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The Flow of New Doctorates

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Abstract

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Keywords

graduate students, doctorates, Ph.D., academic labor market

Disciplines

Education | Higher Education | Labor Economics | Labor Relations

Comments

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The Flow of New Doctorates

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I. *Introduction*

A. *Projections of Shortages and an Overview of the Study*

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

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

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

How these estimates are arrived at can

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be illustrated by summarizing Bowen and Sosa's (1989) projection model of the demand and supply for faculty in the arts and sciences with doctorates. First, they use data on the current age distribution of faculty and estimates of departure rates (to nonacademia, retirement, and death) by age to project the replacement demand for faculty each year. Quite strikingly, they show that plausible changes in retirement behavior induced by the abolition of mandatory retirement have only small effects on replacement demand.

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

As shown below, the number of Ph.D.'s granted by U.S. universities has been roughly constant in recent years. Increasingly, however, nonacademic job opportunities are available to Ph.D.'s and Ph.D. recipients are non-American citizens whose observed probabilities of obtaining academic appointments in the United States are low.[1]

Projections of academic labor supply are based upon these trends and forecasts of the number of college graduates. Supply and demand forces are then integrated and projections of future shortages obtained. Even their most "optimistic" set of assumptions lead to forecasts of a 43 percent underproduction of new doctorates in the arts and sciences as a whole, and a 66 percent underproduction in the humanities and social sciences, during the 1997–2002 period (Bowen and Sosa 1989, Table 8.5).

As noted by Bowen and Sosa, their projections of the supply side of the academic labor market, which are typical of those used in other studies, are based on a number of simplifying assumptions. Similarly, their proposed policy remedies to increase the flow of new doctorates, such as increasing financial support for graduate students and shortening the time it takes students to receive degrees, are made presenting only scanty evidence on the likely magnitude of supply responses to these changes. This essay, which draws heavily from my study (Ehrenberg 1991), reviews the academic literature and available data (from a wide range of sources) to summarize what we know about new doctorate supply and what we need to know to make informed policy decisions.[2]

The plan of the essay is as follows. In the remainder of this section some background data are presented on the academic labor market and new Ph.D. production in the United States. Section II describes a schematic model of academic labor supply and indicates the underlying trends since 1970 in a number of variables that contribute to projections of shortages of faculty. In Section III a general model of occupational choice and the decision to undertake and complete graduate study is sketched. This framework,

[1] These probabilities depend upon foreign students' desired employment, academic employers' desires to hire foreign students, and U.S. immigration policies.

[2] A number of topics discussed in the longer study are not discussed here. These include the choice of sector of employment for new and experienced doctorates; changes over time in the "quality" of doctorates; issues relating to faculty age structure, productivity, and retirement, the supply of foreign scholars and American trained doctorates from foreign countries to the U.S. labor market; the substitutability of faculty with and without doctorates in academia; and an overall evaluation of the likelihood, and if it materializes, the significance of projected doctorate shortages. Readers interested in these topics can consult my longer study.

TABLE 1.1
FACULTY EMPLOYMENT IN INSTITUTIONS OF HIGHER EDUCATION IN THE LATE 1980S IN THE UNITED STATES

Type of Institution	(1)	(2)	(3)	(4)	(5)	(6)
Doctorate Granting	213	.062	.40			
Research Univ. I	70	.021	.22	77	.65	29
Research Univ. II	34	.010	.07	.82	.58	.20
Doctorate Granting I	51	.015	.06	.69	.64	.20
Doctorate Granting II	58	.017	.05	.73	.65	.18
Comprehensive	595	.176	.26			
Comprehensive I	424	.125	.23	.66	.54	.14
Comprehensive II	171	.050	.03	.66	.51	.15
Liberal Arts	572	.169	.07			
Liberal Arts I	142	.042	.03	.77	.72	.28
Liberal Arts II	430	.127	.04	.63	.50	.17
Two-Year Institutions	1367	.403	.20	.43	.12	.03
Specialized Institutions	642	.189	.05	.58	.38	.21
Total	3389					

(1) Number of institutions of higher education in 1987
(2) Share of institutions of higher education in 1987
(3) Share of full-time total faculty employment in 1988–89
(4) Proportion of faculty who are full-time in 1988–89
(5) Proportion of full-time faculty with Ph.D.'s in 1988–89
(6) Proportion of part-time faculty with Ph.D.'s in 1988–89
Sources: Cols. (1)–(2): Carnegie Foundation for the Advancement of Teaching (1989), Table 2. Cols. (3)–(6): Authors' calculations from the College Entrance Examination Board (1989). All proportions are weighted (by faculty size) means of individual institution proportions.

available data, and the prior academic literature are then used to address students' choice of college majors, decisions to undertake and complete graduate study, and decisions on the time it takes to complete Ph.D. programs. Section IV addresses issues relating to minority and female doctoral production. Finally, the concluding section summarizes the implications of the paper for both future research needs and public policy.

B. *Background Data on the Academic Labor Market*

In 1987 approximately 722,000 faculty were employed at institutions of higher education in the United States and about 64 percent of these were full-time employees (American Council on Education 1990, Table 104). These faculty were employed at over 3,300 different institutions and Table 1.1 presents some background data on their distribution in a recent year across various Carnegie Foundation categories of institutions.

Doctoral-granting institutions represent slightly more than 6 percent of all institutions of higher education (column 2), however, they employ 40 percent of full-time faculty (column 3). Similarly, comprehensive institutions—institutions that grant some graduate degrees—represent about 18 percent of all institutions and employ 26 percent of full-time faculty. In contrast undergraduate liberal

TABLE 1.2
1989–90 AVERAGE FACULTY SALARIES BY INSTITUTIONAL CATEGORIES, AFFILIATION, AND ACADEMIC RANK

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

Source: American Association of University Professors (1990, Table 3).
[a] Only two-year colleges where faculty have standard academic ranks are included in these tabulations.

arts colleges and two-year institutions, which in turn represent about 17 and 40 percent of all institutions, employ only 7 and 20 percent respectively of full-time faculty. While the vast majority of faculty at four-year institutions are full-time, more than half of all faculty at two-year institutions are part-time employees (column 4).

Columns (5) and (6) make clear that not all faculty have doctorate degrees. At major doctoral-granting universities, on average less than two-thirds of full-time faculty have doctorates, while at selective liberal arts colleges (liberal arts I institutions) this number rises to over three-quarters. In contrast only 12 percent of full-time faculty at two-year colleges have doctorates and part-time faculty at all institutions rarely have such degrees. While some faculty are employed in fields where the terminal degree typically is not a doctorate (e.g., fine arts, physical education), these data suggest that academics without doctorates may be viewed as possible substitutes for academics with doctorates, especially at non-research oriented institutions, if a "shortage" of doctorates materializes.[3]

How much are academics paid? Table 1.2 contains information obtained by the American Association of University Pro-

[3] This issue is addressed in Ehrenberg 1991, ch. 10.

fessors from their annual survey of institutions of higher education on average faculty salaries by institutional category, affiliation (public/private/church related), and rank for the 1989–90 academic year. The AAUP institutional categores are similar but not identical, to the Carnegie Foundation, classifications used in the previous table.

On average, nine-month academic salaries for full professors, associate professors, and assistant professors were $53,540, $39,590 and $32,970, respectively, in 1989–90.[4] As Table 1.2 indicates, however, salaries vary widely across categories of institutions.[5] Among the four-year institutions, doctoral-level institutions pay higher salaries than comprehensive institutions, which in turn pay higher salaries than general baccalaureate institutions. Within each four-year institutional category, private independents tend to pay more than public institutions, which in turn pay more than church-related institutions. While the salary differences across institutional categories and affiliations are most pronounced at the full professor level, they exist at other ranks as well.

Why do such differences exist? In part the category differences may reflect that research oriented institutions compete more aggressively for scholars and also that the private independent sector may have the most flexibility to adjust salary levels to compete in this academic market. While other factors may also be involved (for example, faculty whose primary interests lie in undergraduate teaching may be willing to accept lower salaries at baccalaureate institutions because of the nonpecuniary advantages such institutions offer to them), it is reasonable to assume that if a shortage of doctorates were to materialize, the institutions that would have the most difficulty attracting faculty would be those with the lowest salaries. In fact, the smaller variability across institutions of average salaries at the assistant professor than at the full professor level suggests that, at the entry faculty level, average salaries reflect competition by all these institutions for faculty.

In addition to variation in average salaries across institutional type and affiliation, salaries vary across disciplines. Table 1.3 presents data on the average salaries of full professors and new assistant professors in 1989–90 for twenty-one disciplines obtained from a survey of state universities and land-grant colleges. These institutions are primarily public and hence they are not representative of the entire academic labor market. Nonetheless, these data make clear how large disciplinary differentials in salary are, even when one eliminates medical schools (which they do) where salaries tend to be highest.

At the full professor level (column 1) salaries in the highest paying discipline in the sample, law, are almost 1.7 times the salaries in the lowest paying discipline, fine arts. At the new assistant professor level (column 2), the differentials are even more pronounced. Here, average salaries of the highest paid discpline, business, are over 1.8 times the average salaries paid in the lowest, fine arts. Not surprisingly, those disciplines with the highest starting salaries tend to be those in which there is both high student demand for instruction and also highly paid nonacademic employment opportunities for faculty. They also tned to be disci-

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

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

TABLE 1.3
AVERAGE SALARIES FOR FULL PROFESSORS AND NEW ASSISTANT PROFESSORS BY DISCIPLINE, 1989–90

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

Source: American Association of University Professors (1990, Table III). These data are taken from the 1989–90 Faculty Survey by Discipline of Institutions Belonging to the National Association of State Universities and Land-Grant Colleges, Conducted by the Office of Institutional Research, Oklahoma State University.

plines in which the ratio of the average full to average new assistant professor salaries (column 3) are relatively low.

Full professors have more institutional and academic "specific human capital" and also tend to have stronger ties to their communities, than their younger colleagues. As such, their probability of leaving their institutions is relatively low (Ronald Ehrenberg, Hirschel Kasper, and Daniel Rees 1991) and thus institutions are under somewhat less pressure to raise their salaries in response to tightening labor market conditions. However, the broad disciplinary differences that exist, even at the full professor level, suggest that labor market conditions do influence faculty salaries and projections of future shortages must take this into account.

