap. 13).

The issue was recently raised by Bowen and Schuster (1986, chap. 2), but the evidence is inconclusive.

On the one hand, Rosovsky (1990) reports that the proportion of those Harvard undergraduates graduating summa cum laude (roughly the top 5 percent of the class) who after graduation attended graduate school in the arts and sciences fell from 77 percent in 1964 to 25 percent in 1981 before rebounding to 32 percent in 1987. Kasper (1990a) surveyed nine highly selective liberal arts institutions and found that, over the last two decades, the number and average quality (as measured by grade-point averages relative to those of the college as a whole) of their undergraduate economics majors had increased but that both the share and the absolute number of their majors choosing to pursue graduate study in economics had fallen substantially. Both these "case studies" suggest that a falloff may have occurred in the number of "high-quality" doctoral students coming from leading research universities and selective liberal arts colleges. Focusing on exceptional undergraduates nationwide, namely, those elected to Phi Beta Kappa or receiving a Rhodes Scholarship, Bowen and Schuster similarly find slight declines in the proportion of each entering academic careers between 1970–74 and 1975–79 (Bowen and Schuster 1986, fig. 11.1).

In contrast, other evidence is mixed or less supportive of the "decline in quality" view. Bowen and Schuster's interviews with faculty at 15 institutions revealed concern that doctoral student quality was declining in the humanities and arts and sciences, but a questionnaire mailed to the chairs of 404 departments (which were among the highest-ranked departments in each of 32 fields) found more support for the notion that graduate students were "better" in 1983–84 than they were in 1968–72 (Bowen and Schuster 1986, table 11.1). A study of graduate admissions at 20 leading research institutions covering the period 1972–80 found that, in the humanities and the social sciences, the number of applicants fell and acceptance rates rose (Garet and Butler-Nalin 1982). While at first glance this may seem to imply declining average quality of graduate students, such a conclusion would necessarily be valid only if the quality distribution of applicants did not improve during the period.

Schapiro, O'Malley, and Litten's (in press) study of graduates of 27 elite private research universities and liberal arts colleges found that the percentage of graduating seniors planning to enter graduate school in the arts and sciences was 11 percent in 1982, rose to 13 percent in 1984, and then fell back to 10 percent in 1989. When the analyses were confined to the top 5 percent of all undergraduates, namely, those students who reported straight A averages, the comparable percentages were 25, 29, and 24. So, even among this elite group of students, propensities to attend graduate school in the arts and sciences did not appear to fall during the 1980s.

Evidence from objective test scores is also less supportive of the declining quality view. Hartnett (1987) contrasted undergraduate Scholastic Aptitude

Test (SAT) scores for individuals who received doctoral and professional degrees (law, business, and medicine) in 1966, 1971, 1976, and 1981 from a set of surveyed institutions and found that the ratio of SAT scores for those who earned doctoral degrees relative to the ratio of scores for those who earned professional degrees did not decline during the period. Thus, it did not appear that better students were increasingly entering professional rather than doctoral programs over the period.

Of course, students who received doctorates in 1981 entered graduate school, on average, in the early to mid-1970s. What has happened to the quality of doctoral students nationwide since then? Some evidence can be obtained from data reported annually between 1975–76 and 1986–87 by the Educational Testing Service on the mean Graduate Record Examination (GRE) Verbal and Quantitative test scores of students *planning* doctoral study (see, e.g., Educational Testing Service 1988).

These data can be used to estimate the annual trends in the mean test scores of students planning doctoral study, by field, as well as the trends that exist after one controls for changes in the SAT scores of undergraduates. The former trends indicate what has been happening absolutely to the quality of students planning doctoral study, while the latter indicate how their quality has been changing relative to that of undergraduate students. The data can similarly be used to estimate the annual trends by field in the sum of the mean GRE score plus two standard deviations in GRE scores during the period 1977–78 to 1986–87. If GRE scores were normally distributed, these would represent the trends in GRE test scores for the upper 2.5 percent of test takers contemplating doctoral study in each field.

The estimates obtained when this was done do not suggest a substantial decline in the average quality of applicants to doctoral programs over the period.[14] The results for all fields combined show declines in the mean or upper-tail verbal scores of less than one point a year, which are more than offset by annual increases in quantitative scores of over three points a year. When SAT scores of undergraduate students are controlled for, on balance no evidence is found of trends in the mean or upper-tail GRE scores. Of course, results do differ by field. Those that show the greatest annual decline in verbal scores are, in the main, fields that have exhibited a large growth in foreign enrollments (e.g., the physical and life sciences).

Since these GRE data refer to all test takers, not solely American citizen and permanent resident test takers, they cannot, in any case, provide firm evidence as to how the quality of American doctoral students has increased. Hence, this is yet another area in which our knowledge is very imprecise. Moreover, given the evidence presented in Table 8.3 that the average starting salaries of doctorates in some fields have not declined relative to average starting salaries in professional alternatives, one might wonder where the specu-

14. These estimates are available from the author.

lation that the average quality of doctorates has declined has come from. That is, why do many people believe that the "better" students are now increasingly attracted to nondoctoral study alternatives?

One possible explanation for this speculation can be illustrated by focusing on potential applicants to doctoral programs in economics. Suppose that, as Table 8.3 shows, the average starting salary of doctorate economists has not changed relative to the average starting salary of lawyers in recent years. Suppose also, however, that the dispersion in starting salaries for economists has remained constant while the dispersion of starting salaries of lawyers has widened considerably (i.e., suppose that the ratio of big city, large law firm salaries has risen relative to other lawyers' salaries). If the higher-paying employers in both fields attract the graduates with the highest ability, the return to ability will in effect have risen in law relative to that in economics. Holding constant the average salary in each, this would encourage the more able students to choose law over economics more frequently.[15]

This line of reasoning can easily be applied to other fields. It emphasizes that decisions to enroll in doctoral programs will be based, not only on expected earnings from doctoral study and other options, but also on the return to ability in each. Prior empirical studies of doctorate labor supply have not taken the return to ability in each option into account.

8.5 Choice of Sector of Employment

8.5.1 New Doctorates

Decisions by new doctorates to accept employment in either the academic or the nonacademic sectors appear to be sensitive to the compensation offered in each sector. Studies that focus on economists (Hansen et al. 1980; Stapleton 1989) or on all new doctorates as a group (Freeman 1975b) find, on average, that an increase of a given percentage in starting academic salaries vis-à-vis starting nonacademic salaries will increase the ratio of new doctorates accepting employment in the academic sector to those accepting employment in the nonacademic sector by an equal percentage. So, for example, a 10 percent increase in starting academic salaries relative to starting nonacademic salaries would likely lead to an increase in the number of new doctorates accepting

15. This, of course, assumes that individuals with potentially high ability as economists would also potentially have high ability as lawyers. The discussion of how individuals are sorted among different alternatives according to their abilities is derived from Roy (1951). The approach has recently been applied to explain why the "quality" of immigrants coming to the United States from various countries differs (Borjas 1987). Whether the assumed changes have occurred in law is an open question and warrants empirical testing. Some of the increase in big city, large law firm salaries represents compensation for more rapid increases in living costs and longer hours of work (Kramer 1989). Many of the highest-ability law students also take relatively low-paying judicial clerkships, although these often lead to high-paying professorial positions (relative to economists) or high-paying practices.

academic employment relative to the number accepting nonacademic employment of about 10 percent, if all other factors remain unchanged.

Have academic relative salaries begun to adjust to existing, and projected, shortages of doctorates? Table 8.9 presents median salary data for new doctoral scientists, social scientists, and engineers employed in the academic and nonacademic sectors for the period 1973–89. These data were obtained from the biennial Survey of Doctoral Recipients (SDR); new doctorates are defined as those with five years' experience or less since receiving their doctorates. Unfortunately, such data are available only since 1973. However, when one looks at how the ratios by field of median new doctorate academic salaries to median new doctorate nonacademic salaries have changed (Table 8.10), some interesting patterns arise.

In most fields, relative academic starting salaries declined through the early 1980s but have been increasing in recent years. An exception is in engineering, where the relative academic salary reached its low point in 1977 and then increased thereafter. Engineering is one of the few fields that experienced an increase in the share of newly employed doctorates entering the academic sector between 1978 and 1988 (going from 23.5 to 28.5 percent; Table 7.7). The increase in the relative academic salary from 0.82 to 0.99 during the period 1977–89 obviously contributed to inducing more new engineering doctorates to enter the academic sector.[16] In contrast, the life, psychological, and social sciences saw their academic shares of new doctorate employment continue to fall between 1978 and 1988 (Table 7.7), and the relative academic salaries in these fields did not begin to rise until 1985 or 1987 (Table 8.10).

Given this evidence that relative academic starting salaries have begun to rise and that the share of new doctorates accepting employment in the academic sector is responsive to the academic relative starting salary, one might expect to observe an increasing share of new doctorates accepting academic employment in more fields in the future. However, several caveats, which relate to the fact that other factors are not likely to remain unchanged, are in order.

First, as nonacademic employment opportunities have expanded for new doctorates, there is evidence (at least for economics) that the share of new doctorates accepting nonacademic employment has increased, other things (including relative earnings) held constant (Stapleton 1989). To the extent that nonacademic employment opportunities for doctorates will continue to expand, increasing relative academic salaries may simply slow down the rate of decline in the share of new doctorates accepting academic employment rather than reversing it. Projections of the growth of nonacademic employment op-

16. I say "contributed to" since the increase in the employment share of 21.3 percent ({[28.5 − 23.5]/23.5} × 100) exceeds the 14.6 percent increase {[.94 − .82]/.82} × 100) in the academic relative salary. This implies that an elasticity of around 1.5, which is somewhat larger than the previous studies have found, would be required to "explain" the changing academic share of employment.

Table 8.9 **Median Salaries of New Doctoral Scientists, Social Scientists, and Engineers Employed Full-Time in the Academic and Nonacademic Sectors**

Field	1973	1975	1977	1979	1981	1983	1985	1987	1989
Physical sciences:									
A	15,181	16,831	18,390	19,967	23,258	26,004	29,482	34,150	36,709
NA	18,091	20,553	22,588	25,930	31,642	36,637	40,797	43,291	46,633
Mathematical sciences:									
A	15,809	17,190	18,100	19,783	22,534	26,473	30,212	33,732	36,839
NA	*	21,985	22,996	25,889	30,635	37,647	39,792	43,307	45,846
Computer sciences:									
A	18,236	19,367	19,612	22,157	27,454	32,760	41,625	46,320	51,896
NA	*	21,525	23,206	26,669	32,914	35,804	42,321	50,239	55,012
Environmental sciences:									
A	15,649	17,365	18,567	20,417	23,250	26,724	30,207	34,210	36,615
NA	*	21,717	22,761	27,129	32,454	37,197	40,061	40,829	42,134
Life sciences:									
A	15,658	17,342	18,996	20,980	24,225	27,275	29,983	33,316	36,569
NA	17,071	20,079	21,618	24,679	29,411	33,038	35,793	39,314	42,441
Psychology:									
A	16,289	17,598	18,396	20,347	22,486	26,082	29,312	32,112	35,534
NA	18,039	20,143	21,580	23,624	27,192	32,316	33,867	37,963	41,552
Social sciences:									
A	16,592	18,007	19,172	20,623	24,106	27,383	29,779	35,332	36,190
NA	20,450	22,485	24,223	27,123	31,097	25,803	39,075	41,639	45,156
Engineering:									
A	17,875	19,767	20,784	23,738	29,028	34,450	40,146	44,558	50,331
NA	20,668	22,873	25,340	28,495	34,727	40,689	45,273	47,387	50,763

Source: Special tabulations prepared from the *Survey of Doctorate Recipients* by the Office of Scientific and Engineering Personnel, National Research Council.

Note: A = academic sector; NA = nonacademic sector. New doctorates are those with five or less postdoctoral years of experience at the survey date.

*Not available.

Table 8.10 Relative Median Salaries for New Doctorate Scientists, Social Scientists, and Engineers

Field	1973	1975	1977	1979	1981	1983	1985	1987	1989
Physical sciences	.839	.819	.814	.770	.735	.710	.723	.789	.787
Mathematical sciences	*	.782	.787	.764	.736	.703	.759	.779	.803
Computer sciences	*	.898	.845	.831	.834	.915	.984	.922	.943
Environmental sciences	*	.800	.816	.753	.716	.718	.754	.838	.869
Life sciences	.917	.864	.879	.850	.824	.826	.838	.847	.862
Psychology	.903	.874	.852	.861	.827	.807	.866	.846	.851
Social sciences	.811	.801	.791	.760	.775	.765	.762	.849	.801
Engineering	.865	.864	.820	.833	.836	.847	.887	.940	.991

Source: Special tabulations prepared from the *Survey of Doctorate Recipients* by the Office of Scientific and Engineering Personnel, National Research Council.

Note: Figures represent ratio of median academic to median nonacademic salaries of doctorates with five or less years postdoctoral experience who are employed full-time in the field.

*Not available.

portunities for scientists and engineers are often based on projections of government and industry research and development expenditures (National Science Foundation 1989d; Forest 1990); uncertainty about proposed reductions in military expenditures, coupled with the existence of persistent budget deficits, makes such projections highly uncertain.

A second caveat is that the relative attractiveness of entering academic versus nonacademic employment depends on more than relative starting salaries. Expected future earnings matter, yet we have little evidence on how doctorates' expected age/earnings profiles in the academic and nonacademic sectors contrast at a point in time or how they have changed over time. Surely, the "quality" of academic jobs available, the time it takes to achieve tenure, and the difficulty of achieving tenure also matter. When the academic labor market is "loose" and more new doctorates are searching for academic jobs than are needed, most doctorates' probabilities of finding positions at better-quality teaching and research institutions will be lower, and publication standards for tenure will increase, as will the time it takes to achieve tenure (Kuh 1977; Kuh and Radner 1980; Perrucci, O'Flaherty, and Marshall 1983; Moore, et al. 1983; Willis 1990). Together these forces reduce the attractiveness of academic careers. In contrast, in tight labor markets, with "shortages" of doctorates (as are projected for the future), these patterns are reversed, the relative attractiveness of academic careers is increased, and this adds to the likelihood that the share of new doctorates choosing academic careers would increase.

Working conditions in both the academic and the nonacademic sectors also surely matter. While it is difficult to measure all these, it is well-known that student/doctorate faculty ratios have been falling over the past two decades (Bowen and Sosa 1989, chap. 5). In addition, while data from three national surveys of faculty conducted by the Carnegie Foundation for the Advancement of Teaching in 1975, 1984, and 1989 do not indicate that substantial changes have occurred in the number of hours per week that professors spend in classroom instruction (Tables 8.11 and 8.12), they do suggest that faculty members spent considerably less time in scheduled office hours per week in 1989 then they did in 1975 (Table 8.13). Lower student/faculty ratios and fewer scheduled office hours (which provides faculty with more flexibility in how they can allocate their time) surely increase the relative attractiveness of academic careers. While academic institutions might hope to respond to projected future shortages of doctorates by increasing faculty work loads, increased competition for scarce faculty will make it difficult for them to do so.

Hand in hand with concern about the reduced share of new doctorates choosing academic careers, concern is often expressed that the academic sector may be (increasingly) losing the highest-quality new doctorates to the nonacademic sector. However, evidence to confirm that this is occurring is not very strong. One detailed study of all students receiving doctorates in economics between June 1972 and June 1978 found that a new doctorate's probability of obtaining a first job in the academic sector was higher the higher the

Table 8.11 **Typical Hours per Week Spent in Undergraduate Classroom Instruction by American Academics**

	Hours				
Category	None	1–5	6–10	11–20	> 20
All respondents:					
1989 (N = 4,923)	6.1	21.1	29.0	39.2	4.6
1984 (N = 4,731)	11.2	24.6	25.3	35.1	3.8
1975 (N = 2,232)	10.0	23.2	25.9	36.0	5.0
Four-year institutions:					
1989 (N = 3,069)	9.5	29.3	35.2	24.8	1.3
1984 (N = 3,552)	13.8	29.1	30.2	25.2	1.7
1975 (N = 1,847)	10.6	24.5	32.9	28.9	3.1
Research institutions:					
1989 (N = 1,011)	18.0	46.1	27.8	7.3	.7
1984 (N = 1,080)	26.4	43.3	21.6	8.0	.7
1975 (N = 1,201)	23.1	38.7	25.2	11.5	1.6
Doctoral institutions:					
1989 (N = 463)	9.2	35.5	40.1	13.3	1.8
1984 (N = 561)	13.9	32.9	32.2	18.9	2.1
1975 (N = 206)	7.0	24.1	52.1	14.6	2.2
Comprehensive institutions:					
1989 (N = 1,256)	4.7	17.6	38.1	38.3	1.3
1984 (N = 1,530)	7.5	20.5	33.9	36.2	1.9
1975 (N = 355)	5.4	17.1	30.1	43.2	4.2
Libreral arts institutions:					
1989 (N = 338)	2.2	13.5	39.4	42.9	2.0
1984 (N = 382)	3.5	18.1	37.1	38.5	2.9
1975 (N = 85)	3.1	15.8	33.6	43.2	4.2

Source: Author's computations from unpublished tabulations provided by the Carnegie Foundation for the Advancement of Teaching from their 1989 (question 9A), 1984 (question 6A), and 1975 (question 8A) National Surveys of Faculty. In 1975 and 1984, a five- to six-hour interval was reported, and the people in this interval were split equally between the one- to five- and the six- to ten-hour categories in this table.

quality of the individual's graduate department (as measured by surveys of reputation or faculty publication counts) and the higher the selectivity (as measured by *Barron's Profiles of American Colleges* 1986) of the individual's undergraduate institution (Willis 1990, chap. 4). To the extent that students who graduate from both highly selective undergraduate schools and highly ranked graduate departments represent our "best and brightest," this suggests that, at least during the 1970s, academe was more likely to attract the most able new doctorate economists, at least initially. More recently, however, a survey conducted in 1988–89 of doctoral candidates from the top 50 graduate programs in economics found that a slightly higher percentage of students from the top 15 programs were accepting jobs in the nonacademic sector than were graduates of the lesser-rated programs (Barbezat 1989b).

