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Chapter Title: Should Policies Be Pursued to Increase the Flow of New Doctorates

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

10.1 Would a Shortage of American Doctorates Really Matter?

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[b]Includes students from foreign institutions.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

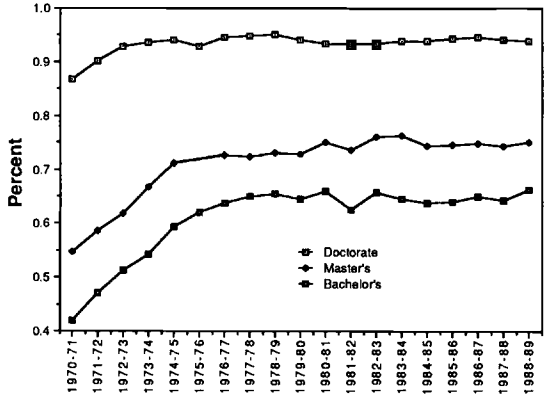

Figure 10.1 Proportion of mathematics department faculty with doctorates.
Source: Author's calculations from data contained in the "Annual AMS-MAA Survey (First Report)." *Notices of the American Mathematical Society* (various issues).
Note: Data for master's degree–granting institutions in 1975–76 appear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

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

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

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

Most of these studies of the doctorate/teaching evaluation relation are dated and suffer from not controlling for factors other than degree that might affect teaching ratings. This is an area that clearly warrants new research. At best, one must remain agnostic—one cannot really say if a reduction in the per-

centage of the faculty with doctorates at Liberal Arts II, Comprehensive II, and two-year institutions would have an adverse effect on the quality of instruction at these institutions.

10.2 Foreign Scholars and American-Trained Doctorates from Foreign Countries

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

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

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

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

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

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

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

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

[a]Percentages.

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

of these magnitudes would be significant contributions to the supply of academics to U.S. institutions.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Source: Cornell University, International Students and Scholars Office.

[a]Data not reported.

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

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

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

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

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

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

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

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

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

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

10.3 Will a Shortage of Doctorates Actually Materialize?

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

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

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

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

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

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

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

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

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

Table 10.6 ***Simulated Effects of Various Changes***

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

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

[a]Not applicable.

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

Similarly, about 8 and 4 percent of doctorates in the two age groups, respectively, who were employed in the nonacademic sector in 1985 had moved to the academic sector by 1987. Each of the factors mentioned above should encourage increased mobility of experienced doctorates from the nonacademic to the academic sector. If the two rates each increased by 3 percentage

points, approximately 4,800 more doctorates, or 2,400 annually, would move to the academic sector over a two-year period. Such a flow would be equivalent to a 16.8 percent increase in the annual flow of new citizen and permanent resident doctorates to academe (row 4).[17]

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

As noted in Chapter 6, all categories of institutions of higher education currently employ a significant share of faculty without doctoral degrees (Table 6.1). Whether a further substitution of nondoctorate for doctorate faculty will materialize depends, in part, on how institutions feel the increased usage of nondoctorate faculty would affect their institutional objectives. How important is it to various types of institutions to maintain the prestige that accrues from having a higher proportion of doctorates on their faculty (Garvin 1980)? Put another way, will the increased salaries that are likely to be commanded

by new doctorates actually induce the institutions that used the relatively loose academic labor markets of the last two decades to increase the share of their faculty with doctorates (Figure 10.1) now to decrease the share of their faculty with doctorates.

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

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

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

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

10.4 Implications for Future Research

Policy decisions aimed at increasing the supply of doctorates should be guided by the findings of academic research. Yet I have here repeatedly emphasized how imprecise our knowledge of key relations is. I have also stressed

the need for further research on a wide variety of topics. Rather than cataloging all these needs, I conclude with a brief discussion of four important examples. These are the determinants of enrollments in doctoral programs, the determinants of time to degree and completion rates, the responsiveness of academic institutions to changes in federal financial support of doctoral students, and the substitutability of nondoctorates for doctorates in the undergraduate educational process.

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

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

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

Both long times to degree and low probabilities of degree completion presumably discourage entry to doctoral programs. For policy purposes, we need to know the determinants of both. As with studies of doctorate supply, prior

studies of the determinants of time to degree have, in the main, also tended to use aggregate time-series data (e.g., Tuckman, Coyle, and Bae 1990). The numerous problems associated with such an approach were discussed in Chapter 8.

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

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

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

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

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

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

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

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

Appendix
Details of the Calculations in Table 10.6

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

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

Increasing the Share of CPR New Doctorates Entering Academe

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

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

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

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

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

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

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

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

Halving the Retirement Rate of Faculty Age 65–69

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

Increasing the Proportion of CPR Female College Graduates Receiving Doctorates

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

Reducing the Number of Doctorate Faculty by 5 Percent

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