Tables 1.1 to 1.3 picture the academic labor market at a given time. However, the academic labor market is fluid and has undergone several swings over the last two decades. For example, between academic years 1970–71 and 1980–81, the salary of the average faculty member in the United States fell by about 21.1 percent in real terms. In contrast, between 1980–81 and 1989–90, the salary of the average faculty member rose by about 16.6 percent in real terms (American Association of University Professors 1990, Table I). To take another example,

TABLE 1.4

Degrees Conferred by Institutions of Higher Education in the United States, 1960–61 to 1987–88

Year	Associates Degrees (1)	Bachelor's Degrees (2)	Master's Degrees (3)	First Professional Degrees (4)	Doctorate Degrees (5)	Ratio of First Professional to Doctorate Degrees (6)	Ratio of Doctorate to Bachelor's Degrees Six Years Earlier (7)
1960–61	—	369,995	81,690	25,253	10,575	2.39	—
1961–62	—	388,680	88,414	25,607	11,622	2.20	—
1962–63	—	416,928	95,470	26,590	12,822	2.07	—
1963–64	—	466,944	105,551	27,209	14,490	1.88	—
1964–65	—	501,713	117,152	28,290	16,467	1.72	—
1965–66	111,607	520,923	140,548	30,124	18,237	1.65	—
1966–67	139,183	558,852	157,707	31,695	20,617	1.54	—
1967–68	159,441	632,758	176,749	33,939	23,089	1.47	.056
1968–69	183,279	729,656	193,756	35,114	26,088	1.34	.063
1969–70	206,023	792,656	208,291	34,578	29,866	1.16	.064
1970–71	252,610	839,730	230,509	37,946	32,107	1.18	.064
1971–72	292,119	887,273	251,633	43,411	33,363	1.30	.064
1972–73	316,174	922,362	263,371	50,018	34,777	1.44	.062
1973–74	343,924	945,776	277,033	53,816	33,816	1.59	.053
1974–75	360,171	922,933	292,450	55,916	34,083	1.64	.047
1975–76	391,454	925,746	311,771	62,649	34,064	1.84	.043
1976–77	406,377	919,549	317,164	64,359	33,232	1.94	.040
1977–78	412,246	921,204	311,620	66,581	32,131	2.07	.036
1978–79	402,702	921,390	301,079	68,848	32,730	2.10	.035
1979–80	400,910	929,417	298,081	70,131	32,615	2.15	.034
1980–81	416,377	935,140	295,739	71,956	32,958	2.18	.036
1981–82	434,515	952,998	295,546	72,032	32,707	2.20	.035
1982–83	456,441	969,510	289,921	73,136	32,775	2.23	.036
1983–84	452,416	974,309	284,268	74,407	33,209	2.24	.036
1984–85	454,712	979,477	286,251	75,063	32,943	2.28	.036
1985–86	446,047	987,823	288,567	73,910	33,653	2.20	.036
1986–87	437,137	991,339	289,557	72,750	34,120	2.13	.036
1987–88	435,537	993,362	298,733	70,415	34,839	2.02	.037

Source: U.S. Department of Education (1990, Table 220).

— not reported or not calculated

between 1970 and 1980 full-time equivalent employment of faculty in the United States rose from 402,000 to 522,000, an increase of more than 2.6 percent a year. In contrast, by 1987 full-time equivalent faculty employment had risen only to 547,000, an increase of less than 0.7 percent a year, and was projected to remain constant through 1990 (American Council on Education 1990, Table 105).[6]

In further contrast to these swings, Table 1.4 indicates that after a tripling of production between 1960–61 and 1970–71, annual production of new doctorates in the United States has remained roughly constant in the 32,000 to 34,000 range throughout the 1970s and 1980s (column 5). However, this relative stability masks a number of substantial changes that did occur during the latter period. While doctoral production remained roughly constant, the number of bachelor's degrees granted in the United States roughly doubled between the mid-1960s and the mid-1970s. As a result the ratio of doctorates granted to bachelor's degrees granted six years earlier fell from .064 in 1970–71 to .035 in 1978–79 and has remained near the lower level since (column 7). A much smaller proportion of college graduates are obtaining doctoral degrees now than they did twenty years ago.[7] Moreover, as will be shown in the next section, the proportion of doctorates awarded to foreign residents has increased substantially during the past two decades so the proportion of American citizen college graduates receiving doctorates has actually continued to decline.

Part of the reason for this is that American college graduates turned increasingly to other forms of post-college study during the 1970s. In 1970–71 the ratio of first professional degrees (law, dentistry, medicine, other professions) to doctoral degrees granted stood at 1.18 (column 7); approximately the same number of first professional and doctoral degrees were awarded. However, by 1977–78, over twice as many first professional degrees as doctoral degrees were awarded and this has continued in every year since. The ratio of masters degrees granted (column 3), which includes MBAs, to doctoral degrees granted (column 6) has also risen; this stood at 7.18 in 1970–71 but rose to 8.58 in 1974–75 and since then has remained close to or above that level.

II. *A Stock-Flow Model of Academic Labor Supply*

A. *A Conceptual Model*

Figure 1 presents a schematic representation of the various components of academic labor supply.[8] Although the focus in this essay is the supply of new doctorates, we may use this figure to identify how public policies influence the supply of academics. The following section presents data on a number of the component stocks and flows that relate to the supply of new doctorates.

The potential flow of American undergraduate students into doctoral study depends initially on the number of undergraduate seniors and the major fields they have chosen to study. Choice of undergraduate major is important because in many fields students usually enter doctoral study from an undergraduate major in the same, or a closely related, field.

[6] Data are not yet available for years after 1987.

[7] What is true in the aggregate is not necessarily true in every field. The scope of this study precludes, however, detailed analyses by field. For a recent analyses of doctoral production in the biomedical fields, see National Research Council 1990.

[8] For expository convenience this figure assumes that all academics have doctoral degrees. Because the vast majority of faculty at two-year colleges do not have doctoral degrees (Table 1.), this figure and the discussion that follows should be thought of as applying to the four-year college market.

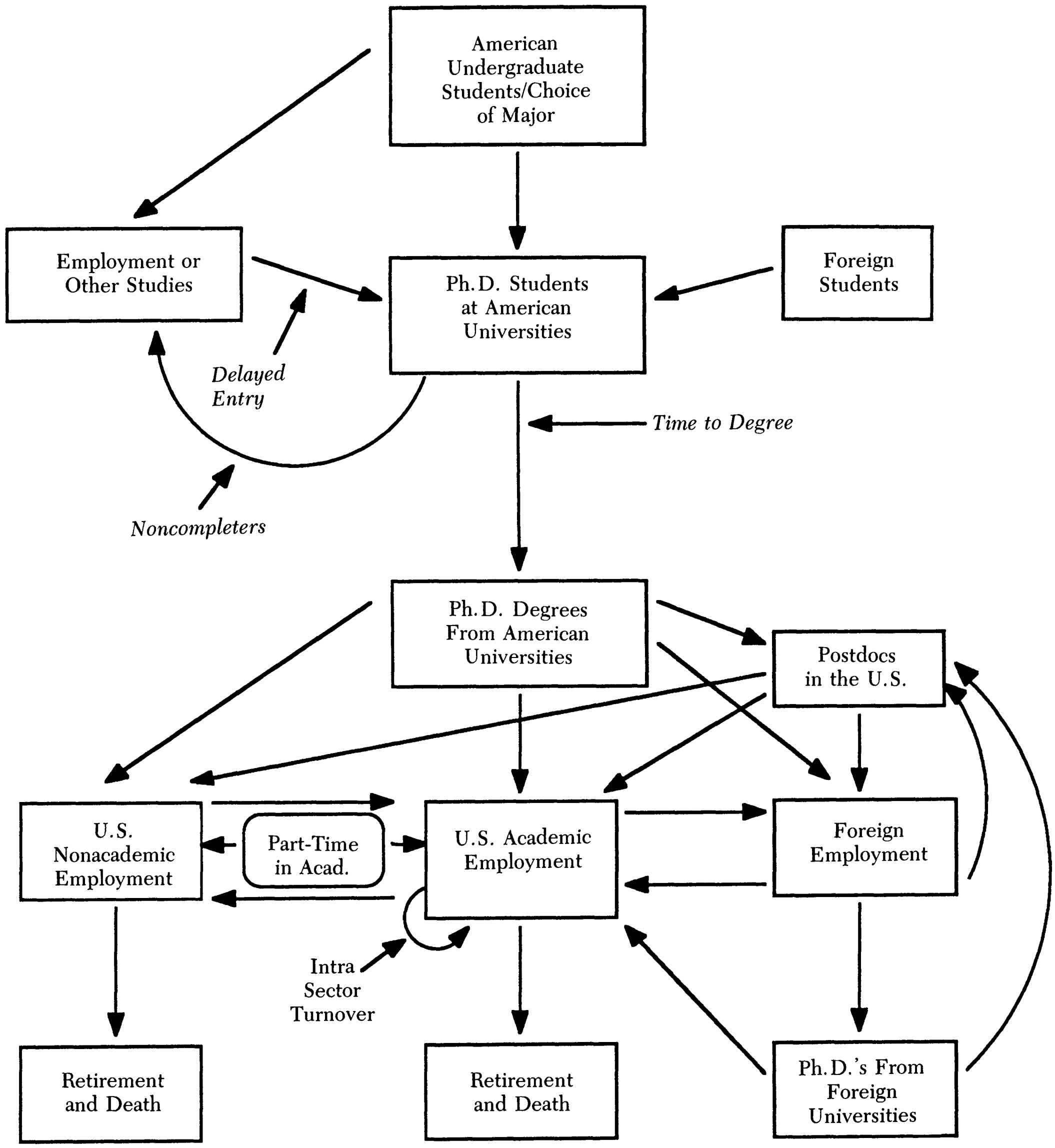

Figure 1. Academic Labor Supply

In 1988, for example, 73 percent of new doctorates in physics and astronomy, 80 percent of new doctorates in chemistry, 76.4 percent of new engineering doctorates, 62 percent of new doctorates in economics, and 57 percent of new humanities doctorates had undergraduate majors in their doctorate field (National Research Council 1989a, Appendix A, Table 2).

Once students receive undergraduate degrees, they face a number of options. They can enter graduate study directly and become Ph.D. students at American institutions, they can search for employment, they can pursue graduate study working towards other degrees (e.g., business, law, medicine, other professions) or they can pursue foreign study. Some of the individuals who fail to enter doctoral study at American institutions directly after receiving their undergraduate degrees may enter at some later date. The sum of American students who are direct and delayed entrants and foreign students who both want to pursue doctoral study in U.S. universities and who are admitted determine the flow of students into doctoral programs in American universities.

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

Students who receive doctorates from American universities face a number of options. Some move directly into U.S. academic positions. Others, especially in the sciences, accept postdoctoral research positions in the academic or nonacademic sectors in which they receive additional research experience for one or two years and then some of these ultimately obtain faculty positions. Other new doctorates accept nonacademic positions in the United States and still others accept foreign employment.

Some of those initially employed in the U.S. nonacademic or foreign (academic or nonacademic) sectors may at a later date find employment in the U.S. academic sector. In addition, American colleges and universities may hire directly as faculty members new doctorates produced at foreign universities. Finally, doctorates employed full-time in the nonacademic sector may "moonlight" and also be employed part-time in the academic sector.