Evidence for doctorates in general is more sketchy. We know that, in the

Table 8.12 **Typical Hours per Week Spent in Graduate or Professional Student Classroom Instruction by American Academics**

	Hours				
Category	None	1–5	6–10	11–20	> 20
All respondents:					
1989 (N = 4,923)	44.5	41.4	11.2	2.4	.5
1984 (N = 4,731)	57.9	31.5	8.0	2.4	.3
1975 (N = 2,232)	47.4	35.9	12.0	3.8	1.0
Four-year institutions:					
1989 (N = 3,069)	34.1	50.0	13.3	2.3	.2
1984 (N = 3,552)	48.6	38.8	9.8	2.6	.3
1975 (N = 1,847)	41.9	40.5	12.9	3.9	.8
Research institutions:					
1989 (N = 1,011)	24.1	59.5	14.6	1.7	.1
1984 (N = 1,080)	32.6	53.5	12.0	2.4	.6
1975 (N = 1,201)	27.7	50.7	15.8	4.6	1.1
Doctoral institutions:					
1989 (N = 463)	27.7	54.0	15.4	2.4	.4
1984 (N = 561)	40.8	43.2	12.5	3.2	.3
1975 (N = 206)	30.9	48.8	15.4	4.2	.8
Comprehensive institutions:					
1989 (N = 1,256)	43.1	41.2	12.1	3.1	.5
1984 (N = 1,530)	57.2	32.4	8.1	2.4	.1
1975 (N = 355)	49.7	34.3	11.4	4.0	.6
Liberal arts institutions:					
1989 (N = 338)	75.1	17.3	5.1	2.5	.0
1984 (N = 382)	81.5	10.5	5.3	2.3	.5
1975 (N = 85)	84.6	11.1	3.1	.9	.4

Source: Author's computations from unpublished tabulations provided by the Carnegie Foundation for the Advancement of Teaching from their 1989 (question 9B), 1984 (question 6B), and 1975 (question 8B) National Surveys of Faculty. In 1975 and 1984, a five- to six-hour interval was reported, and the people in this interval were split equally between the one-to five- and the six- to ten-hour categories in this table.

mid-1950s, doctorates who accepted postdocs, who often represent the very best graduate students in the sciences, were more likely to take a first job in academe than were other doctorates who accepted employment immediately on graduation (Tables 7.7 and 7.9).[17] Special tabulations prepared from the SED by the National Research Council also allow us to ascertain how the percentage of new doctorates in 1988 with employment plans in the U.S. academic sector varied (by field) between Research I and all other doctorate-granting institutions and, within institutional category, by the doctorates' major sources of financial support during their studies.

These tabulations, presented in Table 8.14, suggest that, in psychology, the

17. Postdocs were also more likely (at least during the early 1970s) to wind up in tenure-track positions in major research universities (National Research Council 1981).

Table 8.13 Typical Scheduled Office Hours per Week of American Academics

	Hours				
Category	None	1–5	6–10	11–20	> 20
All respondents:					
1989 (N = 4,923)	4.2	66.1	22.7	5.4	1.6
1984 (N = 4,731)	8.2	43.5	33.4	9.9	5.2
1975 (N = 2,232)	8.9	38.7	30.3	11.8	10.5
Four-year institutions:					
1989 (N = 3,069)	4.8	64.9	24.0	4.8	1.5
1984 (N = 3,552)	9.5	47.7	30.3	7.9	4.6
1975 (N = 1,847)	8.7	40.0	29.5	11.2	10.7
Research institutions:					
1989 (N = 1,011)	9.1	70.6	15.9	3.1	1.2
1984 (N = 1,080)	17.0	54.3	20.1	5.2	5.6
1975 (N = 1,201)	14.3	42.1	21.6	8.3	13.6
Doctoral institutions:					
1989 (N = 463)	4.6	63.6	24.9	5.0	1.8
1984 (N = 561)	7.9	46.3	32.6	8.2	4.9
1975 (N = 206)	7.7	39.6	29.5	11.6	11.5
Comprehensive institutions:					
1989 (N = 1,256)	1.7	64.5	27.2	5.3	1.3
1984 (N = 1,530)	5.9	46.0	35.9	8.6	3.8
1975 (N = 355)	4.8	39.9	34.5	11.8	8.9
Liberal arts institutions:					
1989 (N = 338)	2.4	49.7	36.6	8.1	3.1
1984 (N = 382)	4.3	40.4	37.9	13.4	4.1
1975 (N = 85)	7.4	35.6	33.8	15.5	7.7

Source: Author's computations from unpublished tabulations provided by the Carnegie Foundation for the Advancement of Teaching from their 1989 (question 9E), 1984 (question 6C), and 1975 (question 8C) National Surveys of Faculty. In 1975 and 1984, a five- to six-hour interval was reported, and the people in this interval were split equally between the one- to five- and the six- to ten-hour categories in this table.

social sciences, the humanities, and the professional fields, students from Research I institutions and, within institutional type, students with financial support (teaching assistantships, research assistantships, or fellowships) tend to be more likely to obtain initial employment in the academic sector. Again to the extent that these students represent the "best and the brightest," the academic sector still appears to be holding on at the entry level to high-quality doctorates. Results for the sciences, also reported in Table 8.14, are less clear because in some of the sciences many of the best new doctorates accept postdocs and are thus not counted as accepting academic employment.

8.5.2 Experienced Doctorates

Data on the age distribution of employed doctorates in the academic and nonacademic sectors, by field, were presented in Table 7.12, and data on mo-

Table 8.14 Percentage of New Doctorates with Employment Plans in the U.S. Academic Sector, 1988

	Physical Science		Computer Science		Engineering		Biological Science		Agricultural Science		Health Science	
	Research I	Other	Research I	Other	Research I	Other	Research I	Other	Research I	Other	Research I	Other
All	33.4	39.1	54.6	63.6	28.7	34.7	43.8	54.8	39.8	45.1	61.4	66.4
U.S. citizen	30.0	36.7	53.7	58.7	26.5	31.3	42.8	54.2	42.1	49.4	61.0	69.5
U.S. citizen/support:												
Own/family	27.1	29.7	45.2	57.1	27.5	44.4	42.9	59.0	45.0	58.3	68.1	72.0
Teaching assistantship	43.7	55.3	66.7	87.5	28.8	60.9	65.8	76.9	30.8	66.7	68.8	60.0
Research assistantship	22.7	34.4	53.7	57.1	27.5	27.3	34.2	56.3	40.0	45.5	40.0	[a]
Fellowship	41.9	35.3	50.0	50.0	34.1	23.1	40.0	47.8	83.3	100.0	64.3	66.7
State loans	28.6	50.0	50.0	50.0	37.5	25.0	57.1	80.0	50.0	[a]	63.6	100.0
Other	20.0	18.9	33.3	27.3	12.5	25.0	36.7	31.3	29.4	37.5	48.1	58.8

	Psychology		Social Science		Humanities		Professional Fields		Total	
	Research I	Other	Research I	Other	Research I	Other	Research I	Other	Research I	Other
All	37.5	24.6	68.5	59.4	82.4	71.9	83.9	66.9	54.3	49.0
U.S. citizen	36.7	24.7	68.1	58.5	82.0	71.6	83.3	65.8	54.0	48.3
U.S. citizen/support:										
Own/family	29.3	20.7	58.9	51.5	73.3	66.7	83.6	59.5	55.0	46.8
Teaching assistantship	54.8	54.1	81.1	74.6	90.0	80.7	91.6	96.8	72.0	72.2
Research assistantship	38.9	37.0	71.8	65.4	80.0	60.0	75.6	90.9	35.0	40.9
Fellowship	55.6	17.4	75.3	64.7	88.9	74.2	89.5	64.7	66.5	48.1
State loans	28.3	18.9	64.5	93.3	87.0	84.0	76.9	70.4	57.2	38.9
Other	29.4	28.1	43.6	36.4	74.4	66.7	63.4	54.1	35.6	35.8

Source: Special tabulations prepared by the Office of Scientific and Engineering Personnel, National Research Council, from the 1988 Survey of Earned Doctorates.

[a]Not available.

bility rates between sectors, by age and field, were presented in Table 7.11. These data can be combined to provide quantitative estimates of the extent to which changes in mobility rates can lead to changes in the number of experienced doctorates employed in the academic sector.

In the aggregate, the stock of employed doctorates in each sector age 35 and under in 1985 was approximately equal to the annual number of new doctorates awarded (all in the range of 30,000), while the stock of employed doctorates in each sector age 35–50 was approximately equal to four to five times the annual flow of new doctorates. In the aggregate, the percentage of those initially employed in academe who had moved to the nonacademic sector two years later was roughly 11 and 5, respectively, for the two age groups, while the percentage initially employed in the nonacademic sector who were employed in the academic sector two years later was 8 and 4, respectively. If one could reduce the out-migration rates from the academic sector by 2 percentage points, over 3,500 more doctorates would remain in the academic sector by the end of the two-year period. If one could increase the in-migration rates to the academic sector by 3 percentage points, over 4,800 more experienced doctorates would be employed in the academic sector by the end of the two-year period. Are changes of such magnitude realistic possibilities?

The literature on sectoral mobility of experienced doctorates is quite limited. There are no studies that address how changing relative earnings prospects in the two sectors influence sectoral mobility. However, several studies do suggest that experienced doctorates' mobility to and from academe depends on the availability of jobs in the academic sector and the general level of tightness in the academic labor market.

Crowley and Chubin (1976) found that considerable movement back to the academic sector of young doctorates in sociology occurred during the 1960s, when academic employment opportunities in sociology were expanding. Rosenfeld and Jones (1988) studied the decisions of over 600 doctorates in psychology with initial appointments in academe on whether to exit from academe during the first six years of their careers and, if so, whether subsequently to return. An excess supply of new psychology doctorates was seen to increase the probability of young academic doctorates moving to the nonacademic sector, as colleges and universities respond to the excess supply by increasing tenure standards and thus increasing the involuntary mobility of young faculty out of the sector.[18] Such an excess supply of new doctorates also made it more difficult for experienced doctorates to return to the academic sector after they had left. Conversely, tighter academic labor markets, as have been predicted for the mid-1990s would lead to less out-migration from and more in-migration to the academic sector.

18. Kuh (1977) found similar changes in tenure probabilities and time to tenure with market conditions for mathematicians.

Table 8.15 Sources of Appointments to Full-Time Academic Positions in Engineering Schools in 1985 and 1987

	1985		1987	
Status Prior to Accepting Position	*T*	*N*	*T*	*N*
Full-time graduate or postdoctoral student (%)	43.5	45.5	44.6	46.4
Full-time faculty at another institution (%)	31.0	26.7	30.4	17.7
Full-time employee in industry/government (%)	20.6	18.4	19.6	22.6
Other or unknown (%)	4.9	9.4	5.3	13.2
Total no. of appointments	936	*	973	265

Source: "ASEE Survey of Engineering Faculty and Graduaate Students, Fall 1985," *Engineering Education* (October 1986), table 8; and "Who Are We? Engineering and Engineering Faculty Survey, Fall 1987, Part II," *Engineering Education* (November 1988), table 2.

Note: T = tenure track; N = non-tenure track.

*Not reported.

Of course, one must be careful about generalizing from these two studies of social science fields. The substantial current differences across fields (Table 7.11) in the probabilities of moving to and from the academic sector reflect both field-specific differences in job opportunities and the transferability of skills between the academic and the nonacademic sectors.

In the humanities, for example, it seems clear that an increase in the availability of academic positions would draw nonacademic doctorates back to the academic sector and reduce (involuntary) mobility out of the sector, for even during the tight humanities labor market conditions of the mid-1980s, the probabilities that nonacademic doctorates moved to the academic sector during the two-year period covered by the data far exceeded the probabilities that academic economists moved to the nonacademic sector during the same time. A halving of the out-migration rates from the academic sector and a doubling of the in-migration rates from the nonacademic sector would have resulted in 2,511 more experienced humanities doctorates being employed at the end of the period in the academic sector. Alternatively, holding out-migration rates constant but simply increasing each in-migration rate by 2 percentage points would have led to an increase in academic employment of 604 by the end of the period.[19] These numbers should be contrasted to the total of 3,553 humanities doctorates that were awarded in 1988 (National Research Council 1989d).

In some fields, a substantial share of academic appointments is currently made to experienced doctorates employed in the nonacademic sector. For example, Table 8.15 shows that, in recent years, approximately 20 percent of full-time appointments in engineering on both tenure and non-tenure tracks went to doctorates who were previously full-time employees in industry and

19. These increases are computed using the data in Table 7.10 and 7.11.

Table 8.16 Sources of New Mathematics Faculty for U.S. Colleges and Universities

	Nontenured						Tenured					
	T	g	a	n	f	o	T	g	a	n	f	o
Doctorate-granting departments:												
1986	381	.467	.367	.010	.136	.018	52	0	.750	.000	.096	.156
1985	342	.389	.471	.020	.088	.032	62	0	.710	.000	.177	.113
1984	396	.452	.367	.023	.121	.035	41	0	.805	.024	.171	.000
1983	347	.432	.378	.040	.104	.046	25	0	.800	.040	.160	.000
1982	377	.459	.393	.050	.082	.016	42	0	.714	*	*	*
1981	371	.431	.402	.003	.113	.051	47	0	.809	*	*	*
1980	278	.429	.410	.029	.082	.050	35	0	.686	*	*	*
1979	380	.447	.421	.039	.066	.026	40	0	.750	*	*	*

	Doctorate-Holding						Nondoctorate					
	T	g	a	n	f	o	T	g	a	n	f	o
All four-year institutions:												
1984	1,336	.338	.477	.049	.086	.049	910	.381	.229	.091	.025	.274
1983	1,276	.334	.472	.064	.067	.063	724	.420	.124	.133	.019	.304
1982	1,371	.386	.451	.058	.058	.047	880	.377	.247	.115	.000	.261
1981	1,366	.343	.467	.070	.059	.061	739	.429	.179	.143	.015	.234
1980	1,355	.330	.444	.065	.089	.073	620	.479	.131	.100	.010	.276
1979	1,135	.335	.485	.053	.066	.062	550	.455	.164	.127	.036	.236
1978	1,080	.407	.417	.074	.046	.056	490	.510	.184	.082	.020	.204
1977	1,140	.404	.439	.035	.061	.061	435	.575	.126	.067	.025	.207

Source: Author's calculations from data found in the "Annual AMS-MAA Surveys (Second Reports)," *Notices of the American Mathematical Society* (various issues).

Note: T = total number of faculty hired; g = share of new hires that are new Ph.D.'s; a = share of new hires from other U.S. or Canadian institutions' faculty; n = share of new hires from the nonacademic sector; f = share of new hires from foreign countries; and o = share of new hires from other sources.

*Data not reported.

government. Given the large number of experienced doctorate engineers employed in the nonacademic sector, one would suspect that this group can provide an increased share of future academic appointments.

In other fields, for example, mathematics, experienced nonacademic doctorates currently make up only a small share of academic appointments. Annual data collected by the American Mathematical Society and reported in Table 8.16 show that experienced nonacademic doctorates make up less than 5 percent of the new faculty hired at doctorate-granting institutions during the period 1979–86 and 3.5–7.5 percent of the new appointments at all four-year institutions.

Given that a large stock of experienced nonacademic doctorates exists in mathematics and many other scientific fields (Table 7.12) but that in some fields (e.g., mathematics) they currently rarely return to the academic sector, the question arises as to whether nonacademic doctorates have retained the types of skills that academe demands. Only if they do is it important to consider how they might respond to increased job opportunities and an increased ratio of academic to nonacademic salaries. While one can only speculate about nonacademic doctorates' interest in teaching and their ability to do so, there is evidence that many nonacademic scientists do have active research programs.

Specifically, Stephan and Levin (1987) studied the publishing performance of physicists, earth scientists, biochemists, and plant and animal physiologists, using data from the 1973, 1975, 1977, and 1979 waves of the SDR, merged with publication data from the *Science Citation Index*. While scientists at highly rated academic institutions published the most, a substantial number of publishing scientists employed in business and industry, government, and federally funded research-and-development centers had publication records that were comparable to those employed in lesser academic institutions (Table 8.17). Although the types of research conducted in academic and nonacademic settings may well differ, there do appear to be many nonacademic scientists in these fields whose research records would qualify them for consideration for academic appointments.

