Volume Title: Economic Challenges in Higher Education

Volume Author/Editor: Charles T. Clotfelter, Ronald G. Ehrenberg, Malcolm Getz, and John J. Siegfried

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-11050-8

Volume URL: http://www.nber.org/books/clot91-1

Publication Date: January 1991

Chapter Title: Decisions to Undertake and Complete Doctoral Study and Choices of Sector of Employment

Chapter Author: Ronald G. Ehrenberg

Chapter URL: http://www.nber.org/chapters/c6085

Chapter pages in book: (p. 174 - 210)

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

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

[a]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	[e]	11,897	12,528 (.95)	[e]	12,057 (.91)
1971	11,000	[e]	12,112	12,528 (.97)	[e]	12,210 (.90)
1972	11,500	[e]	12,481	12,684 (.98)	[e]	12,324 (.93)
1973	11,600	[e]	12,659	13,308 (.95)	[e]	12,753 (.91)
1974	12,100	[e]	13,319	14,172 (.94)	[e]	13,400 (.90)
1975	12,800	[e]	14,044	15,000 (.94)	15,688 (.90)	15,123 (.85)
1976	13,300	[e]	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	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	[a]	.782	.787	.764	.736	.703	.759	.779	.803
Computer sciences	[a]	.898	.845	.831	.834	.915	.984	.922	.943
Environmental sciences	[a]	.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.

[a]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	[a]	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.

[a]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	[a]	[a]	[a]
1981	371	.431	.402	.003	.113	.051	47	0	.809	[a]	[a]	[a]
1980	278	.429	.410	.029	.082	.050	35	0	.686	[a]	[a]	[a]
1979	380	.447	.421	.039	.066	.026	40	0	.750	[a]	[a]	[a]

	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.

[a]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.