Each year approximately 15 percent of full-time assistant professors and 7 to 10 percent of the full-time associate and full professors who are employed in American collges and universities "turnover" and are not employed at the same institution in the next year (Ehrenberg, Kasper, and Rees 1991, Tables 1, 2 and 3). At the assistant professor level, turnover reflects both voluntary movement to other U.S. academic institutions, foreign institutions, or the nonacademic sector and involuntary mobility to these places due to denial of reappointment and/or tenure. At the associate professor level, turnover primarily reflects voluntary mobility. Finally, at the full professor level it reflects voluntary mobility to other positions, retirements, and deaths. Obviously the age distribution of the faculty has a major impact on exits from the academic sector, as younger faculty are more likely to move to a nonacademic employer, while older faculty are more likely to retire or die.

B. *Trends in Academic Labor Supply*

1. *The Production of Doctorates.* During the last two decades substantial changes have occurred in the distribution of college students' majors. For example, during the 1970–71 to 1987–88 period the proportion of students majoring in business almost doubled, rising to nearly one-quarter of all bachelor's degrees granted. The shares of engineering and other professional degrees increased substantially, while the shares of education and arts and science degrees declined substantially. Within the arts and sciences, the humanities and social sciences were hit the hardest, with the former's share declining by over one-third and the latter's share declining by an even

TABLE 2.1
SHARE BY DISCIPLINE OF DOCTORATES AWARDED BY U.S. COLLEGES AND UNIVERSITIES, 1960–88

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

Source: National Research Council 1989a, Tables A and C).

greater amount (U.S. Department of Education 1989, Table 105). Changes in the fields women have chosen to study are an important cause of these changing proportions (Sarah Turner and Bowen 1990).

Some of these trends are reflected in the disciplinary distribution of doctorates awarded by American colleges and universities for the 1960–88 period presented in Table 2.1. Most striking is the one-third drop since the early 1970s in the proportion of doctoral degrees awarded in the humanities, which reflects the important influence that an individual's undergraduate major has on his field of graduate study. The share of doctoral degrees granted in the social sciences has not substantially declined; this apparent divergence from the comparable undergraduate trend may partially reflect that the shift in students from undergraduate social science to business majors probably was a shift of students who were unlikely to choose doctoral study.

The shift in the distribution of degrees awarded is also heavily influenced by the inflow of foreign graduate students into the various fields. Over the last 30 years the share of new doctorates from American universities awarded to U.S. citizens and permanent residents has fallen from about 90 to 80 percent. The decline has been most pronounced in the physical sciences and engineering where foreign students (temporary residents in the U.S.) represented about 30 and 35 percent, respectively, of new doctorates awarded in 1988 (National Research Council 1989, Table C). As will be shown below, foreign students are less likely to remain in the United States once they receive their degrees. Thus, given the total number of new doctorates produced, an increase in the proportion who are foreign may reduce the potential academic labor supply to American colleges and universities.[9]

While the number of doctorates produced in American academic institutions has remained roughly constant, the time it takes for students to complete their degrees has lengthened during the past two decades. Data on median years of time spent enrolled as a doctoral student are reported for the 1968–88 period by

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

TABLE 2.2
MEDIAN YEARS TO DEGREE FOR DOCTORATE RECIPIENTS BY BROAD FIELD, 1968–88

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

Source: National Research Council (1989a, Table 1).

field in Table 2.2. Median *registered time* to degree rose over the period by almost a year and a half from 5.5 to 6.9 years.[10] The increase in registered time to degree was somewhat smaller in the sciences and engineering fields, but considerably larger in other fields, including the humanities, where registered time-to-degree rose by three years from 5.5 to 8.5 years.

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

Data are also presented in Table 2.2 on *total time-to-degree*, the total length

[10] In more recent work, Bowen et al., have shown that part of the reported increase in time-to-degree in the humanities is a statistical artifact caused by the grouping of individuals by year of degree, rather than by year of program entrance, during a period in which the size of entering cohorts was decreasing. See Bowen, Graham Lord, and Sosa 1991.

TABLE 2.3
DOCTORAL COMPLETION RATES AT SELECTED MAJOR RESEARCH UNIVERSITIES

Class Years Entering	A (1975–77)		B (1975–80)		C (1970–82)		D (1974–80)		E (1975–77)		F (1975–77)	
Field	N	%	N	%	N	%	N	%	N	%	N	%
Anthropology	66	43.9	49	43.0	152	39.0	30	33.3	31	51.0	69	55.1
Architecture	24	37.5					28	39.3			25	44.0
Astronomy	15	60.0			65	72.0					10	70.0
Biochem & Mol Bio	68	77.9			134	75.0	59	64.4			60	75.0
Biology							67	73.1	57	63.0		
Business Admin	59	54.2			103	62.0					56	66.1
Chemical Eng	42	83.3			90	53.0	88	85.2			35	60.0
Chemistry	213	83.1	93	87.0	424	68.0	157	75.8	84	60.0	66	74.2
City Reg Plan	21	42.9			141	51.0					34	61.8
Civil Eng	152	55.9			235	57.0	53	73.6			38	57.9
Classics	28	25.0	23	61.0	47	51.0	41	36.6			21	52.4
Comp Lit	66	19.7	21	71.0	50	52.0	61	50.8			14	50.0
Dramatic Art	24	25.0			38	39.0					14	78.6
Economics	97	59.8	66	48.0	247	51.0	41	36.6			21	52.4
Education	230	43.9			385	64.0					707	50.9
Elec Eng & CS	211	50.2	26	46.0	502	55.7	102	89.2			106	53.8
English	109	34.9	94	46.0	211	57.0	102	60.8	82	49.0	90	55.6
French	20	35.0	23	52.0					34	50.0		
Genetics	23	82.6			59	52.0					18	50.0
Geology & Geophy	43	60.5	51	61.0	118	45.0	65	72.3			14	71.4
German	27	33.3	6	17.0	68	37.0	39	48.7			11	36.4
History	105	19.0	54	31.0	153	41.0	111	32.4	61	52.0	88	42.1
Ind. Eng./ Oper. Res.	51	39.2			152	58.0					32	46.9
Linguistics	36	47.2	22	55.0	160	47.0	6	10.00			49	40.8
Mat Sci & Eng	57	66.7			137	64.0					9	44.4
Mathematics	199	46.7	47	72.0	169	54.0	116	77.6			68	50.0
Mechanical Eng.	122	58.2			123	35.0	70	75.7			35	62.9
Music	24	75.0	6	50.0	84	54.0	64	37.5			111	54.1
Nr East Studies	26	23.1					55	45.4			31	45.2
Nuclear Eng	32	50.0			25	68.0					49	73.5
Philosophy	30	43.3	37	49.0	80	46.0	64	40.6	42	40.0	35	28.6
Physics	147	67.3	102	70.0	400	60.0	141	79.4	56	71.0	51	58.9
Physiology	21	71.4			44	59.0			7	86.0	15	66.7
Political Science	92	51.1			210	45.0	110	29.1			74	40.5
Psychology	72	68.1	31	90.0	165	64.0	76	67.1	57	56.0	165	73.3
Romance L&L	6				152	50.0	75	38.7			42	42.9
Slavic L&L	23	21.7	23	52.0	60	32.0					18	33.3
Sociology	70	41.4	63	65.0	135	59.0	63	41.3			72	52.8
Statistics	45	62.2			32	63.0	39	69.2			14	14.3

Univ. A: Completion rate as of May 1988.
Univ. C: Completion rate as of May 1988.
Univ. D: Completion rate after seven years following the first enrollment for each cohort.
Univ. E: Completion rate as of December 1987.
Univ. F: Completion rate as of January 1988.
Source: Unpublished tabulations prepared by the University of California at Berkeley Graduate Division dated May 3, 1989.

of time between an individual's receipt of the bachelor's degree and his receipt of a doctoral degree. Median total time-to-degree has risen by 2.4 years from 8.1 to 10.5 years; again much smaller increases are observed for the sciences and engineering, with larger increases for other fields. Total time-to-degree will be larger than registered time-to-degree if students delay entry to graduate programs, if they start study in one field and then switch to another at a later date, or if they spend some time not enrolled in graduate study after their initial entry. Evidence from the Educational Testing Service on the mean number of years between the time students planning doctoral study first take the Graduate Record Examination (which is required for admission by many institutions) and when they received their bachelor's degrees suggests that college graduates are increasingly delaying entry to doctoral study; on average, test takers waited a year and a half longer in 1987 than they did in 1976 (Educational Testing Service 1988, Table 42 and earlier years' reports).

Completion rates for entrants into doctoral programs vary widely across fields and institutions. Data for a set of selected major research universities for periods during the 1970s and early 1980s appear in Table 2.3. These data suggest that completion rates tend to be higher in the sciences than in the humanities and that in most of these programs lie in the 40 to 70 percent range.[11] Even the very best science graduate students, those who win prestigious National Science Foundation Graduate Fellowships, had completion rates of 80 percent or less during the 1962–1976 period (Lindsey Harmon 1977, Table 1; Joan Snyder 1988). These completion rates should be contrasted with completion rates of over 98 percent in top 20 American law schools, and of over 90 percent in major American medical schools.[12] Doctoral study is considerably riskier than its alternatives.

2. *Initial Post-Degree Experiences of New Doctorates*. Each year when doctoral candidates submit their dissertations to their graduate schools for final approval they are asked to respond to the *Survey of Earned Doctorates* (*SED*) that is administered by the National Research Council. Among the questions asked in the *SED* is whether they have made definite employment plans in the United States and, if so, whether their employment is in the academic or nonacademic sectors.[13] Data on the sectoral distribution of employment for U.S. citizen and permanent resident new doctorates from the *SED* are reported in Table 2.4 for 1968, 1978, and 1988. Quite strikingly, the share of these employed new doctorates finding employment in academia has declined in the aggregate from two-thirds in 1968 to about one-half in 1988. With the exception of health sciences and business and management, the academic share declined in all fields. Indeed, while almost 94 percent of employed new doctorates in the humanities were employed in academia in 1968, by

[11] The rates reported in Table 2.3 may slightly understate the true completion rates because a) some people who were noncompleters as of the survey dates will ultimately complete their degrees, and b) one school (University D) reports only those who completed degrees within seven years of their first enrollment.

[12] The law school data come from Barrons (1986) and are for the mid-1980s. The American Medical Association (1988) reports a net attrition rate of 2.6 percent of 1986–87 enrollments at AMA approved medical schools. Because most medical schools have a four-year curriculum, success rates exceed 90 percent. Finally, while completion rates of MBA programs are not collected, James Schmotter, associate dean at Cornell University's Johnson School of Management, reports that Cornell's MBA completion rate is 98 percent.

[13] It is rare for U.S. citizen doctorates to have definite employment plans outside the United States.