Of course, one must caution that these results on publishing performance are only for selected science fields. Similar evidence is required for other science fields, the social sciences, and the humanities before one can conclude that, in general, a large stock of nonacademic doctorates have retained the skills that academe demands. In addition, to the extent that there is a much greater dispersion of compensation in the nonacademic than in the academic sector and the most talented doctorates command the highest salaries in both sectors, the financial cost of returning to the academic sector may often be highest for the most talented nonacademic doctorates. As such, the very people academe wants to attract back the most may well be the people who are least likely to want to return.[20]

20. I am indebted to Albert Rees for this point.

Table 8.17 Publishing Performance of Academic and Nonacademic Doctoral Scientists in the Stephan/Levin Sample

		Those That Publish					
	All	All	ACE	NON-ACE	BUS/IND	FFRDC	GOVT
Physicists:							
PUB1	1.72	3.67	4.26	2.98	3.57	3.87	3.23
PUB2	.74	1.58	1.77	1.39	1.59	1.55	1.50
PUB3	4.25	9.04	12.06	7.09	8.13	8.99	7.19
PUB4	1.71	3.66	4.69	3.15	3.55	3.34	3.11
PPUB	.47	[a]	[a]	[a]	[a]	[a]	[a]
N	7,231	3,399	854	517	418	695	184
Earth scientists:							
PUB1	1.00	2.71	3.25	2.58	1.95	2.71	2.28
PUB2	.53	1.43	1.71	1.43	1.11	1.22	1.19
PUB3	1.76	4.78	6.80	4.06	2.64	4.98	3.64
PUB4	.91	2.46	3.51	2.09	1.47	2.22	1.90
PPUB	.37	[a]	[a]	[a]	[a]	[a]	[a]
N	3,649	1,350	412	315	119	61	306
Biochemists:							
PUB1	3.91	6.09	6.89	6.07	4.69	4.87	6.62
PUB2	1.53	2.38	2.80	2.41	1.70	2.02	2.43
PPUB	.64	[a]	[a]	[a]	[a]	[a]	[a]
N	4,685	2,998	517	733	169	92	296
Plant and animal physiologists:							
PUB1	3.39	5.56	5.52	6.27	3.97	5.14	4.47
PUB2	1.38	2.26	2.44	2.55	1.71	1.95	1.75
PPUB	.61	[a]	[a]	[a]	[a]	[a]	[a]
N	3,344	2,040	355	508	29	81	161

Source: Stephan and Levin (1987).

Note: PUB1 = mean number of publications in the two years following the survey year; PUB2 = adjusted (for coauthors) mean number of publications in the two years following the survey year; PUB3 = mean number of publications adjusted for "impact" in the two years following the survey year; PUB4 = adjusted (for coauthors and "impact") mean number of publications in the two years following the survey year; PPUB = proportion of doctorates that published at all during the period; *N* = sample size; All = entire sample; ACE = those employed in the field in academic institutions ranked by the American Council on Education; NON-ACE = those employed in the field in nonranked institutions; BUS/IND = those employed in the field in business and industry; FFRDC = those employed in federally funded research-and-development centers; and GOVT = those employed in government.

[a]Not available.

9 The Demographic Distribution of American Doctorates

9.1 Faculty Age Structure, Productivity, and Retirement

The supply of academics depends not only on the supply of new doctorates and the sector of employment choices of new and experienced doctorates but also on the age structure of faculty and their retirement behavior. As Table 7.10 indicates, the percentage of doctoral scientists, social scientists, and engineers employed by academic institutions who were age 60 and older rose from 6.9 in 1977 to 11.6 in 1987. A similar increase, in the share of academic doctorates age 45–60 also occurred.[1] As such, the proportion of faculty who are nearing retirement will remain high over the next 20 years. High levels of faculty retirements, which lead to high levels of replacement demand for faculty, contribute to projections of faculty shortages.[2]

Of course, as of 1994, faculty will no longer be subject to mandatory retirement at age 70. If an appreciable number of older faculty can be induced to stay on beyond age 70, would this substantially reduce projected shortages? Is it likely that a substantial number could be induced to stay on? Finally, is it the case that, after some age, on average, teaching and research productivity of faculty begin to decline so that, rather than trying to induce older faculty to remain, universities might more profitably think about ways to "encourage" them to retire?

Bowen and Sosa (1989, chap. 8) have answered the first question, at least for faculty in the arts and sciences. They show that, if the expected retirement rate of faculty in the 65–69 age range could have been cut in half as of 1987, the effect in their projection model would have been to reduce the replacement

1. Changes in the age distribution of doctorate humanists, the vast majority of whom are academics, are quite similar (National Research Council 1989b, 1986, 1982, 1978).

2. As noted in Chapter 6, Bowen and Sosa (1989) have emphasized that the primary cause of projected faculty shortages is the increased demand for new faculty, not the increased replacement demand caused by increased retirements.

demand for faculty by 8 percent during the period 1987–92. This reduction would be equivalent to a 6.5 percent increase in the supply of new doctorates, and, while in itself such an increase would only partially close the shortage they project, it would be a step in the right direction.

Unfortunately, the net effect of delayed retirements on the replacement demand for faculty projected in their model would be much smaller in subsequent five-year periods, as the reduced retirements from the 65–69 age group in each of these periods would be partially offset by an increased number of faculty ages 70 and older who would retire during each period. Indeed, they project that, over the period 1997–2012, the net effect of halving the retirement rates of faculty in the 65–69 age range would be equivalent to only about a 2 percent reduction in the replacement demand for faculty.

With respect to the second question, several recent studies suggest that the uncapping of mandatory retirement in 1994 is unlikely to have effects on retirement rates of even the above magnitudes. Rees and Smith (1990) contrasted arts and sciences faculty retirement behavior at 12 public research universities and private liberal arts colleges that have already eliminated mandatory retirement (owing to state laws or institutional decisions) with faculty retirement behavior at 22 similar public and private research universities and private liberal arts colleges that currently require mandatory retirement at age 70. They found no differences in mean retirement ages between capped and uncapped institutions, even after controlling for institutional type and discipline (humanities, social science, sciences). Mean retirement ages at elite private research universities were seen to be higher than at other institutions, and only at elite public and private research institutions do an appreciable number of faculty currently wait until age 70 to retire. Since very few private research universities have eliminated mandatory retirement yet, this suggests that uncapping might potentially lead to delayed faculty retirement in this set of institutions.

A second study (Lozier and Doris 1990), which focused on a broader set of 101 institutions, also concluded that changes in mandatory retirement laws have little short-run effects on retirement rates. A survey of over 500 retired professors from these institutions found that 80 percent claimed that mandatory retirement rules had not been a significant determinant of when they retired. Since many of the other 20 percent retired at age 70 and many of these people claimed that they would have preferred to retire at age 75 or later, the authors concluded that the uncapping of mandatory retirement will lead to a gradual small shift in retirement patterns.

In contrast, two earlier studies that tried to predict the effect of the increase in the mandatory retirement age from 65 to 70, which was legislated in 1978 and went into effect in 1981 for most colleges and universities, found somewhat larger effects on professors' expected ages of retirement. Holden and Hansen (1989) conducted a survey in 1980 of a sample of faculty age 50 and over from a stratified national sample of institutions and found, after holding other factors constant, that those employed in institutions that had already raised the mandatory retirement age to 70 planned to retire about one year later than those who faced mandatory retirement at age 65. Montgomery (1989; cited in Holden and Hansen 1989) summarized research contrasting retirement ages in 1980 in Consortium on Financing Higher Education (COFHE) institutions with mandatory retirement ages of 65 and 70 and concluded that faculty facing mandatory retirement at 70 retired, on average, some two years later.

Neither of these earlier studies controlled for the possibility that faculty members may have chosen employment at institutions whose mandatory retirement ages were consistent with their preferences. Such self-selection (faculty who want to retire late choosing institutions with later mandatory retirement ages) would distort their comparisons and cause them to overstate the effects of relaxing mandatory retirement laws. Moreover, there is no reason to suspect that the effect on retirement ages of the movement of mandatory retirement from age 70 to no mandatory retirement would be the same as the effect of the movement of mandatory retirement from age 65 to age 70.

Would increases in retirement ages lead to a decline in faculty productivity? The issue of how faculty productivity varies with age has been addressed for both teaching and research, using proxy measures for productivity in both cases. Feldman's (1983) meta-evaluation of over 100 previous studies concluded that half found no relation and half found a weak negative relation between professors' ages and their students' evaluations of their teaching effectiveness. However, all these studies were cross-sectional in nature and thus do not permit one to identify how a given professor's teaching effectiveness varies over his or her career. In addition, none focused on the teaching effectiveness of professors near the ends of their careers.

More recently, Kinney and Smith (1989) studied the relation between students' evaluations of teaching effectiveness and professors' ages for tenured arts and sciences professors at a single selective research institution. They found that, in cross sections, teaching effectiveness seemed to increase for tenured professors in the humanities and social sciences as they neared age 70 while for professors in the physical and biological sciences there seemed to be a very slight decline.[3] These findings suggest that, at least for this one institution, the uncapping of mandatory retirement should not lead to a dramatic decline in faculty teaching effectiveness.

Similarly, studies of the relation between faculty research productivity and age leave one with the impression that uncapping will not have a major effect on faculty research productivity. Reskin (1985) surveyed the prior literature

3. Kinney and Smith (1989) also emphasize that cross-sectional age–teaching effectiveness relations may be distorted if retirement ages vary systematically with teaching effectiveness. For the institution they studied, they find that there is a slight tendency for the most effective teachers to retire earlier in the humanities and the physical and biological sciences and later in the social sciences.

on how publications and citations vary with faculty members' ages. Although results differ across disciplines, typically she found that, while peak research productivity occurs when faculty members are 10 to 20 years out of graduate school, those faculty who are 40 years out of graduate school publish as much on average as relatively young faculty.

Related evidence is presented by Biedenweg and Shelley (1988), who found that, while the average indirect cost recovery (the amount of external research funding) of Stanford University faculty peaks in the 46–50 age range, average indirect cost recovery of faculty age 66–70 is *higher* than that of faculty who are younger than 40. Similar findings for another major research university are reported in Howe and Smith (1990).

Levin and Stephan's (1989a) study of the publishing performance of biochemists, earth scientists, physicists, and plant and animal physiologists similarly suggests that, while publication counts tend to decline starting somewhere between ages 40 and 55 (depending on the field), older doctorate scientists often publish as much as doctorate scientists below the age of 40. Finally, preliminary results from a Barnard College study of faculty research productivity at 13 elite liberal arts colleges indicate that the fraction of faculty age 60 and above who are in the top quartile of researchers (as measured by recent publications and citations) is about the same as the fraction of all faculty who are in this top quartile (25 percent).[4]

All the studies discussed above are cross-sectional in nature. Levin and Stephan's (1989b) longitudinal study of six subfields of physics and earth science finds that, with the exception of particle physics, scientists in these subfields do appear to publish somewhat less after a point as they age. A second longitudinal study of male sociologists and psychologists found a very high correlation between faculty members' career publications and their publications between the ages of 59 and 70 (Havighurst 1985). Apparently, those faculty who are relatively productive among their cohort when they are young remain relatively productive at the later stages of their careers.

Taken as a group, these results suggest that the uncapping of mandatory retirement is not likely to lead to a substantial decline, on average, in faculty research productivity. Rather, the problem it may create is that some relatively unproductive researchers, who previously could be mandatorily retired at age 70, may now be "attached" to major research universities for longer periods of time. One suspects that the selective use of retirement incentives can help "encourage" relatively unproductive older faculty to retire.[5]

4. I am grateful to Dean Robert McCaughey of Barnard College, director of the Higher Education and College Faculty Study, which is being funded by the Spencer Foundation, for providing me with these results.

5. For example, for a number of years, Stanford University has been alleged to have a retirement incentive plan in which only "below average" productivity faculty have been allowed to participate. Given the result cited above that relatively productive people tend to be so throughout their lifetimes, having a low salary relative to salaries of similarly aged faculty in one's department has been used to measure "below average" productivity.

Of course, some people assert that the relations between publication counts, research grants, and citations, on the one hand, and faculty age, on the other, do not fully convey the importance of having a constant stream of new young faculty entering academe. Young faculty are needed to introduce new research methodologies, new ideas, and new lines of research as well as to serve as role models and mentors for potential new doctorates (National Research Council 1979; Hansen 1985). While this might suggest to some that retirement incentives be given to encourage all faculty to retire at age 70, recent simulations suggest that, even if one doubles the fraction of faculty staying on beyond age 70, the proportion of faculty below age 40 will increase in the United States over the next two decades (Rees and Smith 1990). Projected growth in faculty positions (because of increasing enrollments and an increased share of faculty near retirement age) much more than offsets any projected decline in faculty positions that might occur because of delayed retirements.

9.2 Female Doctorates

As Table 9.1 indicates, between 1973 and 1988, the share of new doctorates awarded by U.S. universities to women rose in the aggregate from 0.18 to 0.35. This almost doubling of the aggregate female share was accompanied by substantial increases in the female shares in all fields. These increases, however, did not eliminate female underrepresentation in many fields. So, for example, while over half of new doctorates in education went to women in 1988, reflecting the opening to women of career options in educational administration, substantial underrepresentation of women remains among physical science and engineering new doctorates, where shares of approximately 0.17 and 0.07, respectively, were observed in 1988.

The rapid growth in the female share of new doctorates might lead one to conclude that the proportion of female college graduates who complete doctoral study has increased substantially since the early 1970s. In fact, this has *not* been the case. Table 9.2 contains information on the number of doctoral degrees awarded to women relative to the number of bachelor's degrees awarded to women six years earlier. This ratio hovered around 0.025 during the entire period 1971–72 to 1987–88, and 0.025 is considerably smaller than the comparable ratio of 0.036 reported in Table 6.4 in recent years for all college graduates (regardless of gender). Put another way, as of 1988, the probability that a female college graduate will receive a doctorate was only about two-thirds the comparable probability for males.

The increase in the female share of doctorates that has occurred was caused by two factors. First, the share of bachelor's degrees received by women increased from 0.424 in 1971–72 to 0.502 in 1987–88 (Table 9.2, col. 2); more female college graduates means more potential female applicants for doctoral study. Second, the absolute number of doctorates awarded to males fell from

Table 9.1 Share of New Doctorates Awarded by U.S. Universities to Women

	Total Doctorates	Physical Sciences	Engineering	Life Sciences	Social Sciences	Humanities	Education	Professional/ Other
1973	.180	.072	.014	.181	.210	.286	.246	.127
1978	.270	.105	.022	.230	.308	.377	.397	.205
1979	.286	.115	.025	.243	.334	.384	.421	.239
1980	.303	.122	.036	.259	.349	.396	.446	.266
1981	.315	.121	.039	.274	.358	.413	.472	.283
1982	.324	.134	.047	.287	.370	.424	.488	.304
1983	.338	.139	.045	.310	.395	.437	.504	.294
1984	.341	.148	.052	.311	.409	.450	.510	.316
1985	.343	.158	.063	.323	.412	.434	.518	.321
1986	.354	.161	.067	.340	.426	.452	.543	.339
1987	.353	.165	.065	.353	.431	.449	.551	.332
1988	.352	.166	.068	.368	.450	.443	.552	.320

Source: Summary Report 1988: Doctorate Recipients from United States Universities (Washington, D.C.: National Academy Press, 1989), table E.

Table 9.2 Female Earned Degrees Conferred by U.S. Institutions of Higher Education

	(1)	(2)	(3)
1971–72	.024	.424	.51
1972–73	.026	.422	.57
1973–74	.023	.434	.82
1974–75	.023	.437	.96
1975–76	.023	.431	1.25
1976–77	.022	.434	1.47
1977–78	.022	.436	1.69
1978–79	.023	.438	1.75
1979–80	.023	.442	1.79
1980–81	.025	.453	1.89
1981–82	.025	.455	1.89
1982–83	.026	.461	2.00
1983–84	.026	.471	2.08
1984–85	.025	.482	2.17
1985–86	.026	.490	2.08
1986–87	.026	.498	2.17
1987–88	.025	.503	2.08

Source: Author's calculations from data in U.S. Department of Education (1989, table 200).
Note: Figures in columns represent (1) ratio of doctoral degrees awarded to women to bachelor's degrees awarded to women six years earlier; (2) share of bachelor's degrees awarded to women six years earlier; and (3) ratio of first professional degrees awarded to women to doctoral degrees awarded to women.

over 28,000 to about 22,000 during the period (U.S. Department of Education 1989, table 200). To a large extent, recent increases in the share of female doctorates reflect a substantial decrease in the likelihood that male college graduates enter and complete doctoral study, not an increased likelihood for female college graduates.

Women are increasingly likely, however, to go on to other forms of post-graduate study, in particular to professional degree programs. In 1971–72 approximately half as many women received first professional degrees as received doctoral degrees (Table 9.2, col. 3). With the opening of the professions to women, female enrollments in medicine, law, and other professional degree programs soared, and, each year since 1982–83, the number of female new first professional degrees has been more than twice the number of female new doctoral degrees. While the ratio of new first professional to doctoral degrees increased somewhat for the population at large during the period 1971–72 to 1986–87 (Table 6.4, col. 6), the increase in the ratio was much more pronounced for females.

One can only speculate about the factors that have induced female college graduates to "flood" into professional rather than doctoral programs. In part, it may reflect the opening up of career opportunities for women in the professions. In part, it may reflect that the lengthening of time to degree, particularly in the nonscience/nonengineering fields (Table 7.4), has a greater effect on women's than men's decisions because longer times to degree require some women to contemplate either postponing childbirth or undertaking doctoral study while they are parents of young children. In part, for similar reasons, the growing need to accept postdoctoral (postdoc) positions in the physical sciences (Table 7.8), which further postpones entry into a permanent academic position, may discourage women from entering doctoral study in the physical sciences. If the latter two hypotheses are correct, and if tightening academic labor markets reduce both time to degree and the need for postdocs (as hypothesized in Chapter 8), one might expect these forces to make doctoral study both in the aggregate and in the physical sciences more attractive to women in the future.