TABLE 2.4

SECTOR OF EMPLOYMENT OF U.S. CITIZEN AND PERMANENT RESIDENT DOCTORATE RECIPIENTS WITH EMPLOYMENT COMMITMENTS IN THE UNITED STATES, 1968, 1978, AND 1988 (PERCENTAGE DISTRIBUTION)

	Academe			Industry			Government			Other		
Field of Doctorate	1968	1978	1988	1968	1978	1988	1968	1978	1988	1968	1978	1988
Total All Fields	66.6	56.4	49.8	14.8	15.3	20.4	7.4	12.5	10.8	11.2	15.9	19.1
Physical Sciences	50.1	37.9	36.2	34.6	45.2	50.0	9.4	14.4	11.8	5.9	2.4	1.9
Physics/Astronomy	52.1	25.9	26.1	25.0	46.9	48.2	16.1	24.1	23.4	6.7	3.1	2.3
Chemistry	29.5	18.4	15.3	58.9	71.4	77.7	4.9	7.7	5.0	6.7	2.5	2.0
Earth, Atmos., Marine	50.7	33.2	39.3	25.9	36.1	30.4	17.8	27.9	29.5	5.6	2.9	0.9
Mathematics	79.9	70.8	75.9	12.6	19.1	19.0	3.7	8.2	2.3	3.9	1.9	2.8
Computer Sciences	NA	58.2	56.6	NA	35.8	32.7	NA	6.0	8.8	NA	0.0	1.8
Engineering	33.3	23.5	28.5	47.0	57.1	55.5	10.6	17.5	15.0	9.1	2.0	0.9
Life Sciences	65.9	59.0	51.9	11.8	20.4	23.7	14.0	16.3	16.8	8.4	4.3	7.6
Biological Sciences	68.0	60.9	47.7	9.0	17.7	27.1	13.0	16.4	18.0	9.9	5.0	7.2
Health Sciences	56.8	62.9	63.1	23.7	17.2	13.8	6.8	14.5	12.5	12.7	5.5	10.6
Agric. Sciences	62.2	53.7	44.3	16.1	26.7	30.8	19.3	17.3	20.4	2.4	2.4	4.4
Soc. Sci.	75.3	58.5	45.1	4.8	9.6	19.4	10.6	16.0	14.2	9.2	16.0	21.3
Psychology	61.0	40.0	29.6	6.5	12.4	24.6	17.0	20.7	16.5	15.6	26.9	29.3
Other Social Sci.	85.1	76.2	66.2	3.7	6.9	12.3	6.3	11.4	11.1	4.9	5.5	10.4
Humanities	93.9	82.6	79.3	6.0	4.9	5.8	1.4	3.8	3.7	4.3	8.7	11.2
Education	68.1	51.9	43.8	1.0	3.4	7.3	3.9	12.5	9.0	26.9	32.2	39.8
Professional/Other	80.9	74.1	73.8	8.9	7.0	8.2	3.9	7.2	6.4	6.3	11.8	11.6
Bus & Mgmnt	84.6	87.0	90.0	9.1	7.9	7.0	1.9	4.3	2.6	4.4	0.8	0.4
Communications	88.9	83.9	81.9	8.3	9.3	8.1	0.0	4.1	2.0	2.8	2.6	8.1

Source: National Research Council (1989a, Table R). The "Other" sector includes elementary/secondary schools, nonprofit institutions, self-employment, and other employers.

1988 slightly less than 80 percent were initially so employed.[14]

Table 2.4 may present a misleading picture of the proportion of new doctorates that are directly entering academic careers because it focuses on those new doctorates who have accepted employment and ignores the increasing share of new doctorates accepting one or two year postdoctoral appointments (postdocs). These positions, found in universities, government, and the private sector, offer doctorates additional opportunities to develop their research skills before moving on to more permanent employment.

Data on the share of new doctorates planning to take up postdocs and academic employment are also published (National Science Foundation 1989b, Table 15). During the 1970 to 1988 period, the share of new science/engineering U.S. citizen doctorates with definite plans who were starting postdocs rose from .22 to .39, which was almost equal to the decline from .44 to .24 in the share accepting academic employment.[15] The trends for permanent residents were similar. In contrast, in the nonscience/nonengineering fields very few students accept postdocs and the small increase that occurred over the last 20 years cannot "explain" the large decline in the share of new doctorates with definite plans accepting academic employment in these fields.[16]

Data are also reported on temporary resident (foreign) new doctorates who reported having definite plans in the United States. Although temporary resident new doctorates with definite plans are less likely to remain in the United States than U.S. citizen and permanent resident new doctorates, the share of the former doing so has increased from .42 to .55 in the total sciences/engineering fields and .22 to .30 in the nonscience/nonengineering areas over the 1970–88 period. Of those who do stay, a greater proportion obtain postdocs than do citi-

[14] Of crucial concern for public policy is whether the declining academic share of employed new doctorates is due to an increasing demand and higher relative salaries for new doctorates in the nonacademic sector, and/or simply due to a scarcity of job openings in the academic sector during the period. While the answer may well vary across fields, if the former is responsible it will be necessary to increase academic salaries relative to nonacademic salaries to attract a greater share of new doctorates into academia. If the latter is true, an expansion of academic job opportunities in itself (without any increase in academic salaries) may lead a greater share of new doctorates to enter academic life and may also induce some doctorates currently employed in the nonacademic sector to enter or reenter academia. See Ehrenberg 1991, ch. 8 for a discussion of these issues.

[15] The social sciences and psychology are included as sciences in these computations. There are variations in behavior within more narrowly defined science/engineering fields. In some of the fields the increase in the share accepting postdocs between 1970 and 1988 was approximately equal to, or greater than, the decrease in the share accepting academic employment (physical sciences, earth and material sciences, life sciences, mathematical sciences, engineering). In other fields, such as the social and psychological sciences, the decline in the share accepting academic employment far exceeded the increase in the postdoc share.

[16] These trends suggest a number of policy issues. Is the increasing share of postdocs in most fields caused by a deepening of knowledge and hence a longer training period required before faculty appointments can be obtained? Or does it represent a response to a relatively loose academic labor market and attempts by doctorates to enhance their attractiveness in the search for permanent academic positions by accepting these lower-paying training positions. Are differences in the growth of postdocs across fields at least partially caused by differences in the strength of the nonacademic labor market across fields? Do postdocs eventually wind up in academic positions so that the net effect on academic labor supply is simply to lengthen the pipeline? Is the increasing "need" for a postdoc partially responsible for the decline in the share of college graduates seeking doctorates? If the increased use of postdocs is a result of a "loose" academic labor market, would a "tight" market lead to an increase in the number of new doctorates directly accepting academic employment? If this occurs, would the decline in the probability that a postdoc is required for academic employment make doctorate study more attractive and increase the flow of college graduates into doctorate programs? Again, see Ehrenberg 1991 for a discussion of these issues.

zen or permanent resident degree holders. Moreover, the share of temporary resident doctorates who find academic appointments was actually as high in 1988 in the total science/engineering area and greater in the nonscience/nonengineering area than the comparable shares of U.S. citizen new doctorates who found academic employment. In part, this reflects that temporary resident doctorates may have difficulty obtaining visas to work in the U.S. nonacademic sector.[17]

What do postdocs actually do upon completion of their appointments? In the aggregate 63.6 percent of U.S. citizen and permanent resident (CPR) postdocs in 1985 were employed in academia in 1987 and over 50 percent were employed in faculty positions.[18] Both of these percentages exceed the 49.8 percent of all employed CPR new doctorates in 1988 who were employed in academia (Table 2.4). Indeed, contrasting the percentages of 1985 CPR postdocs employed in the academic sector in 1987 in the physical sciences (54.0), life sciences (67.7), and social sciences and engineering (61.7), with the comparable percentages of CPR new doctorates employed in academia in 1988 (Table 2.4), it is clear that in each field CPR postdocs *are* more likely to enter academia than are CPR new doctorates who accept employment immediately upon graduation.

A similar conclusion appears to hold for temporary resident postdocs (Ehrenberg 1991, ch. 7). Temporary resident new doctorates thus contribute to academic labor supply in the U.S., both directly upon receipt of their doctorates and subsequently to postdoc appointments. However, because their immigration status directly affects their ability to remain in the United States, it is likely that their expected length of academic careers here is shorter than that of otherwise comparable CPR new academics.

III. *Decisions to Undertake and Complete Doctoral Study*

A. *Introduction*

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

B. *The Decision to Undertake and Complete Doctoral Study*

The decision to undertake and complete doctoral study is a special case of the theory of occupational choice. Individuals are assumed to evaluate the expected pecuniary and nonpecuniary ben-

[17] Whether an expansion of temporary resident academic employment in the U.S. is possible, or desirable, and the likely effects of recent changes in immigration law, are discussed in Ehrenberg 1991, ch. 10.

[18] Every two years the National Research Council Office of Scientific and Engineering Personnel conducts a national probability survey of all doctorates residing in the United States. The *Survey of Doctoral Recipients* (*SDR*) is longitudinal in design and one can track individuals' changes in status over two-year periods if they respond to the survey in two consecutive periods. These estimates come from special tabulations from the *SDR* reported in Ehrenberg 1991, Table 7.7.

efits 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, the individual's choice of undergraduate major will depend, at least partially, on a comparison of the expected labor market returns consequent upon various majors. Other things 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 upon 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 foregone earnings) of such study.

Second, given an individual's interest, aptitude, family background, and undergraduate major, the decision to enter and complete doctoral study in a field depends upon a number of factors. The expected current and future streams of pecuniary and nonpecuniary benefits from entering the workforce directly, or from pursuing graduate study in the field, in other fields, or 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 foregone earnings) it takes to complete each. Other things equal, higher benefits (higher earnings, better working conditions) and lower costs (lower tuition, more generous aid policies, higher completion rates, and shorter time-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 undergraduate study may discourage the pursuit of 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 the field. Finally, to say decisions are influenced by expected current and future pecuniary benefits does not provide any insight about 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 to 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 upon starting salaries received by graduates in the field (Richard J. Cebula and Jerry Lopes 1982; J. Fiorito and R. C. Dauffenback 1982). Another 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 upon the individual's expected present value of earnings (over the first twelve years of a career) in each field but *not* on his expected starting salary (Mark Berger 1988).[19] 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.

Studies of individuals' decisions to enter and complete doctoral study are surprisingly few and all follow in the tradition of Richard Freeman (1971). Table 3.1 summarizes the results of these studies, as well as two related studies for MBA's 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 a number of variables. That is, they report what the effects are, in percentage terms, on the outcome of a one percent increase in each of the nine variables. A "dot" in a column indicates that the variable was not included in the analyses done 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 doctorate study.[20] It is remarkable that each study took account of three or fewer of the hypothesized important factors and no study included earnings opportunities and financial aid in closely allied doctoral fields, or students' debt levels upon 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 doctorates' earnings in the field matter. Some find doctoral supply very sensitive to earnings in the field, while others find elasticities of less than unity. Similarly, while most studies agree that higher earnings in other professions reduces doctoral labor supply, 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 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 ten percent increase in graduate student stipend levels, other things equal, would probably result in a 2 to 3 percent increase in the number of new doctorates. Finally, only one study has included average time-to-degree as an explanatory variable and, while it finds that longer time-to-degree tends to reduce doctoral supply, it was based on only twelve observations and the estimated effect was insignificantly different from zero.