The nature of academic careers may also influence the types of institutions in which new female doctorates locate. "Up or out" tenure decisions are made during the sixth or seventh years of an individual's initial tenure-track appointment, and, especially in doctoral institutions, substantial efforts are required to begin research programs and bring them to fruition. These demands often come at a time when family formation decisions have already been postponed by young female doctorates or young children are already present in their households. As a result, new female academics may often feel pressured to "choose" between their families and their careers.[6]

It is probably not surprising, then, that one observes that women constitute a greater share of the full-time assistant professors at undergraduate institutions than they do at doctoral institutions (Table 9.3). In addition, female new doctorates are much more likely to be employed part-time and on non-tenure-track positions than are male new doctorates (Heath and Tuckman 1989). While some might argue that such patterns reflect discrimination against female new doctorates, especially by research universities, a recent survey of new job market applicants from top economics doctoral programs concluded that females rated employment in a liberal arts college as being preferable to employment in a top-tier graduate department while males ranked the two choices in reverse order (Barbezat 1989b). Similarly, the survey concluded that a higher proportion of females expected to work part-time during part of their careers or to withdraw from the labor force temporarily. Females stressed maternity leaves and family responsibilities as the reasons for these actions.

Even if the tendencies of female faculty to be employed disproportionately at undergraduate institutions or in non-tenure-track positions were the result of voluntary choice, these choices have implications for the attractiveness of academic careers and hence doctoral study for women. It is difficult to move from primarily undergraduate to more research-oriented (Youn and Zelterman

6. New male academics also face such pressures. However, considerable research shows that the vast majority of household and parental responsibilities fall on females in two-earner households, although younger males are increasingly assuming more important roles (Blau and Ferber 1986, chap. 5).

Table 9.3 Proportion of Female Faculty and Female/Male Salary Ratios by Rank, Institutional Category, and Affiliation in 1989–90

	Proportion Female[a]				Female/Male Salary Ratio[b]			
Affiliation	A	Pu	Pr	C	A	Pu	Pr	C
Professors:								
Doctoral level	.09	.09	.08	.17	.90	.90	.88	.90
Comprehensive	.15	.15	.15	.11	.96	.97	.95	.91
General baccalaureate	.16	.15	.18	.16	.94	.96	.93	.93
Associate professor:								
Doctoral level	.23	.22	.24	.29	.94	.96	.93	.92
Comprehensive	.26	.26	.25	.30	.95	.96	.93	.93
General baccalaureate	.30	.31	.33	.30	.95	.99	.94	.97
Assistant professors:								
Doctoral level	.35	.36	.30	.40	.90	.91	.91	.91
Comprehensive	.40	.41	.42	.40	.94	.94	.93	.93
General baccalaureate	.43	.40	.44	.46	.96	.95	.97	.96

Source: Author's calculations from "The Annual Report on the Economic Status of the Profession, 1989–90," *Academe* 76 (March–April 1990), tables 4, 16.

Note: A = all four-year institutions; Pu = public; Pr = private independent; and C = church related.

[a]Share of full-time faculty members in the rank who are female.

[b]Weighted (by institution size) average salary of full-time female faculty in the rank divided by the weighted average salary of full-time male faculty members in the rank.

1988); as a result, it is not surprising that the female share of associate and full professors at doctoral institutions tends to be less than their share at comprehensive institutions, which in turn tends to be less than their share at general baccalaureate institutions (Table 9.3). Salaries, especially at the senior levels, tend to be higher at doctoral than at comprehensive institutions and higher at comprehensive than at baccalaureate institutions (Table 6.2). Hence, on average, female full-time faculty are disproportionately found teaching in lower-paying institutions and thus can expect to have lower career earnings than male full-time faculty. Studies also suggest that part-time non-tenure-track academic positions rarely lead to tenure-track positions, tend to receive smaller salary increases than full-time positions, and have limited opportunities for promotion (Tuckman and Pickerill 1988).

Within institutional categories and academic ranks, the average full-time female faculty member also receives a lower salary than the average full-time male faculty member (Table 9.3). For example, in doctoral institutions in 1989–90, the typical female professor received 90 percent, the typical associate professor 94 percent, and the typical assistant professor 90 percent of her male counterpart's salary. In part, but only in part, this reflects the fact that females in senior ranks tend to have somewhat less seniority than males (Kasper 1990b). In part, this reflects the fact that females represent a greater share of doctorates in such fields as the humanities (Table 9.1), which tend to be relatively low paying (Table 6.3), than they do in such fields as engineering and the physical sciences, which, because of market conditions, tend to be higher paying. In part, some might argue that this reflects salary discrimination against female faculty.[7] Save for the gender differences that are due to seniority differences, lower within-institution pay for females will also discourage women from entering doctoral study and academe.

Clearly, policies that increase the attractiveness to women of employment at higher-paying research-oriented universities would increase the attractiveness to them of academic careers and doctoral study. Provision for "tenure clocks" to be slowed or temporarily stopped for a year when children are born or adopted—an alternative that some institutions are beginning to experiment with—may prove useful, as would provisions for reduced teaching loads for new assistant professors, another alternative that many economics departments and business schools are now adopting (Stromsdorfer 1989).[8] Of course, to increase the flow of women into doctoral study in the sciences and engineering requires policies to increase precollege mathematics and science training for women, to increase the flow of women into undergraduate science and engineering majors, to provide women with incentives and encouragement to enter and complete doctoral study, and then to facilitate the start of their research careers (National Science Foundation 1988d, 1989e).

9.3 Minorities

Table 9.4 presents data on the race and ethnicity of U.S. citizen and permanent resident new doctorates during the period 1978–88. While there have been increases in both the absolute number and the share of new doctorates awarded to native Americans, Asians, and Hispanics, in contrast the number and share of new doctorates awarded to blacks declined over the period. Indeed, in 1988, only 3.8 percent of new doctorates were awarded to blacks, even though they represent over 13 percent of the 18- to 24-year-old population in the United States. Similarly, although Hispanic doctorate production has been increasing, in 1988 only 2.8 percent of new doctorates were awarded to Hispanics, even though they represent over 10 percent of the 18- to 24-year-old population in the United States (Carter and Wilson 1989, table 1).

In fact, these data do not fully convey the extent of the underrepresentation in many fields of blacks and Hispanics in the new doctorate population. Table 9.5 presents data on the field distribution of U.S. citizen doctorates in 1988 by race and ethnicity. Quite strikingly, 46 percent of new black doctorates

7. For a comprehensive study of gender-based salary differences in academe over the period 1968–84, see Barbezat (1989a).

8. Of course, while reduced teaching loads for new assistant professors would increase the attractiveness of academe to new doctorates, they would lead to increased work loads for other faculty or an increase in the demand for new faculty.

Table 9.4 **Doctorates Received by U.S. Citizens and Permanent Residents by Race and Ethnicity (share of the total)**

	Total	Native Americans	Asian	Black	Hispanic	White	Unknown Race/ Ethnicity
1978	26,635	60	1,032	1,106	538	22,342	1,557
		(.002)	(.039)	(.041)	(.020)	(.839)	(.058)
1979	26,784	81	1,102	1,114	539	22,396	1,552
		(.003)	(.042)	(.042)	(.020)	(.836)	(.058)
1980	26,512	75	1,102	1,106	485	22,461	1,283
		(.003)	(.042)	(.042)	(.018)	(.847)	(.048)
1981	26,342	85	1,073	1,110	526	22,470	1,078
		(.003)	(.041)	(.042)	(.020)	(.853)	(.041)
1982	25,616	77	1,044	1,143	614	22,140	638
		(.003)	(.041)	(.045)	(.024)	(.864)	(.025)
1983	25,633	82	1,043	1,005	608	22,244	651
		(.003)	(.041)	(.039)	(.024)	(.868)	(.025)
1984	25,250	74	1,019	1,055	607	21,863	632
		(.003)	(.040)	(.042)	(.024)	(.859)	(.025)
1985	24,687	95	1,069	1,043	634	21,291	555
		(.004)	(.043)	(.042)	(.026)	(.862)	(.022)
1986	24,513	99	1,059	949	679	21,222	505
		(.004)	(.043)	(.039)	(.028)	(.866)	(.021)
1987	24,569	115	1,167	906	710	21,124	547
		(.005)	(.047)	(.037)	(.029)	(.860)	(.022)
1988	24,783	93	1,233	951	693	21,353	460
		(.004)	(.050)	(.038)	(.028)	(.862)	(.019)

Source: Summary Report 1988: Doctorate Recipients from United States Universities (Washington, D.C.: National Academy Press, 1991), table F.

Table 9.5 Race and Ethnicity of U.S. Citizen Doctorates Awarded in 1988 (share of field total/share of race/ethnic group total)

Field	Native Americans	Asians	Blacks	Hispanics	Whites
Total	93	612	805	594	20,685
	(.004/1.00)	(.027/1.00)	(.035/1.00)	(.026/1.00)	(.91/1.00)
Physical science:	11	111	32	69	2,913
	(.004/.118)	(.035/.181)	(.010/.039)	(.022/.116)	(.93/.014)
Physics & astronomy	1	19	11	13	645
Chemistry	5	47	17	43	1,231
Earth, atmos., & mar. sci.	2	8	2	8	476
Mathematics	2	17	1	3	308
Computer science	1	20	1	2	253
Engineering	4	141	19	43	1,527
	(.002/.043)	(.081/.230)	(.011/.024)	(.025/.072)	(.881/.074)
Life sciences:	18	127	71	84	4,019
	(.004/.194)	(.029/.208)	(.016/.088)	(.019/.141)	(.931/.197)
Biological science	6	100	36	61	2,867
Health science	5	16	25	10	586
Agricultural science	7	11	10	13	586
Social sciences:	12	85	158	133	3,864
	(.003/.129)	(.020/.134)	(.037/.196)	(.031/.224)	(.909/.187)
Psychology	7	37	96	89	2,382
Anthropology	2	3	5	10	234

were in the field of education. As a result, while blacks represented 3.5 percent of the American citizen doctorates awarded in 1988, they represented only 1.0 percent of those awarded in the physical sciences, 1.1 percent in engineering, 1.6 percent in the life sciences, and 2.8 percent in the humanities. The small absolute number of black and other underrepresented minority doctorates produced in most fields should make clear the difficult task that American institutions of higher education face in trying to achieve increased minority representation on their faculties.

Given current levels of production of minority doctorates, an institution can succeed in improving its minority representation primarily by inducing minority faculty from other institutions to move to it (Mooney 1989). One would suspect that the net result of this competition will be to redistribute minority faculty toward higher-paying doctorate-granting institutions (Table 6.2), which will benefit minority faculty economically in the short run and may also help increase the flow of future minority doctorates in the longer run.[9]

Understanding why minority doctorate production is currently so low and ascertaining what policies might more directly increase the number of minority doctorates are of utmost importance both for equity reasons and because the share of these groups in the youth population is increasing. Put another way, unless we can substantially increase the share of doctorates received by minorities, other things being equal, the total number of new American doctorates will decline.

The factors responsible for the underrepresentation of minority doctorates can be identified early in the educational pipeline. The black and Hispanic shares of the 18- to 24-year-old population rose during the period 1976–88 from 0.123 to 0.139 and from 0.058 to 0.103, respectively, but the white share fell from 0.859 to 0.826 (Carter and Wilson 1989, table 1).[10] While high school completion rates rose substantially for blacks, remained roughly constant for whites, and began and ended at roughly the same level for Hispanics during the period, the 1988 rate of 0.823 for whites exceeded the 0.754 rate for blacks, which in turn exceeded the 0.552 rate for Hispanics (Carter and Wilson 1989, table 3). The latter is equivalent to a 45 percent Hispanic high school dropout rate.

The fraction of students who graduate from high school that ever enroll in

9. An unresolved issue is what effect such competition will have on the historically black colleges and universities in the United States. In 1987, 97 of these institutions granted 20,291 bachelor's degrees, 4,064 master's degrees, 194 doctoral degrees, and 853 first professional degrees. Assuming that these degrees were all awarded to blacks, they represent, respectively, 35.8, 29.7, 25.2, and 24.9 percent of the degrees awarded to black Americans (Carter and Wilson, 1989, tables 4–7, 12). These institutions tend to be relatively low paying ones, and, if they are weakened by losing some of their better faculty to other institutions, this may have an adverse effect on black doctorate production.

10. Unlike other statistics reported in this chapter, those for whites and blacks discussed in this paragraph include Hispanics of those races. While they exclude Asians and native Americans (they are not broken out separately in these data), the double counting of Hispanics leads the sum of the shares of the three groups to exceed one.

Table 9.6 **Degree Attainment by Race/Ethnicity, Selected Years**

	1976	1981	1985	1987
White:				
BS	.884	.864	.853	.849
MS	.850	.820	.797	.791
DS	[a]	.877	.888	.890
PS	.907	.905	.890	.875
Black:				
BS	.064	.065	.059	.057
MS	.066	.058	.050	.048
DS	[a]	.040	.039	.033
PS	.043	.041	.043	.048
Hispanic:				
BS	.020	.023	.027	.027
MS	.017	.022	.024	.024
DS	[a]	.019	.024	.027
PS	.017	.022	.027	.029
Asian American:				
BS	.012	.020	.026	.033
MS	.013	.021	.028	.030
DS	[a]	.019	.022	.024
PS	.015	.020	.026	.032

Source: Carter and Wilson (1989, tables 4, 5).

Note: BS = share of all bachelor's degrees awarded; MS = share of all master's degrees awarded; DS = share of all U.S. citizen doctoral degrees awarded; and PS = share of all first professional degrees awarded.

[a]Not reported.

a two-year or four-year college also varied over time and across groups. During the period 1976–88, it rose from 0.535 to 0.586 for whites but fell from 0.504 to 0.466 for blacks and from 0.489 to 0.472 for Hispanics (Carter and Wilson 1989, table 1). Not only are blacks and Hispanics less likely to graduate from high school than whites, but, if they graduate, they are also less likely ever to be enrolled in college. Nonetheless, because of the growing shares of blacks and Hispanics in the youth population and the increasing black high school graduation rates. Blacks and Hispanics represent a growing share of the 18- to 24-year-olds who have ever been enrolled in college.

However, enrollment shares do not necessarily translated into degree-attainment shares. While the white share of all bachelor's degrees awarded in the United States since 1976 has roughly tracked the white share of ever-enrolled students, in recent years both the black and the Hispanic shares of bachelor's degrees granted have been less than their enrollment shares (Table 9.6).[11] For example, in 1987, the black and Hispanic shares of bachelor's

11. The sums across the five groups in Table 9.6 of the bachelor's degree, master's degree, and professional degree shares are each less than one because of the omission of nonresident degree shares from the table.

degrees granted were 0.057 and 0.027. Moreover, while the Hispanic bachelor's degree share has risen since 1976, the black degree share has actually fallen.

What factors explain the difference between the bachelor's degree attainment and the ever-enrolled-in-college statistics? Blacks enrolled in two-year colleges are less likely to graduate from them than are white enrollees. If they do graduate, they are less likely to enroll in four-year colleges than are white two-year college graduates. Once enrolled in four-year colleges, they are also less likely to graduate (see Part I). Some similar patterns are observed for Hispanic students, who are also more likely to be enrolled in two-year colleges than white students (Olivas 1986).

Moreover, on receiving bachelor's degrees, blacks are less likely to attain subsequent degrees than are whites, Hispanics, Asian Americans, or native Americans. The white share of doctoral and first professional degrees exceeds their share of bachelor's degrees. The Hispanic and native American shares of all graduate degrees are approximately equal to their bachelor's degree share, and the former have been increasing over time.[12] In contrast, the black shares of all graduate degrees are less than the black bachelor's shares and, save for first professional degrees, have been declining over time (Table 9.6).

Another way to look at the data is to contrast, as has been done earlier for the entire population (Table 6.4) and for females (Table 9.2), the number of doctorates awarded to a group relative to the number of bachelor's degrees awarded to the group six years earlier. Using 1980–81 bachelor's degree data and 1986–87 doctoral degree data, the ratios for white non-Hispanics, black non-Hispanics, Hispanics, Asians or Pacific Islanders, and native Americans/Alaskan natives are 0.030, 0.017, 0.034, 0.056, and 0.029, respectively. The 0.017 figure for blacks stands out quite clearly.

The underrepresentation of most minority groups in the pool of new doctorates reflects primarily their underrepresentation among the pool of college graduates; save for blacks, minority groups' doctorate/bachelor's ratio is about the same as or greater than that of whites.[13] As such, policies to increase the flow of doctorates from most minority groups should probably focus on increasing the flow of college graduates. These include policies to increase high school graduation rates, increase four-year college participation rates for

12. These bachelor's shares, however, are substantially less than their population shares and thus remain a matter of serious social concern. While Asian-Americans share of doctorates in each year is less than their bachelor's share, this is an artifact of the rapid growth in their bachelor's share. In fact, the 1987 doctorate share for the group (0.24) exceeds its 1981 share of bachelor's degrees, 0.21.

13. One qualification is in order here. Some Hispanic citizen new doctorates are individuals who were previously foreign residents, were schooled (through college) abroad, came to the United States for graduate study, and then achieved permanent resident and subsequent citizenship status by marrying American citizens. To the extent that a large number of Hispanic citizen doctorates are obtained this way, I may well be overstating the doctorate/bachelor's ratio for Hispanic American citizens who grew up in the United States. I am grateful to Michael Olivas for stressing this point to me.

high school graduates, and then increase retention rates of college enrollees. In contrast, black college graduates are much less likely to receive doctorates than are graduates from all the other minority groups. Hence, policies designed to increase both the flow of blacks into doctoral programs and their retention are needed, as are policies designed to increase the flow of black college graduates.

Potential policies to increase the flow of low-income black college graduates are discussed in Clotfelter (see Part I). Here, the focus is on factors that may currently limit the flow of black college graduates into doctorate programs. One study of graduating seniors from elite private COFHE institutions found that, after controlling for grades, family income, father's education, and college debt levels, black graduates were in fact as likely to pursue graduate study as white graduates (Schapiro, O'Malley, and Litten, in press). Moreover, neither high debt levels nor low family income levels negatively affected these students' probabilities of attending graduate school, and black/white differences in grades and parental education levels were sufficiently small that graduate school attendance probabilities for blacks and whites were the same in the raw data as well.

Unfortunately, most black undergraduates do not attend, or graduate from, elite COFHE institutions. Indeed, full-time black undergraduates enrolled in four-year institutions are much less likely than comparable whites to attend selective four-year colleges and universities (see Part I). As is demonstrated in the next chapter, graduates of the best research universities (Research I and Research II) and the selective liberal arts colleges (Liberal Arts I) earn a disproportionate share of doctorates. Hence, the distribution of black undergraduates across institutional types has an adverse effect on black students' propensity to attend graduate school.

The distribution of black college graduates by broad category of major is quite similar to the distribution of white college graduates by major, so differences in undergraduate fields of study per se probably do not contribute to black/white differences in the propensity to attend graduate school.[14] In contrast, black students who take the GRE score, on average, more than 100 points lower on both the quantitative and the verbal aptitude tests (Educational Testing Service 1988, tables 59, 60) than white test takers, and such performance differences may adversely affect their interest or opportunity to enter graduate programs.[15]

As noted above, black college students tend to come from lower-income

14. For example, the shares of bachelor's degrees awarded by U.S. institutions in 1986–87 to whites (blacks) were 0.24 (0.26) in business, 0.09 (0.08) in education, 0.09 (0.06) in engineering, 0.18 (0.20) in other professional fields, and 0.39 (0.40) in arts and sciences (U.S. Department of Education 1989, table 215).

15. No normative judgment should be drawn from this statement as to whether these differences reflect "cultural bias" in the GREs or differences in the backgrounds of black and white students that leave the former less prepared to enter and complete doctoral programs.

families than white college students. While there is no evidence nationally that low family income levels affect the probability of entering graduate school and only mixed evidence that debt burdens do (see Chapter 8), evidence on racial and ethnic differences in the probability of having college loans suggests that financial variables may adversely affect black graduate school attendance.

Table 9.7 presents information on college loan burdens for full-time four-year college students in 1986–87 by race/ethnicity and family income class. Black dependent students from each family income class are much *less* likely to have taken out college loans than students from other race/ethnic groups.[16] Whether this reflects a lower willingness of black families to borrow to finance higher education or a greater concentration of black students in lower-priced public institutions (which reduces their need to borrow) cannot be ascertained from these data. Black independent students in each income class are also less likely to have loans than all other independent students in an income class (save for Asians in a few income classes). However, the loan burdens that these black students acquire are a much higher share of their income (0.637) than are the loan burdens of any other group. Taken together, these results suggest that a lower willingness to borrow for black dependent students and higher loan burdens for black independent students may contribute to the lower probability that black college graduates enroll in graduate school.

The ways that black students finance graduate education once they do enter graduate school serve to exacerbate this problem. As Table 9.8 indicates, in 1988, black doctorates were less likely to have received their degrees from Research I universities than white doctorates for all fields except psychology. In most fields, a smaller proportion of doctorates were self-supporting (family support, loans, nonacademic earnings) in Research I than in other institutions. Hence, on balance, a greater share of black than white doctorates were self-supporting.[17]

These data suggest that increased financial support for black students contemplating doctoral study may prove to be an effective way of expanding the number of black doctorates. Both the federal and state governments and a number of universities and private foundations have, in fact, recently expanded, or introduced, doctoral fellowship programs for minority groups.[18]

It is also important to stress that Schapiro, O'Malley, and Litten (in press) found that having a precollege interest in a career in higher education signifi-

16. Dependent students are those who can be claimed as dependents on their parents', or other adult's, income-tax returns. Independent students are heads of households.

17. Within fields and institutional type, black doctorates were less likely to be self-supporting in some cases.

18. For example, the National Science Foundation sponsors a special minority graduate fellowship program, and the Ford Foundation provides doctoral and postdoctoral fellowship for minorities.

Table 9.7 **Percentage of All Four-Year College Full-Time Students Receiving Loan Aid and Average of Loans (for those with loans), 1986–87 Academic Year**

	All		Asian		Black		Hispanic		White	
Family Income Class	%	$	%	$	%	$	%	$	%	$
Dependent students:										
All	33.5	2,341	42.6	2,592	22.8	2,348	49.3	2,177	32.7	2,364
0–7,500	40.3	2,150	71.7	1,157	23.0	2,307	53.7	2,054	38.5	2,225
7,501–15,000	50.9	2,215	28.5	2,011	34.1	2,720	48.8	2,079	53.4	2,217
15,001–25,000	50.9	2,295	54.1	1,776	27.8	2.053	60.1	2,220	52.6	2,316
25,001–40,000	39.3	2,343	32.1	3,162	26.6	2,330	49.5	2,209	39.6	2,351
40,001 and over	20.9	2,474	48.8	3,095	14.0	2,416	30.0	2,395	20.7	2,479
Independent students:										
All	51.5	2,403	35.9	2,537	44.7	2,230	51.5	2,406	52.4	2,416
0–5,000	58.1	2,340	29.2	2,908	51.9	2,229	52.6	2,275	62.0	2,372
5,001–10,000	62.3	2,423	52.6	2,545	33.7	1,847	57.0	2,626	65.5	2,421
10,001–15,000	55.5	2,433	44.1	1,500	21.6	2,500	40.9	2,237	57.7	2,473
15,001 and over	33.4	2,500	.0		24.2	2,934	47.7	2,590	32.7	2,454
Dependent students:										
1. Average loan		2,341		2,592		2,348		2,177		2,364
2. Average family income of families with loans		31,026		32,026		28,313		21,009		33,464
3. (1) divided by (2)		.074		.080		.083		.104		.071
Independent students:										
1. Average loan		2,405		2,537		2,230		2,406		2,416
2. Average family income of families with loans		9,157		6,651		3,500		8,075		
3. (1) divided by (2)		.263		.381		.637		.297		.247

Source: Tabulations prepared by Dr. Daniel Sherman of Pelavin Associates, Inc., from the U.S. Department of Education, *1987 National Post Secondary Student Aid Study.*

Table 9.8 **Primary Sources of Financial Support for Black (B) and White (W) Graduate Students Receiving Doctorates in 1988, by Field and Institution Type**

	% Share													
	Total Science		Physical Sciences		Agricultural and Biological Sciences		Social Sciences		Psychology		Engineering		Nonscience/ Engineering	
Primary Source	B	W	B	W	B	W	B	W	B	W	B	W	B	W
All institutions (*N*)	(241)	(10,339)	(28)	(1,880)	(44)	(3,367)	(68)	(1,648)	(99)	(2,403)	(19)	(1,529)	(553)	(8,902)
University teaching assistant	11.4	17.8	26.9	21.6	7.5	14.6	10.7	22.1	6.0	12.5	.0	7.7	7.7	14.3
University research assistant	12.3	18.8	26.9	33.6	20.0	22.7	7.1	9.5	8.3	7.8	17.6	32.7	1.7	2.9
University other[a]	11.4	6.4	3.8	4.4	17.5	7.8	12.5	7.6	10.7	6.0	17.6	7.2	10.0	6.1
Total university[b]	35.1	43.0	57.7	59.6	45.0	45.0	30.4	39.3	25.0	26.3	35.3	47.7	19.4	23.3
Total federal[c]	17.1	17.8	19.2	23.7[a]	32.5	29.0	10.7	7.9	13.1	5.0	17.6	21.3	6.9	3.5
Total personal[d]	42.7	36.6	3.8	13.8	17.5	23.9	53.6	50.0	60.7	67.3	17.6	19.8	68.5	68.9
Total other[e]	5.2	2.5	19.2	2.9	5.0	2.1	5.4	2.9	1.2	1.4	29.4	11.3	5.2	4.2
Research I institutions (*N*):	(138)	(6,411)	(17)	(1,363)	(26)	(2,212)	(36)	(1,121)	(57)	(993)	(14)	(1,165)	(251)	(4,588)
University teaching assistant	15.0	18.0	18.8	18.5	12.5	12.6	17.2	23.6	10.2	17.0	.0	6.8	8.3	19.2
University research assistant	12.5	21.8	31.3	37.5	16.7	23.2	10.3	10.1	6.1	9.7	25.0	34.8	1.4	4.0
University other	12.5	6.1	.0	4.0	12.5	6.7	17.2	9.0	14.3	6.0	16.7	6.7	13.9	7.4

Total university[b]	40.0	46.0	50.0	60.0	41.7	42.4	44.8	42.7	30.6	32.7	41.7	48.3	23.6	30.5
Total federal	18.3	22.3	18.3	22.1	37.5	34.7	6.9	8.6	16.3	7.4	25.0	21.9	9.7	4.3
Total personal	35.0	29.4	6.3	11.7	16.7	20.8	41.4	46.1	51.0	58.5	.0	19.4	61.6	61.5
Total other	6.7	2.4	25.0	2.5	4.2	2.1	6.9	2.6	2.0	1.4	33.3	10.4	5.1	3.7
Other institutions (*N*):	(103)	(3,928)	(11)	(517)	(18)	(1,155)	(29)	(527)	(42)	(1,410)	(5)	(384)	(302)	(4,314)
University teaching assistant	6.6	17.4	40.0	30.0	.0	18.4	3.7	19.2	.0	9.3	.0	10.5	7.2	9.2
University reaearch assistant	12.1	14.0	20.0	23.3	25.0	21.8	3.7	8.4	11.4	6.6	.0	26.8	1.9	1.8
Other university	9.9	6.8	10.0	5.4	25.0	9.9	7.4	4.7	5.7	5.9	20.0	8.6	6.8	4.8
Total university[b]	28.6	38.1	70.0	58.6	50.0	50.0	14.8	32.2	17.1	21.8	20.0	45.9	16.0	15.9
Total federal	15.4	10.9	20.0	17.9	25.0	18.1	14.8	6.3	8.6	3.3	.0	19.3	4.6	2.8
Total personal	52.7	48.3	.0	19.6	18.8	29.8	66.7	58.0	74.3	73.6	60.0	21.0	74.1	76.6
Total other	3.3	2.7	10.0	3.9	6.3	2.1	3.7	3.5	.0	1.3	20.0	13.8	5.3	4.8
Proportion of group receiving degrees from Research I institutions	.57	.62	.39	.73	.59	.66	.55	.68	.58	.41	.74	.76	.45	.51

Source: Special tabulations prepared by the Office of Scientific and Engineering Personnel, National Research Council, from the 1988 Survey of Earned Doctorates.

[a]Primarily fellowships and college work study.

[b]Sum of three previous categories.

[c]Primarily fellowships.

[d]Primarily family support, loans, and nonuniversity earnings.

[e]Primarily grants from other organizations and foreign support.

cantly increased the probability that graduates from COFHE institutions enrolled in graduate school. While no analyses were conducted of how such interest varies by race and ethnicity, it is likely that, because the socioeconomic distribution of black families differs from that of white families and because of the paucity of black (and other minority) "role models" among the professoriate, black students will have less interest in and familiarity with academic careers. This suggests that programs that widen their exposure to academic life, such as targeted minority undergraduate research experiences, may also prove useful.[19]

19. An example is a program sponsored by the Dana Foundation that is providing 150 undergraduates at black colleges with both funds to eliminate their college debts and research apprenticeships with senior researchers at Duke University (Teltsch 1989).

10 Should Policies Be Pursued to Increase the Flow of New Doctorates?

10.1 Would a Shortage of American Doctorates Really Matter?

Suppose that a "shortage" of American doctorates does occur in the future. Would this have a substantial negative effect on academe? To answer this question, one needs to know which types of institutions would be hurt the most by a shortage and the extent to which such a shortage would have an adverse effect on undergraduate education, on the flow of future generations of students into doctoral programs, and on the research productivity of faculty at American colleges and universities.

To the extent that doctorates value both their economic well-being and the nonpecuniary conditions of their employment, such as research opportunities and opportunities to teach bright students, the hardest-hit institutions are likely to be those that are relatively low-paying and nonselective. The average faculty salary data presented in Table 6.2 indicate that salaries are lower in comprehensive and baccalaureate institutions than they are in doctoral-level institutions and about the same in two-year and baccalaureate institutions. Within the comprehensive and baccalaureate categories, salaries are lowest at Liberal Arts II and Comprehensive II institutions.[1] Taken together, this sug-

1. As the following tabulations from the 1989–90 American Association of University Professors (AAUP) salary survey indicate, among four-year institutions, salaries tend to be lowest at Liberal Arts II and Comprehensive II institutions:

Institution Type	Professor	Associate Professor	Assistant Professor
Research I	59,803	41,698	35,448
Research II	52,953	39,477	32,720
Doctorate-Granting I	51,790	39,099	32,547
Doctorate-Granting II	48,283	37,363	31,906
Comprehensive I	46,222	36,925	30,344
Comprehensive II	37,217	31,079	26,141
Liberal Arts I	47,067	35,812	29,051
Liberal Arts II	33,813	28,476	24,314

gests that the institutions that will have the greatest difficulty recruiting new doctorates if a shortage materializes will be two-year institutions and Liberal Arts II and Comprehensive II institutions. Together, these institutions currently employ about 27 percent of all full-time faculty, but only about 12.3 percent of full-time doctorate faculty (Table 6.1).

Would this result in a substantial reduction in the research produced by faculty in American institutions of higher education? As Table 10.1 indicates, both federally funded and total college and university research expenditures are heavily concentrated in the major research universities. In 1988, research expenditures at the top 200 institutions (which are primarily Carnegie category research and doctorate-granting institutions) represented 97 percent of the total research expenses of American colleges and universities. Hence, only a very small share of our nation's research is currently being undertaken in the potentially hard-hit institutions.

Furthermore, research output appears to be as highly concentrated as research expenditures. For example, in a recent year, 80 percent of the highly competitive National Science Foundation research awards to economists went to faculty employed at only 30 institutions (Nelson 1989). Similarly, among the economists with the largest number of citations to their works over the period 1971–85, 96 percent of the top 25 were at 12 institutions, and 77 percent of the top 150 were at 16 institutions (Medoff 1989). This concentration of top scholars in a small number of economics departments is in fact typical of many science and social science disciplines (Fox 1983).

More striking, perhaps, is the concentration of publishing scholars among graduates of a small number of graduate departments. Again, using economics as an example, 65 percent of the individuals who contributed articles to

Table 10.1 **Concentration of Federal Research-and-Development Expenditures at Major Research Universities**

Institutions	(1) Share of All Colleges' and Universities' Federally Financed R&D Expenditures in Fiscal Year 1987	(2) Share of All Colleges' and Universities' Total R&D Expenditures in Fiscal Year 1987
Top 10	.24	.21
Top 20	.40	.35
Top 30	.48	.45
Top 40	.56	.54
Top 50	.63	.60
Top 100	.84	.83
Top 150	.93	.92
Top 200	.97	.97

Source: Author's calculations from National Science Foundation (1989b, table B-30).

Note: Total R&D expenditures include federal, state, and local government, industry, institutional, and other sources of support.

the *American Economic Review* during the period 1960–72 received their doctorates from just 10 highly rated programs, while 88 percent of the contributors received their degrees from 25 top departments (Sun 1975). More recent studies, which focus on publications in wider numbers of journals, find heavy (although not as high) representation from graduates of the top 25 departments (Hirsch et al. 1984; Hogan 1986). Studies from other disciplines confirm that graduates of top programs are disproportionately represented among publishing scientists and social scientists (Fox 1983).

Together, the results outlined above suggest that, if a shortage of new doctorates were felt primarily by the relatively nonselective Liberal Arts II, Comprehensive II, and two-year institutions, it would not have a substantial effect on research productivity. Indeed, since research grants, research expenditures, and publications are so heavily concentrated among faculty from and graduates of top graduate departments, even if the shortage adversely affected the ability of lesser departments (say those in the Doctorate-Granting II category) to attract new doctorates to their faculty and to enroll new graduate students, this too would not substantially affect American institutions' research productivity.

Of course, assuming that the "quality" distribution of doctorates did not change (see Chapter 8) and that the highest-quality doctorates seek to go to the very best departments, the average quality of new doctorates employed at all but the very best institutions would fall because of a doctorate shortage. Intuitively, if the top institutions were forced to reach deeper down into the quality distribution to fill their positions, the quality of applicants available to fill other positions would decline. All but the very top research universities and teaching colleges would find themselves hiring lower-quality applicants, and the resulting decline in average doctorate faculty quality at doctorate-producing, liberal arts, and comprehensive institutions would lead to some decline in aggregate faculty research productivity.

Would a reduction in the number of doctorates teaching at the Liberal Arts II and Comprehensive II institutions have an adverse effect on the flow of undergraduates into doctoral programs? Table 10.2 presents information for 1988 on the percentage of doctorates whose undergraduate degrees came from various Carnegie categories of institutions, by field and Carnegie category of graduate institution. The column labeled "Other Four Year" contains data on percentages of new doctorates whose undergraduate degrees were from Liberal Arts II or Comprehensive II institutions.