In general, these studies are of little use for policy simulations. While both doctorates' relative earnings and financial support for graduate students clearly influence doctoral supply, our knowledge of the magnitude of these responses is

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

[20] Omitted from the table for brevity, are undergraduate loan burdens, the probability of obtaining academic jobs, and doctorate and other programs, completion rates. None of the cited studies considers these variables.

too imprecise to be useful.[21] Furthermore, the studies summarized in Table 3.1 are based on analyses of science or social science fields. The responses of potential humanities doctorates to economic variables may be different from those of potential scientists and social scientists.

C. *Underlying Trends*

1. *Choice of Major.* Data on average starting salaries of college graduates, by major, for the 1973–88 period, appear in Table 3.2.[22] Given the major swings in the distribution of majors across fields during the 1970s and 1980s, 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 their relative starting salaries. Similarly, the dramatic growth in business majors was apparently not associated with a rise in their relative starting salaries. While the starting salary in education fell substantially relative to engineering during the 1974–82 period, it has risen back to its initial level since then. The share of education majors, which fell through the mid-80s, has in fact increased slightly in more recent years (U.S. Department of Education 1989, Table 105).

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 might then 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 influences choice of major (Berger 1988). If the steepness of age/earnings profiles has increased for majors in fields such as business and engineering, and/or declined for majors in fields such as the humanities or 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 does not represent 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 was over 10 percent higher than it was in 1971–72 (Table 1.4). 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 (American Council on Education 1989, Table 11, Table 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 col-

[21] Whether variation in these estimates of the effects of a given variable are due to differences in responses across fields, differences in responses across time periods, or differences in model specifications, cannot be established without research that replicates existing studies using data from different fields and/or different time periods and research that uses different models to reanalyze the data used in the prior studies.

[22] 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 masters 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.

TABLE 3.1

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 (71)	1959–64	52 Fields (changes across fields)	New Ph.D.'s	.	.	.	.	.18*	.23**	.	.	.
Sloan (71)	1934–66	Medical Schools	Applicants	.	.	(a)	(b)	.	.	.	.	(h)
Freeman (75)	1956–72	Physics	New Ph.D.'s	.	.	.82*	−.42	.	.	.	.	.
			Entrants Grad School	.	.	.87	−1.04*					
Scott (79)	1965–74	Economics	New Ph.D.'s	.	.	1.25*(c)	.	.	.	.	.	.
	1961–74		Entrants Grad School	.	.	.	.	.16*	.	.	.	.
Kuh & Radner (80)	1967–76	Mathematics	New Ph.D.'s	.	.	.44	−1.67*	.	.	.	.	.
Hoffman & Low (83)	1962–76	Economics	Entrants Grad School	.	.	2.6*(d),4.8*	−1.2*(d),−4.0*(e)	.	.	.	.	.
Alexander & Frey (84)	13 years	MBAs	Ratio MBA's/Pool Potential Applicants	.	.	1.44*(f)	.	.	.	.	.	−.48
Huffman & Orazem (85)	1962–82	Agricultural Economics	New Ph.D.'s	.	.	3.0*	−2.80*	.	.33*(g)	.	.	.
			Entrants Grad School	.	.	.43	−.70	.	.57*(g)	.	.	.

Baker (89)	1975–87	Biomedical Sci.	Entrants Grad School	.	.	.59**	.	1.36*	.	.	−.50	.
Stapleton (89)	1961–85	Economics	New Ph.D.'s	.	.	.91*	.64	.	.	.	.	.

(1) current earnings opportunities if don't 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
(9) tuition
*(**) statistically significantly different from zero at the .05 (.10) level, two-tailed test.
Source: Author's interpretations of the original studies.
Notes: a Computation of elasticity not possible.
b Computation of elasticity not possible.
c Elasticity with respect to ratio of starting salary to median professional salary.
d Rational expectations model estimate.
e "Naive" expectations model estimate.
f Elasticity with respect to ratio of MBAs' salaries to undergraduates' salaries.
g Elasticity with respect to TA/RA salaries.
h A dollar increase in the direct cost of medical school (tuition-stipends) generates 6–14 applicants.

TABLE 3.2

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)	—
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)	—
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)	—
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)	—
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)	—
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)	—
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)	—
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)

Source: Corkhill (1986) and College Placement Council, *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 (1988, Table III–2).

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

leges' increased propensity to enroll more marginal students. To the extent that the increased college enrollments thus comes from lower "quality" and/or older students, these students' interests are likely to be more pragmatic in nature, which may help explain the shift in majors towards 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 changes in values and attitudes, which have led to a widened range of career alternatives for women.

2. *Doctoral and Professional Degrees*. Table 1.4 illustrated the dramatic growth in the ratio of first professional to doctoral and masters to doctoral degrees that occurred during the 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 3.3. which contains for the 1970–88 period starting salary information for new assistant professors in mathematics, (col. 1), physics (col. 2), and economics (col. 3), as well as MBA's (col. 4), new lawyers in nonpatent law firms (col. 5), and new graduates with masters degrees in engineering (col. 6). Presumably individuals contemplating doctoral study in economics might also consider getting MBA or law degrees, while those people considering doctoral training in mathematics and physics might also consider professional engineering degrees. As such, my focus is on comparisons of new academics' salaries to salaries in the professions that these academics may have alternatively chosen to study for and enter.

The ratios of average starting salaries of assistant professors in economics to average starting salaries of MBA's and lawyers, respectively, are found in parentheses in columns (4) and (5). These data do *not* suggest that the average starting assistant professor salary in economics declined relative to those of MBA's or lawyers during the period. Column (6) presents the ratio of starting mathematics assistant professors' salaries to starting masters of engineering graduates' salaries and here there is some evidence of a decline during the 1970s. Between 1972 and 1982 the ratio declined from .93 to .73, a substantial drop; however since 1982 it has risen back to near its initial level. The ratio of new assistant professors of physics to new masters of engineering graduates' salaries is omitted from the table for brevity; 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 1.3 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 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.[23] While the ratio of full professor to assistant professor salaries in the aggregate has remained roughly constant during the 1970s and 1980s (Daniel Ham-

[23] See, for example, the annual salary survey in the November issue of *Student Lawyer* each year.

TABLE 3.3

AVERAGE STARTING SALARIES FOR PH.D. ECONOMISTS, MATHEMATICIANS, AND PHYSICISTS, MBA'S, LAWYERS, AND MASTER DEGREE IN ENGINEERING GRADUATES

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

(1) Median 9 month academic salary for new assistant professors in mathematics departments.
(2) Median monthly academic salary for new physics assistant professors employed in universities multiplied by 12.
(3) Average 9 month salary for new assistant professors in economics.
(4) Average starting salary for new MBAs with nontechnical undergraduate degrees.
(5) Average starting salary across 8 cities (unweighted) of lawyers entering nonpatent law firms.
(6) Average starting salary of graduates with masters degrees in engineering (average across subfields).
Sources: Corkhill (1986), and *CPC Salary Survey* (various issues—(4) and (6); ***Students Lawyer's*** "Annual Salary Survey" (various issues)—(5); American Institute of Physics (various issues)—(2); American Economic Association, *Annual Salary Survey* (data prior to 1985 provided by Professor David Stapleton at Dartmouth)—(3); *Notices of the American Mathetical Society* (various issues)—(1).
Note: All salaries are in current dollars.

ermesh 1988), the return to seniority in the professions may have increased during the period and this would make the professions more attractive relative to doctoral study. In fact, some evidence exists that this did occur between 1982 and 1989 for lawyers.[24]

[24] 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.

Second, the average salary data in professional fields may give a misleading impression of the earnings opportunities that individuals contemplating doctoral study could earn 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

TABLE 3.4
PERCENTAGE OF FULL-TIME SCIENCE/ENGINEERING GRADUATE STUDENTS IN DOCTORATE GRANTING INSTITUTIONS BY MAJOR SOURCE OF SUPPORT

Year	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

Source: Author's computations from National Science Foundation (1990, Table C15), and National Science Foundation (1983, Table C14).

their alternatives.[25] Although "hard" data on this point are not readily available, the dispersion of earnings between graduates of top and lesser professional programs may have widened over time and thus the professional schools may well have become even more attractive relative to doctoral study, even though the comparisons of average starting salaries presented above do not indicate this.

3. *Financial Support for Graduate Students and Undergraduate Loan Burdens.* The lengthening of median years of registered time to degree (Table 2.2) and the increased proportion of science/engineering graduate students taking postdoc appointments have surely discouraged potential students from undertaking doctoral study. Even if direct costs of doctoral study and the postdocs were financed fully, first through fellowships and assistantships, and then through postdoc stipends, a longer period before assuming regular employment implies increased costs in terms of foregone earnings. Hence, even if the earnings of new doctorates relative to professional degree holders had not changed, the lengthening "training period" for new doctorates should reduce doctoral enrollments. However, the magnitude of the response is in question and, unfortunately, as described above, the econometric literature provides little guidance on this point.

Have the direct costs of doctoral study been fully subsidized? Table 3.4 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 nonuniversity related employment, loans, and support from other family members) was about the same in 1974, the first year the data were available, as it was in the last year, 1988. The composition of support changed, however, with proportionately fewer students receiving 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 subsidized to the same degree in 1988 as they were in 1974.[26]

[25] Some evidence to support this conjecture is found in Rodney Hartnett 1987, Table 4. He 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 his sample of professional school graduates in 1981 were *each* 30 points *lower* than the comparable median scores for doctoral recipients in 1981.

[26] National data on average doctoral student stipends are not available. However, data for one university provide some evidence on this point. From 1974–75 to 1987–88 the average graduate student stipend at Cornell rose by 117 percent. During the same period, the average starting salaries of new as-

TABLE 3.5
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
ENVIRON SCIENCE			PSYCHOLOGY		
Fellowship	10.7	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 & 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

Source: Author's computations from National Science Foundation (1990, Table C16) and National Science Foundation (1983, Table C23).

This would be an erroneous conclusion, however, for two reasons. First, as Table 3.5 indicates, the proportion of these full-time students on fellowships declined in all fields, as increasingly students' graduate training was financed either through research or teaching assistantships (depending upon the field). 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.[27]

sistant professors in math, new assistant professors in economics, new MBA's, new lawyers in nonpatent law firms, and new graduates with masters degrees in engineering rose by 129, 154, 160, 151 and 174 percent, respectively (Table 3.3). 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.

[27] 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.

Second, these data refer only to full-time students. However, in the aggregate, the percentage of science/engineering graduate students enrolled on a part-time basis rose from 26.3 to 31.5 percent during the period (National Science Foundation 1990, Tables C2 and C5; National Science Foundation 1983, Tables C6 and C41). 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. By lengthening the average time needed to complete degrees, this contributes to reduced doctoral enrollments.

Of course, not only has median registered time-to-degree increased substantially over the last twenty years, but the median length of time between an individual's receipt of a bachelor's degree and his doctorate has increased by an even greater amount (Table 2.2). In part this reflects individuals' increasingly delaying their initial entry into doctoral programs. Other things equal, the later the age at which new doctorates start their careers, the fewer the number the years that they will have to reap the "return" on their investments, and thus the smaller the incentive potential students have to undertake doctoral study.[28]

What role may have loan burdens from undergraduate school 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 percent in 1970–71 to 16.9 percent in 1975–76, but then rapidly grew to 48.0 percent in 1982–83 and have remained in that range ever since (Donald Gillespie and Nancy Carlson 1983, Table 6 and *Trends in Student Aid: 1980–1990*, 1990, Table 4). 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 upon graduation. While the number with debts has increased, average levels of debt have remained roughly constant in recent years in nominal terms, and declined somewhat in real terms (*Trends in Student Aid*, 1990, Table 5; Janet Hansen 1987).[29]

Evidence on the effects of debt upon graduation from college on career choice and the decision to undertake doctoral study is impressionistic and/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 did not go on to graduate school said that concern over borrow-

[28] 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 July 1, 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.

[29] Partially this reflects that throughout the period the GSL annual loan 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 referred to do not permit one 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.

ing was "very or extremely important" in preventing them from going to graduate school (Sandy Baum and Saul Schwartz 1988). Other studies reported that individuals with high undergraduate debt burdens are more likely to choose careers and/or undergraduate majors that promise high earnings opportunities (American Council on Education 1985; Kathryn Mohrman 1987). It is unclear from these latter studies, however, which way the 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, find no evidence that debt levels affect postgraduate plans (Janet Hansen 1987).

The econometric study by Morton Shapiro, Michael O'Malley, and Larry Litten (1991) 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 upon his having a high debt level upon graduation, after holding constant other individual and family characteristics. This study arbitrarily defined cutoff points for having high and low debt (e.g., \$12,500 or higher in 1989) and included in the "not enroll in graduate school" group were all students who planned to enroll in professional programs (e.g., law, medicine, business). 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 remains a question. Of course, growing debt burdens may have differential impacts on minority students from low-income families; this point is discussed in the next section.

D. *Time-to-Degree*

David Breneman (1976) developed an economic model of the doctoral production process to explain why (a) registered time-to-degree, (b) the attrition rate, and (c) the timing of attrition, varied widely across doctoral fields at the University of California at 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 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 Breneman emphasized was the desire to maximize faculty members' prestige and the resources flowing to their department. To the extent that faculty members' prestige in the scholarly community depended in the 1950s and 1960s upon 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.[30]

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, a weak student may have a substantially negative impact 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, where 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 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 the timing of attrition, across 28 fields at Berkeley during the 1947–68 period. 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.

Subsequent empirical studies of time-to-degree have been surprisingly few. Two recent ones are James Abedi and Ellen Benkin (1987) and Howard Tuckman, Susan Coyle, and Yupin Bae (1990). The former studied the determinants of time-to-degree for 4,225 doctorates from the University of California at Los Angeles during the 1976–85 period. Unfortunately, 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, for possible sample selection bias (only students who completed doctorates are included in the sample), or for the likelihood that the effect of having an assistantship depends both on the type of assistantship held and the field. While teaching assistantships, which take time away from study, may slow down degree progress vis-à-vis those with fellowships, research assistantships may actually speed up completion if they increase holders' research skills by more than fellowship holders can achieve on their own, or if research assistant activities are on, or directly related to, an individual's dissertation topic.

The latter estimated median time-to-degree equations for each of eleven fields using national data for a 20 year period. Small sample sizes in the aggregate data, coupled with high multicollinearity among explanatory variables, prevented it from obtaining precise estimates of the effects of changing graduate support patterns and labor market conditions.

Future econometric analyses of the determinants of time-to-degree surely must use individual data, be institutionally-based, separate 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 time-to-degrees, it is interesting to contrast the data for the 1974–88 period on changes in time-to-degree by

[30] 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 2.4), 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, on average are of lower "quality" than their counterparts taking jobs in the academic sector. Analyses of new doctorates' sectors of employment are presented in Ehrenberg (1991, ch. 8).

field (Table 2.2) 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 (Table 3.5), and of science/engineering graduate students enrolled part-time.[31]

Between 1974 and 1988, median registered time-to-degree rose by .5 years or less for both the physical sciences and engineering (Table 2.2). 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 assistants actually declined by almost 7 percentage points in the physical sciences (Table 3.5). In both fields, the percentage of students that were part time also declined during the period.

In contrast, between 1974 and 1988, median registered time-to-degree rose by 1.7 years in the social sciences (which in Table 2.2 includes psychology). The substantial decline in the shares of full-time students in psychology and the social sciences whose major source of support were fellowships was accompanied by increases in the shares of those with teaching assistants and self-support (Table 3.5) and increases in the share of all doctoral students in the field enrolled part time.

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 assistant support 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 fellowship and research assistant support would be on median time-to-degree and what the direct effects of increased support and reduce time-to-degree would be on students' decisions to enter and complete doctoral study, it would not necessarily follow that increased governmental, corporate, or foundation support for doctoral students would be an effective way of expanding doctoral production.[32] Often absent from the policy debate has been any concern for the possibility that increased support from external sources 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 science/engineering graduate students to use the funds saved either to support graduate students in other disciplines or for other purposes (non-graduate student expenditures or tuition increase reductions). Conversely, cutbacks in federal support may lead institutions to offset partially the cutbacks by increasing their own expenditures. Indeed, as Table 3.4 indicates, the fall between 1974 and 1988 in the percentage of full-time science/engineering graduate students supported by federal funds was

[31] Unfortunately, data on the types of financial support received by doctoral students in the humanities are not reported.

[32] The discussion above, and that follows, stresses the role of financial support for graduate students on individuals' decisions to enter graduate study, on completion rates, and on times-to-degree. There are a host of other "noneconomic policies" that institutions and departments can pursue that will influence these outcomes (e.g., better faculty advising). See Association of Graduate Schools 1990 for a extensive discussion of such policies.

accompanied by an increase 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 external 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 from policy makers' intentions.[33] To analyze fully the effects of an increase in federal, or other external, support for doctoral students thus requires an analysis of the extent to which external funds displace institutional funds. Only one forthcoming study has addressed this issue (Ehrenberg, Rees, and Brewer). Analyses that ignore potential displacement effects will probably overstate the effects of increased federal support.

IV. *The Demographic Distribution of New American Doctorates*

A. *Female Doctorates*

As Table 4.1 indicates, between 1973 and 1988 the share of new doctorates awarded by U.S. universities to women rose in the aggregate from .18 to .35. This almost doubling in the aggregate female share was accompanied by substantial increases in the female shares in all fields. These increases, however, did not eliminate female underrepresentation in many fields.

The rapid growth in the female share of new doctorates might lead one to conclude that the proportion of female college graduates who complete doctoral study has increased substantially since the early 1970s. In fact, this has *not* been the case. Table 4.2 contains information on the number of doctoral degrees awarded to women relative to the number of bachelor's degrees awarded to women six years earlier. This ratio hovered around .025 during the entire 1971–72 to 1987–88 period and .025 is considerably smaller than the comparable ratio of .036 reported in Table 1.4 in recent years for all college graduates (regardless of gender). Expressed differently, as of 1988 the probability that a female college graduate will receive a doctorate was only about two-thirds the comparable probability for males.

The increase in the female share of doctorates that has occurred was caused by two factors. First, the share of bachelor's degrees received by women increased from .424 in 1971–72 to .503 in 1987–88 (Table 4.2, column 2); more female college graduates means more potential female applicants for doctoral study. Second, the absolute number of doctorates awarded to males fell from over 28,000 to about 22,000 during the period (U.S. Department of Education 1989, Table 200). To a large extent, recent increases in the share of female doctorates reflect a substantial decrease in the likelihood that male college graduates enter and complete doctoral study, not an increased likelihood for female college graduates.

Women are increasingly likely, however, to go on to other forms of postgraduate study and, in particular, to professional degree programs. In 1971–72 approximately half as many women received first-professional degrees, as did

[33] The issue being raised here is very similar to one confronted by policy makers 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. See Ehrenberg and Joshua Schwarz 1986 for a review of this literature.

TABLE 4.1

SHARE OF NEW DOCTORATES AWARDED BY U.S. UNIVERSITIES TO WOMEN

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

Source: National Research Council (1989a, Table E).

TABLE 4.2
DEGREES AWARDED TO FEMALES BY U.S. INSTITUTIONS OF HIGHER EDUCATION

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

(1) ratio of doctorate degrees awarded to women to bachelor's degrees awarded to women six years earlier
(2) share of bachelor's degrees awarded to women
(3) first professional degrees awarded to women as a proportion of doctoral degrees awarded to women
Source: Author's calculations from data in U.S. Department of Education (1989, Table 200).

doctoral degrees (Table 4.2, column 3). With the opening of the professions to women, female enrollments in medicine, law, and other professional degree programs soared and each year since 1982–83, the number of female new first-professional degrees has been more than twice the number of female new doctoral degrees. While the ratio of new first-professional to doctoral degrees increased somewhat for the population at large during the 1971–72 to 1986–87 period (Table 1.4, column 6), the increase in the ratio was more pronounced for females.

One can only speculate about the factors that have induced female college graduates to "flood" into professional rather than doctoral programs. It may reflect the opening up of career opportunities for women in the professions. It may reflect that the lengthening of time-to-degree, particularly in the nonscience/nonengineering doctoral fields (Table 2.2), has a greater effect on female than male decisions because longer times-to-degree, require some women to contemplate postponing childbirth or undertaking doctoral study while they are parents of young children. For similar reasons, the growing need to accept postdoc positions in the physical sciences, which further postpones entry into a permanent academic position, may discourage women from entering doctoral study in the physical sciences. If the latter two hypotheses are correct and if projected tightening academic labor markets reduce both time-to-degree and the need for postdocs (as hypothesized in Section III), one might expect these forces to make doctoral study, both in the aggregate and in the physical sciences, more attractive to women in the future.

The nature of academic careers may also influence the types of institutions in which new female doctorates work. "Up or out" tenure decisions are made during the sixth or seventh years of an individual's initial tenure-track appointment and, especially in doctoral institutions, substantial efforts are required to begin research programs and bring them to fruition. These demands often come at a time when family formation decisions have been postponed by young female doctorates and/or young children are already present in their households. As a result, new female academics may feel pressured to "choose" between their families and their careers.[34]

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

TABLE 4.3
PROPORTION OF FEMALE FACULTY[a] BY RANK, INSTITUTIONAL CATEGORY, AND AFFILIATION IN 1989–90

Affiliation	All Four-Year Institutions	Public	Private/ Independent	Church-Related
Professors				
Doctoral Level	.09	.09	.08	.17
Comprehensive	.15	.15	.15	.11
General Baccalaureate	.16	.15	.18	.16
Associate Professor				
Doctoral Level	.23	.22	.24	.29
Comprehensive	.26	.26	.25	.30
General Baccalaureate	.30	.31	.33	.30
Assistant Professors				
Doctoral Level	.35	.36	.30	.40
Comprehensive	.40	.41	.42	.40
General Baccalaureate	.43	.40	.44	.46

Source: Author's calculations from American Association of University Professors (1990, Table 16).