In the aggregate, only 3.2 percent of new doctorates from Research I institutions and 7.0 percent of new doctorates from other doctorate-granting institutions (Research II, Doctorate I, and Doctorate II) received their undergraduate degrees from Liberal Arts II or Comprehensive II institutions. Since 65 percent of new doctorates were awarded by the Research I institutions, this implies that, in total, only about 4.5 percent of new doctorates in 1988 received their undergraduate degrees from Liberals Arts II and Comprehensive

Table 10.2 **Percentage of Ph.D.s from Various Categories of Undergraduate Institutions, by Field and Carnegie Category of Graduate School, 1988**

Field[a]	Research I	Other Research/ Doctorate	Comprehensive I	Liberal Arts I	Other Four Year	Specialty and Other[b]
Physical science:						
Research I (70)	29.8	12.1	10.9	8.7	3.0	35.4
Other (30)	12.1	19.3	15.4	7.6	5.1	40.5
Computer science:						
Research I (74)	29.4	10.5	6.6	3.4	3.1	47.0
Other (26)	14.3	22.6	9.8	3.0	5.3	45.1
Engineering:						
Research I (73)	29.7	9.9	4.6	1.7	.7	53.4
Other (27)	10.1	22.5	6.5	1.2	1.2	58.5
Biological science:						
Research I (65)	39.6	15.1	10.9	10.1	3.2	21.1
Other (35)	19.9	23.6	17.8	8.1	7.7	22.9
Agricultural science:						
Research I (70)	28.6	13.8	7.8	3.3	2.5	44.0
Other (30)	18.4	23.4	7.1	.8	3.7	46.6
Health science:						
Research I (72)	28.0	16.6	14.5	5.8	4.7	30.5
Other (28)	15.9	24.9	20.0	3.7	7.8	27.8
Psychology:						
Research I (42)	35.2	17.9	18.2	11.9	4.7	12.0
Other (58)	20.0	25.4	21.7	9.2	6.9	16.8
Social science:						
Research I (66)	27.2	14.0	10.1	10.4	3.3	35.0
Other (34)	14.1	23.3	16.8	6.4	4.8	34.5
Humanities:						
Research I (67)	29.2	15.1	14.6	15.5	5.2	20.4
Other (33)	13.8	21.7	18.1	11.9	13.6	20.9
Professional fields/other:						
Research I (56)	21.2	15.0	14.3	6.6	4.5	38.3
Other (44)	14.2	21.5	19.5	4.3	11.7	28.8
Total arts/sciences/professional/engineering:						
Research I (65)	30.6	13.6	10.9	8.4	3.2	33.3
Other (35)	15.5	22.7	16.5	6.9	7.0	31.4

Source: Special tabulations prepared by the Office of Scientific and Engineering Personnel, National Research Council, from the 1988 Survey of Earned Doctorates.

[a]Numbers in parentheses are the percentage of degrees in the field granted by that type of graduate school.

[b]Includes students from foreign institutions.

II institutions. The percentage was somewhat higher in the humanities, professional fields, psychology, and health sciences, about the same in the biological sciences, but substantially lower in all other fields.[2]

2. In the humanities, Bowen and Sosa's (1989) primary concern, about 8 percent of new doctorates received their degrees from these institutions.

Table 10.3 National Science Foundation Graduate Fellowship Programs for Fiscal Year 1989, Three-Year Fellowship Awards

Field (No. of Winners)	% of Winners Attending Graduate School at Research I Universities	% of Winners Who Went to Undergraduate School at: Research I Universities	Liberal Arts I Colleges	Comprehensive II Universities	Liberal Arts II Colleges
Regular program:					
Physical sciences (130)	96.9	68.5	12.3	.8	1.5
Earth, atmospheric, and marine sciences (25)	84.0	64.0	16.0	4.0	4.0
Life sciences (192)	93.2	60.9	18.2	.5	2.0
Social sciences (97)	92.8	63.9	18.6	.0	1.0
Psychology (46)	95.7	65.2	17.4	.0	.0
Mathematics and computer/ information sciences (98)	94.9	79.6	5.1	1.0	.0
Engineering (172)	94.8	69.8	2.3	.0	1.7
Total Regular program (760)	94.2	67.4	11.8	.6	1.6
Total minority programs (100)	95.0	66.0	7.0	2.0	1.0

Source: Author's calculations from award data in *National Science Foundation Graduate Fellowship Program for Fiscal Year 1989 Three-Year Fellowship Awards* (Washington, D.C., 1989); *National Science Foundation Minority Graduate Fellowship Program for Fiscal Year 1989 Three-Year Fellowship Awards* (Washington, D.C., 1989); and institutional classification data in Carnegie Foundation for the Advancement of Teaching (1987).

The small number of new doctorates whose undergraduate degrees came from Liberal Arts II and Comprehensive II institutions suggests that, even if these institutions have difficulty recruiting new doctorates to their faculties, the flow of undergraduates to subsequent doctoral study will not be substantially affected. Indeed, even if the flow from these institutions were cut by one-quarter, this would reduce the total flow into doctoral study by only 1.1 percent.

Furthermore, the share of these institutions in the total number of doctorates produced probably overstates their share of the very best entering doctoral students. Table 10.3 shows the percentage of prestigious National Science Foundation (NSF) Graduate Fellowship winners in fiscal year 1989 who attended undergraduate school at various Carnegie categories of institutions. In the aggregate, only 2.2 percent of the regular fellowship winners and 3.0

percent of the minority fellowship winners attended Comprehensive II and Liberal Arts II institutions. Only in the earth, atmospheric, and marine sciences did these institutions produce a substantial share (8 percent) of fellowship winners; however, in absolute terms, this represented only two awards.[3]

A shortage of doctorates that affected primarily two-year, Comprehensive II, and Liberal Arts II institutions would thus be unlikely to have major adverse effects on the research productivity of faculty at American colleges and universities (although it would likely lead to a reduction in the average quality of faculty in all but the top departments) or on the flow of students, especially the most talented ones, into doctoral study. The remaining issue to address is the likely effect of such a shortage on the quality of undergraduate education.

In beginning this discussion, it is useful to point out that many institutions used the relatively loose academic labor markets of the last two decades to upgrade their faculty substantially. To illustrate this point, data on the percentage of mathematics department faculty with doctorates for the period 1970–71 to 1988–89 are presented in Figure 10.1. During these two decades, the percentage of mathematics faculty with doctorates in doctorate-granting institutions rose from 86.8 to 94.0, in master's degree–granting institutions from 54.6 to 75.0, and in bachelor's degree–granting institutions from 42.0 to 66.2. Virtually all the increase occurred during the 1970s; the percentages remained roughly constant throughout the 1980s.

Assuming that mathematics is typical of other disciplines, did these increases lead to an improvement in the quality of undergraduate education?[4] If, as is postulated above, a shortage of doctorates would be felt primarily by less selective institutions among the bachelor's- and master's-granting categories and by two-year colleges, and if the percentage of faculty members with doctorates in these institutions would decline, would this lead to a decline in the quality of undergraduate education at these institutions?

There is a voluminous literature on the correlates of teacher ratings and students' performance on standardized tests, which unfortunately does not provide unambiguous answers to these questions. Some studies find that a faculty member's rank per se does not affect student evaluations of his or her performance, while others find a weak positive correlation (Centra 1981; Feldman 1983; Marsh and Overall 1981). Other studies find no difference in the final examination scores of introductory economics students taught by faculty and graduate students (nondoctorates), although these studies tend to take place at major doctorate-producing institutions, which will probably not be

3. It is interesting to note that almost three-quarters of the minority fellowship winners were undergraduates at Liberal Arts I colleges or Research I universities. Very few minority NSF fellowship winners were undergraduates at historically black institutions.

4. As noted by Bowen and Sosa (1989), data from the 1975 and 1984 Carnegie surveys of faculty (Anderson, Carter, and Malizio 1989, table 107) show no increase between 1975 and 1984 in the percentage of faculty holding doctorates. Figure 10.1 suggests that most of the increase for mathematicians occurred prior to 1975 and that mathematics may well be typical of other disciplines.

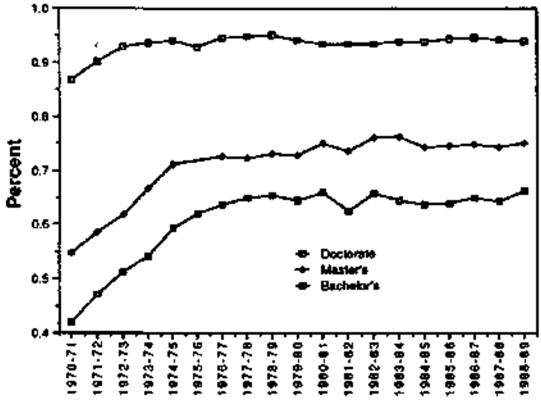

Figure 10.1 Proportion of mathematics department faculty with doctorates.
Source: Author's calculations from data contained in the "Annual AMS-MAA Survey (First Report)." *Notices of the American Mathematical Society* (various issues).
Note: Data for master's degree–granting institutions in 1975–76 appear to be in error in the original source and are excluded from the table.

affected that much by projected doctorate shortages (Siegfried and Fels 1979; Siegfried and Walstad 1990; Watts and Lynch 1989).

Still other studies find a weak positive correlation between the research productivity of faculty and their teaching evaluations (Feldman 1987). Moreover, this correlation tends to be strongest at institutions at which research does not appear to be valued very highly. To the extent that Comprehensive II and Liberal Arts II institutions fall in this category and that faculty with doctorates have higher research outputs than faculty without doctorates, these studies suggest that there may be a cost, in terms of lower-quality instruction, of a shortage of doctorates.

Studies that focus directly on the relation between faculty members' educational backgrounds and their teaching ratings are limited, and their findings vary across institutional types. Studies of major research institutions and elite public teaching colleges (where the vast majority of faculty have doctorates) tend to find that students rank faculty with doctorates as being better teachers, or being higher-quality lecturers, or knowing their subject matter better (Alciatore and Alciatore 1979; Metz 1970; Riley, Ryan, and Lifshitz 1950). In contrast, early studies of teacher evaluations at less prestigious teaching colleges (where many faculty did not have doctorates) found that faculty with doctorates tended to score more poorly than or about the same as nondoctorate faculty on teaching evaluations (Hudiburg 1965; Rader 1968; Metz 1970).

Most of these studies of the doctorate/teaching evaluation relation are dated and suffer from not controlling for factors other than degree that might affect teaching ratings. This is an area that clearly warrants new research. At best, one must remain agnostic—one cannot really say if a reduction in the percentage of the faculty with doctorates at Liberal Arts II, Comprehensive II, and two-year institutions would have an adverse effect on the quality of instruction at these institutions.

10.2 Foreign Scholars and American-Trained Doctorates from Foreign Countries

One noted American academic administrator has recently asserted that two-thirds to three-quarters of the world's top institutions of higher education are located in the United States (Rosovsky 1990, chap. 2). Foreign students flock to the United States for doctoral study. Given the academic freedom that American institutions of higher education offer as well as the relatively good research facilities and high standards of living that academics have here vis-à-vis academics in most other countries, it is reasonable to ask if an increased supply to U.S. institutions of foreign academics and newly trained temporary resident doctorates from U.S. universities could help avert projected doctorate shortages in the United States.

It is natural to start this discussion by focusing on current statistics on these flows. The first three rows of Table 10.4 contain information from the 1988 Survey of Earned Doctorates on the number of doctorate recipients from American universities, the number of these who had made definite future plans as of the date they received their degrees, and the number in the latter group with definite plans in the United States. These data are reported separately for all new doctorates and temporary resident new doctorates and for those with definite plans in the United States who are entering academic employment and postdoctoral (postdoc) positions. The approximately one-third of new doctorates who did not have definite plans as of the survey date as well as the small number with definite plans who did not report their location are ignored in the simulations that follow. Thus, these simulations understate the total number of new doctorates entering the U.S. academic sector.

Information on the shares of U.S. citizen and permanent and temporary resident postdocs in 1985 who held academic appointments in the United States in 1987 were presented earlier (Table 7.9) and are recorded in the fourth row.[5] Assuming that the share of postdocs accepting academic employment remains roughly constant over time, as do the number of postdocs, one can compute an estimate of the number of U.S. academic positions that were filled by new doctorates and recently completed postdocs in 1988. That estimate is 9,877, of which 898, or 9.1 percent, were temporary resident doctorates (rows 5 and 6).

Suppose one were to double the share of temporary resident new doctorates with definite plans in the United States—0.316 in 1988 (row 7). Such an

5. These simulations assume that the "lower-bound" estimates in Table 7.9 for temporary residents are the correct ones. The figure .59 in row 4, col. 1, of Table 10.4 is a weighted average of the temporary resident and U.S. citizen and permanent resident figures from Table 7.9.

Table 10.4 **Simulated Effects of Increasing the Number of Temporary Resident New Doctorates Who Remain in the United States on U.S. Academic Labor Supply**

	All New Doctorates, N	Temporary Resident New Doctorates, T
1. Total in 1988	33,456	6,176
2. Total with definite plans in 1988	22,089	3,911
3. Total with definite plans in the United States in 1988:	18,455	1,952
A. Academic employment	6,952	623
B. Postdoctoral study	4,958	1,019
4. Estimated share of postdocs in U.S. academic positions two years later	.59	.27
5. Estimated steady-state flow into U.S. academic employment (row 3A) + [(row 3B)(row 4)]	9,877	898
6. Share of temporary resident new doctorates in new doctorate academic employment (row 5, col. T)/(row 5, col. N)		.091
7. Share of temporary resident new doctorates with definite plans in the United States (row 3, col. N)/(row 1, col. N)		.316
8. Simulated effect on total flow into U.S. academic employment of doubling share of temporary resident doctorates with definite plans in the United States (100)(row 6, col. N)		9.1[a]
9. Simulated effect on total flow into U.S. academic employment of doubling the share of temporary resident postdocs in U.S. academic positions two years later [(1,019)(.27)/9,877](100)		2.8[a]

Source: Rows 1–3: National Science Foundation (1988e, table 15). Row 4: author's calculations from data in Table 7.9.

[a]Percentages.

increase, other things held constant, would be equivalent to a 9.1 percent increase in the flow of doctorates into U.S. academic positions (row 8). Alternatively, suppose one were to double the share of temporary resident new doctorates in postdoc positions who wind up in U.S. academic positions two years later. Such a doubling, ceteris paribus, would lead to a 2.8 percent increase in the flow of new doctorates into U.S. academic positions. Increases of these magnitudes would be significant contributions to the supply of academics to U.S. institutions.

Several qualifications are, however, in order. First, not all new doctorates or postdocs accepting academic employment wind up in faculty positions; some wind up in research associate or administrative positions. Temporary resident doctorates accepting academic appointments may well be disproportionately represented in the research associate category (see below). Second, unless temporary residents (nonimmigrants) can convert to permanent resident (immigrant) status, their expected tenure at American institutions will be shorter than their American citizen and permanent resident counterparts. Thus, the estimates given above may be overestimates. Finally, temporary resident doctorates constituted a smaller share of the new doctorates accepting academic employment or postdocs in the nonscience/nonengineering fields than in the science/engineering fields. Hence, doubling the share of nonscience/nonengineering temporary resident doctorates accepting American academic appointments would have a smaller percentage effect on the flow of new doctorates into U.S. nonscience/nonengineering faculty positions than the stimulation above suggests. Since it was the humanities where projections of shortages by Bowen and Sosa (1989) were the largest, such changes would thus have a much smaller effect on projected humanities faculty shortages.

Data on the flow of experienced foreign scholars into U.S. academic positions are harder to come by. In spite of well-publicized stories in the press about increases in the number of experienced British scholars moving here, no hard data on the number of foreign scholars in the United States really exist (Walker 1989).

As is well known, U.S. immigration policy is based primarily on family reunification criteria. While some foreign academics may enter the United States this way or as refugees seeking asylum, the vast majority enter as nonimmigrants who are temporarily admitted to the country for specific purposes. By far the vast majority, perhaps 90 percent, are employed under the H-1 and J-1 classifications of Section 101(a)(15) of the Immigration and Nationality Act (Farley 1988).[6]

The H-1 classification provides for the temporary admission of workers of "distinguished merit and ability." Determination of whether an individual is eligible for such a classification is made by the Immigration and Naturalization Service (INS) on submission of an application filed by an employer. Once approved, the individual may be employed for up to five years by the employer and may, under circumstances described below, have his or her status adjusted to that of a permanent resident (immigrant to the United States) without first having to leave the country. Colleges and universities that conduct

6. The 90 percent estimate comes from Michael Olivas of the University of Houston Law Center's Institute for Higher Education, Law, and Governance (private correspondence, 18 June 1990).

international job searches and can document that the qualifications of a foreign academic exceed those of domestic applicants usually have little difficulty obtaining H-1 classifications.

The J-1 (exchange visitor) classification permits foreign visitors to work for up to three years in approved "exchange visitor programs" sponsored by (among others) educational institutions. Individuals in the United States under J-1 visas are required in many cases to leave the country for two years before they can obtain permanent resident status. As a result, although this classification is used frequently for visiting scholars (e.g., Fulbright exchanges), explicit visiting appointments, or term research associate appointments, it is used only infrequently for faculty appointments that are meant to be permanent. As such, attention is limited to individuals on H-1 visas below.