It is not surprising, then, that women constitute a greater share of the full-time assistant professors at undergraduate institutions than at doctoral institutions (Table 4.3). In addition, female new doctorates are much more likely to be employed part-time and on nontenure track positions than are male new doctorates (Julia A. Heath and H. P. Tuckman 1989). While some might argue that such patterns reflect discrimination against female new doctorates, especially by research universities, a recent survey of new job market applicants from top economics doctoral programs concluded that females rated employment in a liberal arts college as being preferable to employment in a top-tier graduate department, while males ranked the two choices in reverse order (Debra Barbezat forthcoming). Of course, whether these preferences are shaped by discriminatory practices is at issue. The survey also concluded that a higher proportion of females expected to work part time during part of their careers and/or to temporarily withdraw from the labor force. Females stressed maternity leaves and family responsibilities as the reasons for these actions.

Even if the tendencies of female faculty to be employed disproportionately at undergraduate institutions and/or in nontenure track positions were the result of voluntary choice, these decisions have implications for the attractiveness of academic careers and hence doctoral study for women. It is difficult to move from primarily undergraduate to more research oriented institutions (Ted Youn and Daniel Zelterman 1988). As a result the female share of associate and full professors at doctoral institutions tends to be less than the comparable share at comprehensive institutions, and this share in turn is less than the comparable share at general baccalaureate institutions (Table 4.3). Salaries, especially at the senior levels, tend to be higher at doctoral than at comprehensive institutions, and at the latter than at baccalaureate institutions (Table 1.2). Hence, on average, female full-time faculty are disproportionately found in lower-paying institutions and thus can expect to have lower career earnings than male full-time faculty. Also part-time non-tenure track academic positions rarely lead to tenure-track positions, tend to receive smaller salary increases than full-time positions, and provide fewer opportunities for promotion (Tuckman and Karen Pickerill 1988).

Clearly policies that would make higher-paying research oriented universities more attractive to women would increase the appeal of academic careers and doctoral study to women. Provision for "tenure clocks" to be slowed or temporarily stopped for a year when children are born or adopted, as some institutions are beginning to experiment with, may prove useful, as would provision of reduced teaching loads for new assistant professors, which many economics departments and business schools are now doing (Ernst Stromsdorfer 1989). Of course, to increase the flow of women into science and engineering doctoral study requires policies to increase precollege mathematics and science training for women, to increase the flow of women into undergraduate science and engineering majors, to provide women with incentives and encouragement to enter and complete doctoral study, and then to facilitate the start of their research careers (National Science Foundations 1988d, 1989c).

B. *Minorities*

Table 4.4. presents data on the race and ethnicity of U.S. citizen and permanent resident new doctorates during the 1978–88 period. While there have been increases in both the absolute number and share of new doctorates awarded to native Americans, Asians, and Hispanics, the number and share of new doctorates awarded to blacks declined over the period. Indeed, in 1988 only 3.8 percent of new doctorates were awarded to blacks, even though they comprise over 13 percent of the 18 to 24 year old population in the United States. Similarly, although Hispanic doctoral production has been increasing, in 1988 only 2.8 percent of new doctorates were awarded to Hispanics, even though they constitute over 10 percent of the 18 to 24 year old population in the United States (Debra Carter and Reginald Wilson 1989, Table 1).

In fact, these data do not fully convey the extent of underrepresentation in many fields of blacks and Hispanics in the new doctoral population. Table 4.5 presents data on the field distribution of U.S. citizen doctorates in 1988 by race and ethnicity. Quite strikingly, 46 percent of new black doctorates were in the field of education. As a result, while blacks earned 3.5 percent of the American citizen doctorates awarded in 1988, they received only 1.0 percent of those awarded in the physical sciences, 1.1 percent in engineering, 1.6 percent in the life sciences, and 2.8 percent in the humanities. The small absolute number of black and other underrepresented minority doctorates produced in most fields should make clear the difficult task American institutions of higher education face in trying to achieve increased minority representation on their faculties.

Given current levels of production of minority doctorates, an institution can succeed in improving its minority representation primarily by inducing minority faculty from other institutions to move to it (Carolyn Mooney 1989). One would suspect that the net result of this competition will be to redistribute minority faculty towards higher paying doctoral-granting institutions (Table 1.2), which will benefit minority faculty economically in the short run. This may also help to increase the flow of future minority doctorates in the longer run, *if* the higher-paying doctoral institutions are the most efficient producers of minority doctorates and *if* the presence of minority faculty serves to aid in the attraction and retention of minority graduate students.[35]

Understanding why minority doctoral

[35] An unresolved issue is what the impact of such competition will be on the historically black colleges and universities in the United States. In 1987, 97 of these institutions granted 20,291 bachelor's degrees, 4,064 master's degrees, 194 doctoral degrees, and 853 first-professional degrees. Assuming that these degrees were all awarded to blacks, they represent, respectively, 35.8, 29.7, 25.2, and 24.9 percent of the degrees awarded to black Americans (Carter and Wilson 1989, Tables 4, 5, 6, 7, and 12). These institutions tend to be relatively low paying ones and if they are weakened, by losing some of their better faculty to other institutions, this may have an adverse effect on black doctoral production.

TABLE 4.4

DOCTORATES RECEIVED BY U.S. CITIZENS AND PERMANENT RESIDENTS BY RACE AND ETHNICITY
NUMBER (SHARE OF THE TOTAL)

Year	Total	Native Americans	Asian	Black	Hispanic	White	Unknown Race/Ethnicity
1978	26,635	60 (.002)	1032 (.039)	1106 (.041)	538 (.020)	22,342 (.839)	1557 (.058)
1979	26,784	81 (.003)	1102 (.042)	1114 (.042)	539 (.020)	22,396 (.836)	1552 (.058)
1980	26,512	75 (.003)	1102 (.042)	1106 (.042)	485 (.018)	22,461 (.847)	1283 (.048)
1981	26,342	85 (.003)	1073 (.041)	1110 (.042)	526 (.020)	22,470 (.853)	1078 (.041)
1982	25,616	77 (.003)	1044 (.041)	1143 (.045)	614 (.024)	22,140 (.864)	638 (.025)
1983	25,633	82 (.003)	1043 (.041)	1005 (.039)	608 (.024)	22,244 (.868)	651 (.025)
1984	25,250	74 (.003)	1019 (.040)	1055 (.042)	607 (.024)	21,863 (.859)	632 (.025)
1985	24,687	95 (.004)	1069 (.043)	1043 (.042)	634 (.026)	21,291 (.862)	555 (.022)
1986	24,513	99 (.004)	1059 (.043)	949 (.039)	679 (.028)	21,222 (.866)	505 (.021)
1987	24,569	115 (.005)	1167 (.047)	906 (.037)	710 (.029)	21,124 (.860)	547 (.022)
1988	24,783	93 (.004)	1233 (.050)	951 (.038)	693 (.028)	21,353 (.862)	460 (.019)

Source: National Research Council (1989a, Table F).

TABLE 4.5

RACE AND ETHNICITY OF U.S. CITIZEN DOCTORATES AWARDED IN 1988[a]

NUMBER (SHARE OF FIELD TOTAL)/(SHARE OF RACE-ETHNIC GROUP TOTAL)

Field	Native Americans	Asians	Blacks	Hispanics	Whites
Total	93(.004/1.00)	612(.027/1.00)	805(.035/1.00)	594(.026/1.00)	20,685(.91/1.00)
Physical Science	11(.004/.118)	111(.035/.181)	32(.010/.039)	69(.022/.116)	2,913(.93/.014)
Physics & Astronomy	1	19	11	13	645
Chemistry	5	47	17	43	1231
Earth, Atmos & Mar Sci	2	8	2	8	476
Mathematics	2	17	1	3	308
Computer science	1	20	1	2	253
Engineering	4(.002/.043)	141(.081/.230)	19(.011/.024)	43(.025/.072)	1,527(.881/.074)
Life Sciences	18(.004/.194)	127(.029/.208)	71(.017/.088)	84(.019/.141)	4,019(.931/.197)
Biological Science	6	100	36	61	2867
Health Science	5	16	25	10	586
Agricultural Science	7	11	10	13	586
Social Sciences	12(.003/.129)	85(.020/.134)	158(.037/.196)	133(.031/.224)	3,864(.909/.187)
Psychology	7	37	96	89	2382
Anthropology	2	3	5	10	234
Economics	0	22	11	8	380
Pol Sci & Int Rel	0	4	7	6	244
Sociology	2	8	14	13	274
Other Social Sci.	1	11	25	7	350
Humanities	7(.003/.075	37(.013/.060)	77(.028/.096)	94(.034/.158)	2,528(.922/.122)
History	1	10	8	13	456
Amer & Eng Lang & Lit	3	11	26	21	845
Foreign Lang & Lit	0	5	3	46	219
Other Humanities	3	11	40	14	1008
Education	35(.007/.376)	82(.016/.134)	370(.071/.460)	152(.029/.256)	4,575(.88/.221)
Teacher Educ	3	8	31	10	323
Teaching Fields	2	10	49	25	690
Other Educ	30	64	290	117	3562
Professional/Other	6(.004/.066)	29(.006/.047)	78(.056/.097)	19(.014/.002)	1,259(.905/.061)
Bus & Management	4	16	16	4	558
Communications	0	1	10	2	171
Other Prof Fields	2	12	52	13	503
Other Fields	0	0	0	0	27

Source: National Research Council (1989a, Table G).

[a] Includes only doctorates whose citizenship and race/ethnic group are known.

production is currently so low, and ascertaining what policies might more directly increase the number of minority doctorates is of utmost importance both for equity reasons and because the share of these groups in the youth population is increasing. Expressed differently, unless we can substantially increase the share of doctorates received by minorities, other things held constant (including academic salaries), the total number of new American doctorates will decline.[36]

[36] Of course, academic salaries should rise in response to a decline in doctorate production and this should lead to a compensating increase in doctorate production. As discussed in Section III, the magnitude of the precise response of doctoral production to salary changes has not been determined.

The factors responsible for the underrepresentation of minority doctorates start early in the educational pipeline. Between 1976 and 1988, high school completion rates rose substantially for blacks, remained roughly constant for whites, and began and ended at roughly the same level for Hispanics during the period. However, the 1988 rate of .823 for whites exceeded the .754 rate for blacks which in turn exceeded the .552 rate for Hispanics (Carter and Wilson 1989, Table 1). The latter implies a 45 percent Hispanic high school dropout rate.

The fraction of students who graduate from high school that ever enroll in a two-year or four-year college also varied over time and across groups. It rose from .535 to .586 during the 1976–88 period for whites, but fell from .504 to .466 for blacks, and from .489 to .472 for Hispanics (Carter and Wilson 1989, Table 1). Not only are blacks and Hispanics less likely to graduate from high school than whites, but if they graduate they are less likely to enroll in college. Nonetheless, because of the growing shares of blacks and Hispanics in the youth population and the increasing black high school graduation rates, blacks and Hispanics represent a growing share of the 18 to 24 year olds who have ever been enrolled in college.

However, enrollment shares do not necessarily translate into degree attainment shares. In recent years both the black and Hispanic shares of bachelor's degrees granted have been less than their enrollment shares (Carter and Wilson 1989, Tables 4 and 5). Moreover, while the Hispanic bachelor's degree share has risen since 1976, the black degree share has actually fallen.

What factors explain the difference between the bachelor's degree attainment and the ever enrolled in college statistics? Blacks enrolled in two-year colleges are less likely to graduate than are white enrollees. If they do graduate, they are less likely to enroll in four-year colleges than are white two-year college graduates. Once enrolled in four-year colleges, they are also less likely to graduate (Clotfelter 1991). Some similar patterns are observed for Hispanic students who are also more likely to be enrolled in two-year colleges than white students (Michael Olivas 1986).

Moreover, upon receiving bachelor's degrees, blacks are less likely to attain subsequent degrees than are whites, Hispanics, Asian-Americans, or native Americans. One way to look at the data is to contrast, as has been done earlier for the entire population (Table 1.4) and for females (Table 4.2), the number of doctorates awarded to a group relative to the number of bachelor's degrees awarded to the group six years earlier. Using 1980–81 bachelor's degree data and 1986–87 doctoral degree data, the ratios for white non-Hispanics, black non-Hispanics, Hispanics, Asian or Pacific Islanders, and native Americans are .030, .017, .034, .056 and .029, respectively. The .017 figure for blacks stands out quite clearly.

The underrepresentation of most minority groups in the pool of new doctorates reflects primarily their underrepresentation among the pool of college graduates; save for blacks, their doctorate/bachelor's ratio is about the same or greater than that of whites.[37] As such, policies to increase the flow of doctorates

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

from most minority groups should probably focus on increasing the flow of college graduates. These include policies to increase high school graduation rates, increase four-year college participation rates for high school graduates, and then increase retention rates of college enrollees. In contrast, black college graduates are less likely to receive doctorates than are graduates from all the other minority groups. Hence, policies designed to increase the flow of blacks into doctoral programs and increase their retention rates in these programs are needed, in addition to policies designed to increase the flow of black college graduates.

Potential policies to increase the flow of low-income black college graduates are discussed in Clotfelter (1991). Here the focus is on factors that may currently limit the flow of black college graduates into doctoral programs. One study of graduating seniors from elite private COFHE institutions found that, after controlling for grades, family income, father's education, and college debt levels, black graduates were in fact as likely to pursue graduate study as white graduates (Shapiro, O'Malley, and Litten 1991). Moreover, neither high debt levels nor low family income levels negatively affected these students' probabilities of attending graduate school and black/white differences in grades and parental education levels were sufficiently small that black and white graduate school attendance probabilities were the same in the raw data as well.

Unfortunately, most black undergraduate students do not attend, or graduate from, elite COFHE institutions. Indeed, full-time black undergraduates enrolled in four-year institutions are much less likely than comparable whites to attend selective four-year colleges and universities (Clotfelter 1991). Graduates of the best research (Research I and Research II) universities and the selective liberal arts (Liberal Arts I) colleges earn a disproportionate share of doctorates. Hence, the distribution of black undergraduates across institutional types has an adverse effect on black students' propensity to attend graduate school.

The distribution of black college graduates by broad category of major is quite similar to the distribution of white college graduates by major, so differences in undergraduate fields of study per se probably do not contribute to black/white differences in the propensity to attend graduate school.[38] In contrast, black students who take the GRE score, on average, more than 100 points lower on both the quantitative and verbal aptitude tests (Educational Testing Service 1988, Tables 59 and 60) than white test takers, and such performance differences may adversely affect their interest and/or opportunity to enter graduate programs.[39]

As noted above, black college students tend to come from lower income families than white college students. While there is no evidence nationally that low family income levels affect the probability of entering graduate school and only mixed evidence that debt burdens do (see Section III), evidence obtained from the U.S. Department of Education's *1987 National Post Secondary Student Aid Study* on racial and ethnic differences in the probability of full-time college students having college loans in 1986–87 suggest that financial variables may adversely affect black graduate school attendance (Ehrenberg 1991, ch. 9).

[38] For example, the shares of bachelors awarded by U.S. institutions in 1986–87 to whites (blacks) were .24 (.26) in business, .09 (.08) in education, .09 (.06) in engineering, .18 (.20) in other professional fields, and .39 (.40) in arts and sciences (U.S. Department of Education 1989, Table 215).

[39] No normative judgment should be drawn from this statement as to whether these differences reflect "cultural bias" in the GRE's or differences in the backgrounds of black and white students that leave the former less prepared to enter and complete doctorate programs.

These data indicate that black dependent students from each family income class are *less* likely to have taken out college loans than students from other race/ethnic groups.[40] Whether this reflects a lower willingness of black families to borrow to finance higher education or a greater concentration of black students in lower priced public institutions, which reduces their need to borrow, cannot be ascertained from these data. Black independent students in each income class are also less likely to have loans than all other independent students in an income class (save for Asians in a few income classes). However, the loan burdens these black students acquire are a higher share of their income than are the loan burdens of any other group. Taken together, these results suggest that a lower williness to borrow for black dependent students and higher loan burdens for black independent students may contribute to the lower probability that black college graduates enroll in graduate school.

The ways black students finance graduate education once they do enter graduate school exacerbate this problem. Special tabulations prepared from the 1988 *Survey of Earned Doctorates* suggest that black doctorates were less likely to have received their degrees from Research I universities than white doctorates for all fields except psychology. In most fields, a smaller proportion of doctorates were self-supporting (family support, loans, nonacademic earnings) in Research I than in other institutions. Hence, on balance, a greater share of black doctorates than white doctorates were self-supporting (Ehrenberg 1991, ch. 9).

These results suggest that increased financial support for black students contemplating doctoral study may prove to be an effective way of expanding the number of black doctorates. Both the federal and state governments and a number of universities and private foundations have, in fact, recently expanded, or introduced, doctoral fellowship programs for minority students.[41]

It is also important to stress that Shapiro, O'Malley, and Litten (1991) found that having a precollege interest in a career in higher education significantly increased the probability that graduates from COFHE institutions enrolled in graduate school. No analyses were undertaken of how such interest varies by race and ethnicity. Nevertheless, because the socioeconomic distribution of black families differs from that of whites and because of the paucity of black (and other minority) "role models" among the professoriate, black students probably have less interest in, and familiarity with, academic careers. This suggests that programs that widen their exposure to academic life, such as targeted minority undergraduate research experiences, may also prove useful.[42]

V. *Concluding Remarks*

Policy decisions aimed at increasing the supply of doctorates should be guided by the findings of academic research. Throughout this essay I have stressed the usefulness of conventional economic choice models in analyzing individuals' decisions to undertake and complete doctoral study and the wide range of "eco-

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

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

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

nomic" variables that influence these decisions. The latter include earnings and employment opportunities, financial support for doctoral students, times-to-degrees, and undergraduate debt levels. Many of these variables can be influenced by policy makers at the governmental, foundation, and corporate levels, as well as by universities and the academic departments within them.

To say that these models are useful, however, is not to say that empirically they have provided us with enough information to make important policy decisions. This essay has repeatedly emphasized how imprecise our knowledge of key relationships is. It has also stressed the need for further research on a wide variety of topics. Rather than cataloging all these needs, I conclude with a brief discussion of three important examples. These are the determinants of enrollments in doctoral programs, the determinants of time-to-degree and completion rates, and the responsiveness of academic institutions to changes in federal financial support of doctoral students.

Some twenty years after Richard Freeman's (1971) seminal work on doctoral labor supply, virtually all researchers studying the topic persist in analyzing aggregate time-series data by field, or pooled across fields. As discussed in Section III, such studies do not permit consideration of many important variables that influence postgraduate decisions, their small sample sizes do not permit precise estimates to be obtained and the lack of data for the humanities has prevented them from analyzing response in the humanities to policy variables. The aggregate data also do not permit analyses of differences in responses by students of different ability levels and different race/ethnic groups, as well as the extent to which loan burdens deter, or postpone, entry into doctoral study.

It is time for scholars pursuing research on doctoral study decisions to shift methodological approaches and use individual level data. Existing representative national data sets, such as the *National Longitudinal Survey of Youths*, the *National Longitudinal Survey of the Class of 1972*, and *High School and Beyond* have proved extremely useful in analyzing college-going behavior (see Clotfelter 1991). However, these data sets are of less use in analyzing doctoral study decisions because each contains in its sample relatively few individuals who ultimately graduate from college and enter doctoral programs. Rather, what is required is a national sample survey of college graduates that is repeated periodically. Such an approach would allow analyses of the effects of individual, family, and institutional characteristics on doctoral study decisions. Moreover, because the survey would be periodically repeated, information on labor market conditions and the characteristics of doctoral programs (e.g., policy variables such as the availability of financial support, and time-to-degree) could be incorporated into the data.

Shapiro, O'Malley, and Litten's (1991) study discussed in Section III, which analyzed data collected from graduating seniors in 1982, 1984, and 1989 from elite COFHE institutions, is a step in the right direction. However, its analyses failed to include any labor market conditions (e.g., starting salaries, academic employment probabilities) or doctoral program characteristics (e.g., nature of financial support) as explanatory variables. In addition, this type of study needs to be extended to encompass a wider range of institutions and a larger number of years.

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

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

The need for information on noncompleters limits the usefulness of the annual *Survey of Earned Doctorates* for studies of time-to-degree. It would be more useful if the *SED* were extended to include data on noncompleters, possibly by surveys administered by the National Research Council.[43] The *SED* also contains no information on students' ability levels (as measured by GRE scores) and without the addition of such data its usefulness is further limited.

Finally, knowledge of the effects of the level and types (fellowship, research assistant, teaching assistant) of financial support on the number of students entering doctoral programs, their completion rates, and their average times to degree is not sufficient to analyze fully the likely effects of an increase in external support for doctoral students on doctoral labor supply. One also needs to know how universities will respond to changes in the external environment they face. Will changes in external funding for doctoral student support induce institutions to alter their own support levels? Will institutions respond to changes in external support by redirecting whatever level of their own financial resources that they expend in a way that partially frustrates the intent of policy changes? For example, will they respond to such changes by altering the distribution of their own support across academic fields or types (fellowship, research assistantship, or teaching assistantship) of support?

To answer such questions requires access to institutionally-based data sets that contain information by field on institutional and external support for graduate students, as well as on other factors that influence each field's demand for graduate students. To control for differences in unobserved variables across institutions and changes in federal policies over time, methods to analyze panel data and data for a number of years for each institution are required. Fortunately, such data are available and initial research on these issues indicates that institutions do respond to changes in external support for graduate students by altering the number of students they support on institutional funds, by altering their distribution of support across fields, and by altering their distribution of support across types (see Ehrenberg, Rees, and Dominic Brewer forthcoming).

[43] One might envision the NRC first surveying departments for names and addresses of dropouts and noncompleters and then surveying the latter directly.

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