Data on the number of H-1 workers admitted by occupation is sketchy and incomplete. The INS does not keep records of the number of doctorate college and university faculty members admitted; rather, it records the number of "postsecondary teachers" admitted. The latter include some nondoctorate faculty as well as faculty at postsecondary proprietary vocational training institutions. In 1978, 193 H-1 "postsecondary teachers" were admitted to the United States. This number grew to 531 in 1984 and then to 1,133 in 1986 (Farley 1988, table 5.2). One senses from these data that a trend toward increased reliance on foreign scholars for faculty may have already begun at American institutions of higher education.

More recent data, presented in Table 10.5, for 10 elite private universities suggest that this is true. Over the period 1986–87 to 1989–90, the number of foreign scholars employed under H-1 visas rose substantially at most of these institutions. Indeed, for the seven that reported comparable data in 1986–87 and 1989–90, total H-1 visa employment rose from 381 to 659 during the period. These institutional-level data are *not* restricted to faculty, and one institution estimates that half to two-thirds of its H-1 employees were research associates.[7] However, if in each institution half *were* faculty, foreign scholars under H-1 visas would have already represented, on average, almost 6 percent of these institutions' full-time faculty in 1989–90.[8] Foreign scholars may also be more important as a share of new hires. For example, one institution reported that, of the 63 full-time tenure-track faculty it hired in 1988–89, seven, or 11 percent, were foreign scholars.[9]

Of course, in order for foreign scholars temporarily admitted to the United States on H-1 visas to stay here permanently, they must convert their status to that of permanent resident. An unknown number do so by marrying U.S. cit-

7. Private communication with Jerry Wilcox, director of Cornell's International Students and Scholars Office, 20 June 1990.

8. This estimate uses institutional full-time faculty employment data reported in American Association of University Professors (1990).

9. These figures are for Cornell and were reported by David Fontenau of Cornell's Office of Institutional Planning and Research, 20 June 1990.

Table 10.5 Foreign Scholars Employed at Selected Elite Private Universities under H-1 Visas and Number of Labor Certifications Filed by These Institutions

	Foreign Scholars under H-1 Visas				No. of Labor Certifications Filed			
	1989–90	1988–89	1987–88	1986–87	1988–89	1987–88	1986–87	1985–86
Harvard	192	162	106	95	52	*	*	*
Stanford	176	87	*	*	*	31	*	*
MIT	125	121	100	94	15	14	24	23
Cornell	127	117	114	68	17	28	13	11
Yale	129	93	76	67	17	12	22	8
Penn	97	*	40	30+	14	*	23	23
Princeton	28	35	25	18	30	9	4	6
Columbia	60	*	*	*	14	*	*	*
Brown	38	30	23	22	8	5	*	*
Dartmouth	20	16	18	17	3	4	4	2

Source: Cornell University, International Students and Scholars Office.

*Data not reported.

izens or permanent residents or by qualifying under other family reunification provisions of the current immigration system.[10] Still others achieve permanent resident status by being classified as members of the professions, as persons of exceptional ability in the sciences or the arts, or as skilled workers who are in occupations that are in short supply. To achieve permanent residency by the latter routes requires an employer to seek and receive a certification from the U.S. Department of Labor of the individual's eligibility and then to sponsor his or her application for permanent residency.

In fiscal years 1988 and 1989, respectively, 1,570 and 1,681 submissions for certification by colleges and universities were approved by the Department of Labor.[11] These numbers are equivalent to a roughly 5 percent increase in new doctorate production.[12] If institutions carefully document their needs and their recruitment efforts during the prior six months, approval rates are quite high (in the range of 95 percent). Table 10.5 also contains data on the number of labor certifications filed by the 10 private universities. The number of certifications filed is considerably less in most cases than the number of foreign scholars present under H-1 visas. Furthermore, these institutional data are again not restricted to faculty. One institution reported that, of the 164 certifications it filed over the period 1980–90 in support of permanent residency applications, only about 52 percent were for faculty.[13]

If more widespread shortages of new doctorates do emerge, colleges and universities should be able to obtain labor certificates more easily and increase

10. A brief primer on immigration law as of 1990 (U.S. Department of State 1990) is in order here. Individuals who marry U.S. citizens are eligible for permanent resident status without limit, as are refugees. Section 201(a) of the Immigration and Nationality Act (INA) sets an annual limit of 270,000 for others, with no more than 20,000 coming from each foreign country (refugee limits are specified by the president under different legislation). Section 203(a) of the INA prescribes the following order of preference: (i) unmarried sons and daughters of U.S. citizens and their children (up to 20 percent); (ii) spouses and unmarried sons and daughters of permanent residents and their children (up to 26 percent plus any unused spaces from i); (iii) members of the professions or persons of exceptional ability in the sciences and arts, spouses, and children (up to 10 percent); (iv) married sons and daughters of U.S. citizens and their spouses and children (up to 10 percent plus any unused spaces from i, ii, and iii); (v) brothers and sisters of U.S. citizens 21 years of age or older and their spouses and children (up to 24 percent plus unused spaces from i, ii, iii, and iv); (vi) skilled and unskilled workers in short supply and their spouses and children (up to 10 percent); and (vii) any spaces not used up by the first six categories (in practice, this category is no longer used). The overall annual limit was raised in 1991 and several of the individual categories altered (Pear 1990).

11. Telephone communication from Dennis Gruskin, Division of Foreign Labor Certification, U.S. Department of Labor, June 1990. Individuals so certified may have doctorates from American or foreign universities, or they may not have doctorates.

12. This calculation ignores those foreign scholars who achieve permanent residency in other ways. While the numbers of these are unknown, data are collected on the fraction of all scientists and engineers who achieve permanent resident status without a labor certification; in 1987, this fraction was 0.56 (National Science Foundation 1988d, table B.2). These data are not restricted to individuals with doctorates, and they exclude individuals who cited their occupation as teacher. If one assumes that 0.5 is the approximate fraction for professors, then the flow of foreign scholars is currently equivalent to a roughly 10 percent increase in new doctorate production.

13. Cornell University International Student and Scholars Office, 20 April 1990.

the flow of foreign scholars on H-1 visas to permanent resident status.[14] This assumes, however, that immigration rules will not be changed in a way that makes it more difficult for foreign professors to move here. In fact, the Immigration Act of 1990 more than doubled the number of permanent visas available that are based on job skills and thus, in the short run, should make it easier for outstanding foreign scholars to move to the United States (Pear 1990; National Association for Foreign Student Affairs 1990).

While the possibility that increased reliance on foreign scholars may partially offset future shortages of American doctorates exists, it is by no means certain. Increased reliance would require continued accommodating immigration policies in the United States and accommodating emigration policies abroad. It would require that the relative attractiveness of academic employment in the United States, both economically and professionally, not substantially diminish, for, if mobility is voluntary, academics can flow out of the United States as rapidly as they flow in. Finally, it would require that foreign scholars have both the required academic background and abilities and sufficient proficiency in English to serve as effective teachers.

Although some concern has been expressed that individuals for whom English is a second language are on average less effective instructors, empirical evidence to this effect is limited. One study found such evidence for introductory economics courses (Watts and Lynch 1989). That study focused on graduate student instructors, not doctorate faculty, and it emphasized the importance of assessing the English competence of foreign graduate students and providing training for them in classroom instruction. A number of states have passed legislation requiring that teaching assistants and faculty be proficient in English.[15]

10.3 Will a Shortage of Doctorates Actually Materialize?

Will a shortage of American doctorates actually materialize? Bowen and Sosa (1989, table 8.5) project shortages of 43 percent or more, 57 percent or more, and 66 percent or more of new doctorates in the arts and sciences overall, in mathematics and the natural sciences, and in the humanities and social

14. One caution: there is already a backlog for fully processed visas under the third (exceptional ability) and sixth (skilled worker in short supply) preferences of Section 203(a) of the INA. For example, as of 1 June 1990, individuals with fully processed approved visas from 1 February 1989 were first being admitted as permanent residents under the third preference and first being admitted from 15 January 1987 under the sixth preference from most parts of the world. For applicants from some countries (e.g., the Philippines), delays were even longer (U.S. Department of State 1990). In 1990, a total of 54,000 individuals could be admitted under these two preferences each year; hence, doubling or tripling the number of certifications requested by colleges and universities (1,681 in fiscal year 1989) should not add to the backlog substantially. Furthermore, the Immigration Act of 1990 more than doubled the number of visas granted on the basis of job skills to 140,000 as of 1991 (Pear 1990).

15. For a discussion of a recent Pennsylvania law, see "Fluency in English Required of Faculty" (1990).

Economics	0	22	11	8	380
Pol. sci. & int. rel.	0	4	7	6	244
Sociology	2	8	14	13	274
Other social sci.	1	11	25	7	350
Humanities:	7	37	77	94	2,528
	(.003/.075)	(.013/.060)	(.028/.096)	(.034/.158)	(.922/.122)
History	1	10	8	13	456
Amer. & Eng. lang. & lit.	3	11	26	21	845
Foreign lang. & lit.	0	5	3	46	219
Other humanities	3	11	40	14	1,008
Education:	35	82	370	152	4,575
	(.007/.376)	(.016/.134)	(.071/.460)	(.029/.256)	(.88/.221)
Teacher educ.	3	8	31	10	323
Teaching fields	2	10	49	25	690
Other educ.	30	64	290	117	3,562
Professional/other:	6	29	78	19	1,259
	(.004/.066)	(.006/.047)	(.056/.097)	(.014/.002)	(.905/.061)
Bus. & management	4	16	16	4	558
Communications	0	1	10	2	171
Other prof. fields	2	12	52	13	503
Other fields	0	0	0	0	27

Source: Summary Report 1988: Doctorate Recipients from United States Universities (Washington, D.C.: National Academy Press, 1989), table G.
Note: Includes only doctorates whose citizenship and race/ethnic group are known.

sciences, respectively, during the period 1997–2002. However, their projections do not fully account for a number of behavioral reactions of college students, new doctorates, experienced doctorates, and institutions that, independent of public policy, *may* potentially offset at least part of the projected shortfall. Possible magnitudes for various responses are summarized in Table 10.6 and discussed below.[16]

As academic labor markets tighten and academic jobs become more plentiful, one should expect to observe an increase in academic salaries for both new and experienced doctorates, an easing of tenure standards, a reduction in the time it takes to complete doctorates, and a decrease in the need for holding postdoctoral appointments in some of the sciences prior to regular academic employment. All these forces should encourage college seniors to enter and complete doctoral programs and new college freshmen to major in fields that lead to doctoral study.

The empirical studies summarized in Table 8.1 do not yield sufficiently precise parameter estimates to enable one to predict how even a given change in new doctorate salaries will translate into a change in new doctorate supply. However, it is probably reasonable to assume that the net effect of all the forces described above will likely increase new doctorate production by at least 10 percent. What such an increase would translate into, in terms of total U.S. citizen and permanent resident new doctorates and the number of these going on to academic employment, using 1988 levels as the base, is found in the first row of Table 10.6.

The tightening of academic labor markets should cause academic salaries for new doctorates to rise relative to nonacademic salaries for new doctorates. This, as well as the increased availability of academic jobs, should slow down and perhaps reverse (as has already occurred in engineering and several other fields—see Table 7.7) the decline in the share of new doctorates choosing academic employment. Table 8.10 suggests that the ratios of new doctorate academic to new doctorate nonacademic salaries have already begun to increase, and in many fields the increase has already been more than 10 percent. Given estimates that the elasticity of the share of new doctorates who find employment in academe with respect to the relative academic/nonacademic salary is in the range of unity and the likelihood that relative academic salary will continue to rise, one might project that the share of new doctorates entering academe might "rebound" by 0.05. As the second row of Table 10.6 indicates, this would have the same effect on academic labor supply as a 9.4 increase in the number of new citizen and permanent resident doctorates produced.

As noted in Table 7.11, about 11 percent of doctorates age 35 and under

16. Details of the calculations underlying Table 10.6 are found in the appendix to this chapter. Bowen and Sosa's (1989) projections allow all of the forces discussed below to reduce the demand for new American doctorates by at most 5 percent.

Table 10.6 Simulated Effects of Various Changes

	(A) Effect on U.S. Citizen and Permanent Resident Doctorate Supply	(B) Effect on U.S. Citizen and Permanent Resident Academic Doctorate Supply
1. Increasing U.S. citizen permanent resident new doctorate supply by 10 percent	2,680 (10)	1,431 (10)
2. Increasing the share of U.S. citizen and permanent resident new doctorates entering academic, both directly and after postdocs, by 0.05	*	1,340 (9.4)
3. Reducing out-migration to the nonacademic sector of experienced academic doctorates age 50 and under by 2 percentage points	*	1,750 (12.2)
4. Increasing in-migration to the academic sector of experienced nonacademic doctorates, age 50 and under by 3 percentage points	*	2,400 (16.8)
5. Increasing the share of temporary resident new doctorates who enter academic employment in the United States, both directly and after postdocs, by 0.05	*	334 (2.3)
6. Doubling the annual flow of experienced foreign scholars entering with labor certifications	1,691 (6.3)	1,691 (11.8)
7. Halving the retirement rate of faculty age 65–69 (steady state)	509 (1.9)	509 (3.6)
8. Increasing the proportion of female college graduates receiving doctorates from 0.026 to 0.030	1,250 (4.6)	673 (4.7)
9. Decreasing the number of faculty with doctorates by 5 percent (one-time change)	11,130 (42.0)	11,130 (77.8)

Note: See the appendix for details. Numbers in parentheses are what the change is equivalent to in terms of a percentage increase in American citizen and permanent resident new doctorates.

*Not applicable.

and 5 percent of those between the ages of 35 and 50 who were employed in academe in 1985 had moved to the nonacademic sector by 1987. Increasing relative academic salaries and the availability of academic jobs as well as an easing of tenure standards should reduce both voluntary and involuntary out-mobility from the academic sector. If each of the rates given above could be reduced by 2 percentage points, approximately 3,500 more doctorates, or 1,750 annually, would remain in the academic sector over a two-year period. This would be equivalent to a 12.2 percent increase in the flow of new citizen and permanent resident doctorates to academe (row 3).

Similarly, about 8 and 4 percent of doctorates in the two age groups, respectively, who were employed in the nonacademic sector in 1985 had moved to the academic sector by 1987. Each of the factors mentioned above should encourage increased mobility of experienced doctorates from the nonacademic to the academic sector. If the two rates each increased by 3 percentage points, approximately 4,800 more doctorates, or 2,400 annually, would move to the academic sector over a two-year period. Such a flow would be equivalent to a 16.8 percent increase in the annual flow of new citizen and permanent resident doctorates to academe (row 4).[17]

Currently, approximately 20 percent of new doctorates are temporary residents of the United States. Approximately one-quarter of these obtain academic employment in the United States, either directly after receiving their degrees or after holding a postdoctoral appointment in the United States. The number of temporary resident doctorates seeking positions here appear greatly to exceed the number who achieve such positions, and shortages of U.S. citizen and permanent resident doctorates would provide universities and colleges with an incentive to expand their hiring of temporary resident doctorates. If the proportion receiving academic appointments here rose by 0.05, this would yield 334 more appointments, which is equivalent to a 2.3 percent increase in U.S. academic doctorate supply (row 5).

Of course, as described in the previous section, temporary residents can accept employment in the United States only for a limited time, unless their residency status changes. Thus, their expected academic job tenure is shorter than that of American citizen and permanent resident new doctorates, unless they eventually receive permanent resident status. In fiscal year 1989, 1,691 experienced foreign scholars and new temporary resident doctorates became permanent residents of the United States via the labor certification route, and perhaps an equal number achieved permanent resident status by other mean (primarily, family reunification). If American colleges and universities were able to double the number of such foreign scholars admitted to the United States via the labor certification route each year, this would be equivalent to an 11.8 percent increase in the flow of U.S. citizen and permanent resident new doctorates to academe.

The abolition of mandatory retirement for faculty as of January 1994 will likely have some effect on faculty retirement ages. As noted in Chapter 9, the existing literature suggests that, on balance, these effects will not be very large. Moreover, Bowen and Sosa's (1989) analysis suggests that, even if the retirement rate of 65- to 69-year-old faculty were cut in half, the long-run effect of this change would be to reduce the number of retirements only by about 2 percent. This would be equivalent to about a 1.9 percent increase in U.S. citizen and permanent resident new doctorate supply and a 3.6 percent increase in the supply of these new doctorates to academe. While these num-

17. These mobility calculations ignore the existence of a pool of doctorates who are not currently employed. For example, over 6 percent of the individuals who received doctorates in the humanities between 1979 and 1984 were not employed in 1985 (National Research Council 1986, table 5). While some of these individuals may have been out of work for family-related reasons, almost half were actively seeking employment. This pool of nonemployed doctorates is another potential source of academic labor supply. They also ignore the possibility that older (age 50 and up) doctorates employed in the nonacademic sector may opt for early retirement from their nonacademic jobs and move to the academic sector.

bers should be viewed as upper-bound estimates of the likely effect of the abolition of mandatory retirement per se (see Rees and Smith 1990), institutions can influence their faculty members to postpone retirement by pursuing institutional policies that provide faculty with incentives to stay on.

The proportion of American female college graduates who ultimately receive doctorates is currently about 0.026; this is lower than the aggregate proportion of American college graduates who ultimately receive doctorates, which is around 0.030. As noted in Chapter 9, a shortening of time to degree and a reduced need for holding postdocs may well influence women's educational decisions above and beyond these variables' effects on men's. If these forces, plus policies that institutions may begin to pursue to attract and retain female faculty (e.g., family leave policies that delay tenure "clocks" after childbirth, sabbatical leaves for nontenured faculty), succeed in raising the proportion of female college graduates who receive doctorates to 0.030 (holding constant the proportion of male college graduates who receive doctorates), the increase in the number of female doctorates choosing academic careers that will result will be in the range of 4.7 percent of the current new doctorate academic labor supply.[18]

The magnitudes of all the effects postulated above are, at best, "guestimates." There is no assurance that any one will occur, nor are most rigorously supported by precise evidence on the magnitudes of behavioral relations. Indeed, one role of this essay has been to point out the many areas in which there is little or no empirical evidence on the size of the behavioral relations. Furthermore, one may question how plausible the magnitudes and signs of some of these postulated effects are—some changes may actually go in the direction of worsening doctorate shortages.

For example, economic expansion and social changes in European and Asian nations could conceivably lead to an increased attractiveness of academic careers abroad and a decline (rather than an increase) in the U.S. employment share of new nonresident doctorates. To take another example, increased nonacademic demand for Ph.D.s might prevent the share of doctorates entering academe from increasing. Nonetheless, if we perform the exercise of simply summing up these effects, in total they are equivalent to a 68.5 percent increase in the supply of U.S. citizen and permanent resident new doctorates to academe.[19] If, on balance, two-thirds of these effects were to result, the shortages projected by Bowen and Sosa would vanish, on average.

Of course, Bowen and Sosa (1989, chap. 9) and others have emphasized the time it takes for the flow of new doctorates to be increased. Because of the

18. This increase in female doctorate production should be thought of as being above and beyond the proportionate increase in male and female doctorate production that is reflected in row 1 of Table 10.6.

19. This summation omits the 2.3 percent figure in row 5 of Table 10.6, assuming that the long-run effect of keeping more temporary resident doctorates here is included under row 6.

length of the doctorate pipeline (see Table 7.4), students first enrolling in doctoral programs in the fall of 1990 will not emerge as new doctorates, on average, until the spring of 1997. To wait for the academic market to respond to projected shortages in the mid-1990s and beyond is almost to guarantee that the shortages will occur, at least in the short run. As such, they and others argue for increased federal financial support for doctoral students now, in the form of increased fellowships and research assistantships, as a way of increasing the output of new doctorates in time to head off the projected shortages.

The discussion above suggests that the academic labor market has, in fact, already begun to respond to current and projected shortages of doctorates, although whether the response will actually prove sufficient to prevent these shortages is not known. Moreover, as Chapter 8 stressed, we have virtually no empirical evidence on what the effects of increased federal financial support for doctoral students would likely be on students' average time to degree or on what the direct effects of changes in the latter and increased financial support for doctoral students would be on the number of students who enroll in, and complete, doctoral programs.

We also have no sense of whether institutions of higher education would respond to increases in federal funding of doctoral students by reducing their own support of doctoral students by an equal, or smaller, amount. If such displacement effects occur, the net effect of the increased federal funding on doctoral supply would be less than what policymakers expected (assuming that they knew the effect of increased aid on doctorate supply). In sum, although increased federal support of doctoral students may be desirable, we really cannot predict with any accuracy what the effects of any given increase would be on doctorate supply.

As is well known, student/doctorate faculty ratios have been declining during the 1980s, in both the arts and sciences and other fields, as institutions have sought to upgrade their status (Bowen and Sosa 1989, chap. 5). Bowen and Sosa's and most other projections of future doctorate shortages assume either that this trend will continue, albeit somewhat more slowly, or that student/doctorate faculty ratios will level off.[20] They, and others, argue that, in a period of tight academic labor markets, it would be difficult for institutions to increase student/doctorate faculty ratios by increasing class sizes or teaching loads of doctorate faculty (Bowen and Sosa 1989, chap. 8). Such actions would decrease the attractiveness of academe as a career option and would likely adversely affect the flow of new doctorates.[21]

20. At one point, Bowen and Sosa (1989, chap. 7) do allow for a 7.5 percent increase in the arts and science student/faculty ratio over the period 1987–2002. However, this increase is allowed for only in projections that call for arts and science enrollments to increase. That is, they allow for reduced faculty replacement demand only when increased demand for new faculty owing to enrollment increases is occurring.

21. Increasing average class size and faculty teaching load may also influence the quality of undergraduate instruction.

This line of reasoning ignores the increased pressures that institutions of higher education are facing because tuition increases far outpaced inflation, rising at almost twice the rate of inflation during the 1980s (Hauptman 1990a; see also Part I). Increasingly, pressure is being brought to bear on higher educational institutions to limit tuition increases and to improve productivity. Rising salaries for doctorate faculty will invariably put pressure on institutions to limit overall cost increases, and, if work loads of doctorate faculty are not permitted to rise, other ways to limit cost increases must be found. One way of limiting cost increases is to allow student/doctorate faculty ratios to rise, without increasing the work load of doctorate faculty, by substituting nondoctorate for doctorate faculty. As discussed earlier in this chapter, the effects on research productivity are likely to be minimal. The prior literature does not provide strong evidence, however, as to what the effects of increased usage of nondoctorate faculty would be on faculty teaching effectiveness.

The effect of even a small increase in the student/doctorate faculty ratio, caused by the substitution of nondoctorate for doctorate faculty, on the demand for new doctorates is extraordinary. For example, a one-time 5 percent reduction in the number of doctorate faculty at each institution is equivalent to increasing the supply of citizen and permanent resident new doctorates entering academe by almost 78 percent (Table 10.6, row 9). A reduction of this magnitude alone would be sufficient to offset several years of projected shortages and would give the other behavioral responses time to kick in.

Others have argued that a larger increase in the student/doctorate faculty ratio is both desirable and possible and that an increase to the late 1970s level in the ratio would effectively eliminate projected doctorate shortages (Cheney 1989). Such an increase seems both unlikely and unrealistic. If caused by increased work loads for doctorate faculty, it would decrease the attractiveness of academic careers just at the time when attempts are being made to increase the flow of people into doctoral study. If caused by the widespread substitution of nondoctorate for doctorate faculty, it might substantially affect the aggregate research productivity of American colleges and universities. Nonetheless, there is room for American colleges and universities to economize somewhat on their use of doctorate faculty. Reductions in the range of 5 percent would probably not have a major effect on aggregate faculty research and teaching productivity or on college graduates' decisions to pursue doctoral study.

As noted in Chapter 6, all categories of institutions of higher education currently employ a significant share of faculty without doctoral degrees (Table 6.1). Whether a further substitution of nondoctorate for doctorate faculty will materialize depends, in part, on how institutions feel the increased usage of nondoctorate faculty would affect their institutional objectives. How important is it to various types of institutions to maintain the prestige that accrues from having a higher proportion of doctorates on their faculty (Garvin 1980)? Put another way, will the increased salaries that are likely to be commanded by new doctorates actually induce the institutions that used the relatively loose academic labor markets of the last two decades to increase the share of their faculty with doctorates (Figure 10.1) now to decrease the share of their faculty with doctorates.

Furthermore, what may be true in the aggregate is not necessarily true in any one field. One of the major strengths of Bowen and Sosa's analyses was their focus on the arts and sciences and their further disaggregation by field of study. They projected vast differences across fields, with substantial shortages emerging in the late 1990s in humanities, social sciences, mathematics, and physical sciences but much smaller (or no) shortages in the life sciences and psychology. The simulations conducted in Table 10.6 are, for the most part, for doctorates in the aggregate, not solely for those in the arts and sciences.

As noted in Chapter 8, most studies of doctorate labor supply focus on the sciences or social sciences; we have no estimates, for example, of supply elasticities in the humanities. It is not obvious that the sensitivity of supply to variables like salaries, stipend levels, and time to degree will be the same across fields. Moreover, luring a substantial number of individuals back to academe from fields such as engineering, where there are substantial stocks of doctorates employed in the nonacademic sector, may also prove easier than luring individuals back in fields such as the humanities, where the stock of doctorates employed in nonacademic settings is much smaller (but see n. 17 above). Similarly, temporary resident new doctorates are much more likely to be found in the sciences than they are in fields like American history, and thus they are unlikely to be a major source of increased academic labor supply in the latter area.

As such, public policies with regard to doctorate production clearly need to be based on detailed field-specific analyses. The variation of market conditions, as well as the likely variation in behavioral responses, across fields suggests that broadly based policies will probably not be in order.

Finally, it must be stressed that the simulations presented in Table 10.6 do not deal explicitly with increasing the probabilities that minorities receive doctorates. Since minority groups represent a growing share of American youths and most are underrepresented among new doctorates, unless policies are pursued to increase the flow of minorities doctorates, more severe doctorate shortages than those projected could result. As discussed in Chapter 9, while some policies can be directed at minority college graduates, it is even more important to increase the likelihood that minorities enter, and ultimately complete, four-year college programs.

10.4 Implications for Future Research

Policy decisions aimed at increasing the supply of doctorates should be guided by the findings of academic research. Yet I have here repeatedly emphasized how imprecise our knowledge of key relations is. I have also stressed the need for further research on a wide variety of topics. Rather than cataloging all these needs, I conclude with a brief discussion of four important examples. These are the determinants of enrollments in doctoral programs, the determinants of time to degree and completion rates, the responsiveness of academic institutions to changes in federal financial support of doctoral students, and the substitutability of nondoctorates for doctorates in the undergraduate educational process.

Some 20 years after Freeman's (1971) seminal work on doctorate labor supply, virtually all researchers studying the topic persist in analyzing aggregate time-series data for relatively short time spans, by field, or pooled across fields. As discussed in Chapter 8, such studies do not permit one to include many important variables that likely influence postgraduate decisions into the analyses, their small sample sizes do not permit precise estimates to be obtained, and the limited aggregate data on the humanities have not permitted them to analyze responses in the humanities to policy variables. The aggregate data also do not permit analyses of how responses by students of different ability levels and different race/ethnic groups vary (key policy questions) and of the extent to which loan burdens deter, or postpone, entry into doctoral study.

It is time for scholars pursuing research on doctoral study decisions to shift methodological approaches and utilize individual-level data. Existing representative national data sets, such as the National Longitudinal Survey of Youths, the National Longitudinal Survey of the Class of 1972, and High School and Beyond have proved extremely useful in analyzing college-going behavior (see Part I). However, these data sets are of less use in analyzing doctoral study decisions because each contains in its sample relatively few individuals who ultimately graduate from college and enter doctoral study. Rather, what is required is a national sample survey of college graduates that is repeated periodically. Such an approach would allow analyses of the effects of individuals, family, and institutional characteristics on doctoral study decisions. Moreover, since the survey would be periodicaly repeated, one could merge into the data variables reflecting labor market conditions and the characteristics of doctoral programs (e.g., availability of financial support, time to degree).

Schapiro, O'Malley, and Litten's (in press) study (discussed in Chapter 8), which analyzed data collected from graduating seniors in 1982, 1984, and 1989 from elite Consortium on Financing Higher Education (COFHE) institutions, is a step in the right direction. However, its analyses failed to include any labor market conditions or doctoral program characteristics as explanatory variables. In addition, this type of study needs to be extended to encompass a wider range of institutions and a larger number of years.

Both long times to degree and low probabilities of degree completion presumably discourage entry to doctoral programs. For policy purposes, we need to know the determinants of both. As with studies of doctorate supply, prior studies of the determinants of time to degree have, in the main, also tended to use aggregate time-series data (e.g., Tuckman, Coyle, and Bae 1990). The numerous problems associated with such an approach were discussed in Chapter 8.

Surely, future studies in this area must also use individual data, be field and institutionally based, separate out the effects of financial support from those of student ability and labor market conditions, and take account of noncompleters as well as completers. The latter point is important because labor market conditions and financial support variables may well influence *both* dropout rates and time to degree for completers. Failure to take account of the former when analyzing data on degree time for completers will lead to inaccurate estimates of the effects of labor market conditions and financial support variables on time to degree.

The importance of having information on noncompleters limits the usefulness of the annual Survey of Earned Doctorates (SED) for studies of time to degree. To increase its usefulness would require extending it to include data on noncompleters, possibly by surveys administered by departments. The SED also contains no information on students' ability levels (as measured by GRE scores), without which its usefulness is further limited.

Knowledge of the effects of the level and types (fellowship, research assistant, teaching assistant) of financial support on the number of students entering doctoral programs, their completion rates, and their average times to degree is not sufficient to analyze fully the likely effects of an increase in federal support for doctoral students on doctorate labor supply. One also needs to know the extent to which changes in external funding for doctoral student support induce institutions to alter their own support levels. Do institutions respond to changes in federal support by redirecting their own financial resources in a way that partially frustrates the intent of policy changes? Are the magnitude of such responses different for changes in fellowship, research assistant, and teaching assistant support?

To answer such questions requires access to institutionally based data sets that contain information by field on institutional and external support for graduate students as well as on other factors that influence each field's demand for graduate students. To control for differences in unobserved variables across institutions and changes in federal policies over time, one would need data for a number of years for each institution. Fortunately, such data are available, and research on those issues is already underway.[22]

Finally, as discussed in the previous section, projections of doctorate shortages depend heavily on the assumption that student/doctorate faculty ratios, which declined during the 1980s, will not increase in the future. One way to economize on doctorate faculty is to substitute more nondoctorate faculty in the undergraduate educational process.

22. For a description, see Ehrenberg (1990).

While economists are equipped to study how changing relative prices of doctorate and nondoctorate faculty have influenced their relative usage, the key issue here is not solely economic. Institutions must come to grips with how increasing their usage of nondoctorate faculty would affect their institutional objectives? How important to them is the "prestige" that accrues from having more doctorate faculty (Garvin 1980)? What would be the effect on the quality of the undergraduate education being provided of reductions in the number of doctorate faculty in some institutions?

Prior studies of faculty teaching effectiveness have not adequately analyzed the influence of having a doctorate degree per se, holding constant other factors such as course level (e.g., freshman, sophomore), course type (e.g., lecture, discussion), instructor experience, and field of study. Extensive research is clearly required in this area, along with serious rethinking by institutions, about whether undergraduate education, especially in less selective institutions, needs to be as doctorate-faculty intensive as it has been in the recent past. A conclusion that not as many doctorates are required might actually serve to increase the number of people entering graduate school, for, if the academic demand for noncompleters ("ABDs") and people terminating graduate study with master's degrees went up, this would reduce the costs of embarking on, but failing to complete, doctoral study.

Appendix
Details of the Calculations in Table 10.6

Increasing the U.S. Citizen and Permanent Resident (CPR) New Doctorate Supply

This calculation takes the total 1988 new doctorate production of 33,456 and assumes that individuals who fail to report their citizenship or residency status are distributed in the same manner as those who do report; thus, 0.199 of new doctorates are temporary residents (National Research Council 1989d, tables A, C). It also makes all the assumptions listed below (in the next section) to reach the conclusion that, as of 1988, 53.4 percent of new CPR doctorates entered academe either directly on receiving their degrees or after completing postdocs.

Increasing the Share of CPR New Doctorates Entering Academe

This calculation assumes that individuals without definite plans at the survey date wind up distributed across employment and study categories in a manner similar to those with definite plans (National Research Council 1989d, table N, R). The proportion of CPR postdocs who wind up in academic appointments two years later is obtained from Table 7.9 in the text.

Reduced Out-Migration to the Nonacademic Sector of Experienced Academic Doctorates

Increased In-migration to the Academic Sector of Experienced Nonacademic Doctorates

These two calculations use the data presented in Tables 7.11 and 7.12 in the text on mobility rates and the age distribution of doctorates in each sector.

Increasing the Share of Temporary Resident New Doctorates Accepting Academic Employment in the United States

This calculation assumes that the individuals without definite plans at the survey date are distributed across employment and study categories in a manner similar to those with definite plans (National Research Council 1989d, table 0 and p. 40), that the share of temporary resident new doctorates is 0.199 (see above), and that the share of temporary resident postdocs who wind up in U.S. academic appointments two years later is the lower-bound estimate of 0.27, obtained from Table 7.9 in the text.

Doubling the Annual Flow of Experienced Foreign Scholars Entering with Labor Certifications

This calculation uses the fiscal year 1989 figure of 1,691 provided by the U.S. Department of Labor, Division of Foreign Labor Certification.

Halving the Retirement Rate of Faculty Age 65–69

Bowen and Sosa (1989, table 8.4) estimate that a halving of the retirement rate for those arts and science faculty age 65–69 would reduce the replacement demand for arts and science faculty by 8 percent during the period 1987–92 and that this would be equivalent to about a 6.5 percent increase in new doctorate supply. For later periods, when retirements of those age 70 and over would increase, replacement demand would be reduced only by about 2 percent. The 2 percent figure is used as a "steady-state" value in the computation, and, following Bowen and Sosa, it is assumed that this would be equivalent to a 1.9 percent increase in new doctorate supply. This is assumed to apply to all faculty, not solely those in arts and science.

Increasing the Proportion of CPR Female College Graduates Receiving Doctorates

This calculation assumes that 0.801 of the 33,456 doctorates went to CPR, that 0.35 of these went to women, and that the number of female CPR doctorates would increase by $(0.4/.26) \times 100$ percent (National Research Council 1989d, tables A, C, E).

Reducing the Number of Doctorate Faculty by 5 Percent

This calculation uses the data in Table 6.1 to compute the fraction of full-time faculty with doctorates and an estimate that 459,000 full-time faculty were employed in 1987 in American institutions of higher education (Anderson, Carter, and Malizio 1989, table 104).